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# lasio Documentation

*Release 0.24.1*

**Kent Inverarity**

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This is a Python 2/3 package to read and write Log ASCII Standard (LAS) files, used for borehole data such as geophysical, geological, or petrophysical logs. It's compatible with versions 1.2 and 2.0 of the LAS file specification, published by the [Canadian Well Logging Society](#). In principle it is designed to read as many types of LAS files as possible, including ones containing common errors or non-compliant formatting.

Depending on your particular application you may also want to check out [striplog](#) for stratigraphic/lithological data, or (still in alpha dev) [welly](#) for dealing with data at the well level. lasio is primarily for reading & writing LAS files.

Note this is *not* a package for reading LiDAR data (also called "LAS files").



# CHAPTER 1

---

## Installation

---

lasio is written to be compatible with Python 2.6+, and 3.2+. The best way to install is using pip.

```
(test) C:\Users\kent>pip install lasio
```

This will download and install lasio's dependencies ([numpy](#) and [ordereddict](#)).

There are some other packages which lasio will use to provide extra functionality if they are installed ([pandas](#), [cChardet](#) and/or [chardet](#), [openpyxl](#), and [argparse](#)). I recommend installing these too with:

```
(test) C:\Users\kent\Code\lasio>pip install -r optional-packages.txt
```

lasio is now installed. See the following pages for examples of how to use the package.

To upgrade to the latest PyPI version, use:

```
(test2) C:\Users\kent\Code\testing\lasio>pip install --upgrade lasio
```

## 1.1 Development version

Installing via pip gets the latest release which has been published on [PyPI](#).

The source code for lasio is kept at:

<https://github.com/kinverarity1/lasio>

Updates are made much more frequently to the master branch here. If you have Git installed, you can keep up to date with these changes:

```
(test2) C:\Users\kent\Code\testing>git clone https://github.com/kinverarity1/lasio
```

```
(test2) C:\Users\kent\Code\testing>cd lasio
```

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```
(test2) C:\Users\kent\Code\testing\lasio>pip install -r requirements.txt  
(test2) C:\Users\kent\Code\testing\lasio>python setup.py develop
```

To update your version with the latest changes on GitHub:

```
(test2) C:\Users\kent\Code\testing\lasio>git pull origin master
```

## 1.2 Testing

Every time `lasio` is updated, automated tests are run:

- [Travis CI](#): Linux, Python versions 2.7, 3.3, 3.4, 3.5, and 3.6.
-  [Appveyor CI](#): Windows, Python versions 2.7, 3.4, 3.5, and 3.6.

`lasio` should also work on Python 2.6 and 3.2, but these are tested only occasionally.

To run tests yourself, first install the testing framework and all the optional packages:

```
(test2) C:\Users\kent\Code\testing\lasio>pip install pytest  
(test2) C:\Users\kent\Code\testing\lasio>pip install -r optional-packages.txt
```

And then run tests:

```
(test2) C:\Users\kent\Code\testing\lasio>py.test
```

## CHAPTER 2

---

### Basic example

---

In the example below you can see how to:

- read a LAS file in
- look at the information in the header
- see basic curve information
- make a graph

```
In [29]: import lasio

In [30]: las = lasio.read(r"C:\Users\kent\Code\las\examples\2.0\49-005-30258.las")

In [31]: las.header
Out[31]:
{'Curves': [CurveItem(mnemonic=DEPT, unit=F, value=, descr=1 DEPTH, original_
↳mnemonic=DEPT, data.shape=(235,)),
  CurveItem(mnemonic=DT, unit=US/F, value=, descr=2 SONIC DELTA-T, original_
↳mnemonic=DT, data.shape=(235,)),
  CurveItem(mnemonic=RESD, unit=OHMM, value=, descr=3 DEEP RESISTIVITY, original_
↳mnemonic=RESD, data.shape=(235,)),
  CurveItem(mnemonic=SP, unit=MV, value=, descr=4 SP CURVE, original_mnemonic=SP,
↳data.shape=(235,)),
  CurveItem(mnemonic=GR, unit=GAPI, value=, descr=5 GAMMA RAY, original_mnemonic=GR,
↳data.shape=(235,))],
'Other': '',
'Parameter': [HeaderItem(mnemonic=BHT, unit=DEGF, value=194.0, descr=BOTTOM HOLE_
↳TEMPERATURE, original_mnemonic=BHT),
  HeaderItem(mnemonic=RMF, unit=OHMM, value=0.441, descr=MUD FILTRATE RESISTIVITY,
↳original_mnemonic=RMF),
  HeaderItem(mnemonic=RMFT, unit=DEGF, value=68.0, descr=MEASURE TEMPERATURE OF RMF,
↳original_mnemonic=RMFT),
  HeaderItem(mnemonic=EKB, unit=F, value=4642.0, descr=ELEVATION KELLY BUSHING,
↳original_mnemonic=EKB),
  HeaderItem(mnemonic=SECT, unit=, value=36, descr=SECTION, original_mnemonic=SECT),
```

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```

HeaderItem(mnemonic=TOWN, unit=, value=47N, descr=TOWNSHIP, original_mnemonic=TOWN),
HeaderItem(mnemonic=RANG, unit=, value=71W, descr=RANGE, original_mnemonic=RANG)],
'Version': [HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS log ASCII,
↳Standard - Version 2.0, original_mnemonic=VERS),
HeaderItem(mnemonic=WRAP, unit=, value=NO, descr=One Line per Depth Step, original_
↳mnemonic=WRAP),
HeaderItem(mnemonic=CREA, unit=, value=02-08-2006, descr=LAS File Creation Date (MM-
↳DD-YYYY), original_mnemonic=CREA)],
'Well': [HeaderItem(mnemonic=STRT, unit=F, value=10180.0, descr=START DEPTH,
↳original_mnemonic=STRT),
HeaderItem(mnemonic=STOP, unit=F, value=10414.0, descr=STOP DEPTH, original_
↳mnemonic=STOP),
HeaderItem(mnemonic=STEP, unit=F, value=1.0, descr=STEP, original_mnemonic=STEP),
HeaderItem(mnemonic=NULL, unit=, value=-999.25, descr=NULL VALUE, original_
↳mnemonic=NULL),
HeaderItem(mnemonic=COMP, unit=, value=Cramer Oil, descr=COMPANY, original_
↳mnemonic=COMP),
HeaderItem(mnemonic=WELL, unit=, value=#36-16 State, descr=WELL, original_
↳mnemonic=WELL),
HeaderItem(mnemonic=LOC, unit=, value=SE SE 36-47N-71W, descr=LOCATION, original_
↳mnemonic=LOC),
HeaderItem(mnemonic=CNTY, unit=, value=Campbell, descr=COUNTY, original_
↳mnemonic=CNTY),
HeaderItem(mnemonic=FLD, unit=, value=, descr=FIELD, original_mnemonic=FLD),
HeaderItem(mnemonic=STAT, unit=, value=Wyoming, descr=STATE, original_
↳mnemonic=STAT),
HeaderItem(mnemonic=CTRY, unit=, value=U.S.A., descr=COUNTRY, original_
↳mnemonic=CTRY),
HeaderItem(mnemonic=DATE, unit=, value=11/91, descr=COMPLETION DATE (MM/YY),
↳original_mnemonic=DATE),
HeaderItem(mnemonic=API, unit=, value=49-005-30258-0000, descr=API NUMBER, original_
↳mnemonic=API),
HeaderItem(mnemonic=SRVC, unit=, value=, descr=SERVICE COMPANY, original_
↳mnemonic=SRVC)]}]

```

```
In [33]: type(las.data)
```

```
Out[33]: numpy.ndarray
```

```
In [34]: las.data.shape
```

```
Out[34]: (235, 5)
```

```
In [35]: for curve in las.curves:
...:     print(curve.mnemonic)
...:     print(curve.unit)
...:     print(curve.data)
...:     print("\n")
...:
DEPT
F

```

```

[ 10180.  10181.  10182.  10183.  10184.  10185.  10186.  10187.  10188.
  10189.  10190.  10191.  10192.  10193.  10194.  10195.  10196.  10197.
  10198.  10199.  10200.  10201.  10202.  10203.  10204.  10205.  10206.
  10207.  10208.  10209.  10210.  10211.  10212.  10213.  10214.  10215.
  10216.  10217.  10218.  10219.  10220.  10221.  10222.  10223.  10224.
  10225.  10226.  10227.  10228.  10229.  10230.  10231.  10232.  10233.
  10234.  10235.  10236.  10237.  10238.  10239.  10240.  10241.  10242.
  10243.  10244.  10245.  10246.  10247.  10248.  10249.  10250.  10251.

```

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```

10252. 10253. 10254. 10255. 10256. 10257. 10258. 10259. 10260.
10261. 10262. 10263. 10264. 10265. 10266. 10267. 10268. 10269.
10270. 10271. 10272. 10273. 10274. 10275. 10276. 10277. 10278.
10279. 10280. 10281. 10282. 10283. 10284. 10285. 10286. 10287.
10288. 10289. 10290. 10291. 10292. 10293. 10294. 10295. 10296.
10297. 10298. 10299. 10300. 10301. 10302. 10303. 10304. 10305.
10306. 10307. 10308. 10309. 10310. 10311. 10312. 10313. 10314.
10315. 10316. 10317. 10318. 10319. 10320. 10321. 10322. 10323.
10324. 10325. 10326. 10327. 10328. 10329. 10330. 10331. 10332.
10333. 10334. 10335. 10336. 10337. 10338. 10339. 10340. 10341.
10342. 10343. 10344. 10345. 10346. 10347. 10348. 10349. 10350.
10351. 10352. 10353. 10354. 10355. 10356. 10357. 10358. 10359.
10360. 10361. 10362. 10363. 10364. 10365. 10366. 10367. 10368.
10369. 10370. 10371. 10372. 10373. 10374. 10375. 10376. 10377.
10378. 10379. 10380. 10381. 10382. 10383. 10384. 10385. 10386.
10387. 10388. 10389. 10390. 10391. 10392. 10393. 10394. 10395.
10396. 10397. 10398. 10399. 10400. 10401. 10402. 10403. 10404.
10405. 10406. 10407. 10408. 10409. 10410. 10411. 10412. 10413.
10414.]

```

DT

US/F

```

[ 59.9 59.9 60.5 63.5 64.5 64.6 61.5 59.2 55.9 52.1 49.1 47.8
  47.2 47.2 48.5 49.6 48.3 46.9 46.6 46.8 46.7 47.8 51.2 51.6
  51.1 51.4 52.3 52.3 51.5 51.2 53.3 57.6 60.6 60.8 59.5 59.7
  61.1 61.6 61.8 62. 62.2 62.2 62.2 60.9 60.8 61.5 61.4 61.9
  63.2 64.4 62.6 61.4 61. 61.1 62.8 65.4 66.3 66.2 68.3 69.8
  70.6 72.4 74.2 74.3 71.5 63.5 60.1 65.2 68.2 66.4 63.2 63.4
  65.3 65.1 64.1 63.9 63.9 63.9 63.9 63.5 62.7 63.1 63.6 61.1
  58.4 58.1 58.1 57.7 57.1 56.6 56.8 59.5 61.3 61.9 61.9 62.1
  62.5 62.5 62.5 62.4 62. 60.7 57.5 56. 56. 57.8 60. 60.3
  60.2 59.9 60.4 60.9 61.4 61.4 56.1 51.2 48.4 48.5 49.8 49.8
  50. 50.9 50.5 47.9 46.3 46.1 46.4 46.4 45.8 45.9 46.5 46.7
  47.3 51.9 55.7 61.2 66.5 68.9 69.6 69.6 69.1 68. 66.9 66.7
  66.6 66. 65. 64.4 64. 64.6 64.7 64.4 64.4 65.5 67.4 69.3
  70.9 72.4 73.3 73.7 73.8 73.4 73.4 74.4 75.4 75.2 72.6 71.6
  72. 74.3 74.6 74.7 72.3 71.9 75.5 77.6 78.3 75.8 73.8 71.6
  69.3 67.1 65. 64. 63.8 63.9 65.1 65.5 64.3 64.4 66. 66.
  64.6 64.9 65. 62.6 60.4 59.3 59.3 62.6 63.6 61.5 61.7 62.3
  61.9 62.3 63.2 63.5 63.5 62.7 60. 57. 54. 49.1 47.2 46.7
  47.1 47.6 48.8 49.8 50.8 51.1 50.2 49. 48.4 50.6 50.7 50.4
  49.9 49.7 49.6 51.5 52.5 53.2 54.1]

```

RESD

OHMM

```

[ 2.20000000e+01 2.10000000e+01 1.97000000e+01 1.89000000e+01
  1.82000000e+01 1.80000000e+01 1.80000000e+01 2.10000000e+01
  2.90000000e+01 5.30000000e+01 3.90000000e+02 1.50100000e+03
  2.09300000e+03 1.67700000e+03 1.07700000e+03 7.65000000e+02
  5.64000000e+02 5.54000000e+02 4.87000000e+02 1.59000000e+02
  7.40000000e+01 5.70000000e+01 5.00000000e+01 4.80000000e+01
  4.80000000e+01 4.90000000e+01 5.60000000e+01 5.90000000e+01
  6.10000000e+01 5.20000000e+01 2.40000000e+01 1.75000000e+01
  1.54000000e+01 1.52000000e+01 1.52000000e+01 1.52000000e+01
  1.47000000e+01 1.29000000e+01 1.20000000e+01 1.10000000e+01

```

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|                |                |                 |                |
|----------------|----------------|-----------------|----------------|
| 1.06000000e+01 | 1.05000000e+01 | 1.05000000e+01  | 1.08000000e+01 |
| 1.11000000e+01 | 1.12000000e+01 | 1.07000000e+01  | 9.90000000e+00 |
| 9.30000000e+00 | 9.00000000e+00 | 9.40000000e+00  | 1.01000000e+01 |
| 1.02000000e+01 | 1.00000000e+01 | 8.00000000e+00  | 7.10000000e+00 |
| 6.50000000e+00 | 5.80000000e+00 | 5.00000000e+00  | 4.20000000e+00 |
| 3.60000000e+00 | 3.30000000e+00 | 3.20000000e+00  | 3.30000000e+00 |
| 4.00000000e+00 | 4.90000000e+00 | 5.40000000e+00  | 5.80000000e+00 |
| 6.20000000e+00 | 6.60000000e+00 | 7.60000000e+00  | 8.90000000e+00 |
| 1.01000000e+01 | 1.12000000e+01 | 1.24000000e+01  | 1.51000000e+01 |
| 1.66000000e+01 | 1.75000000e+01 | 1.80000000e+01  | 1.80000000e+01 |
| 1.80000000e+01 | 1.80000000e+01 | 1.90000000e+01  | 2.10000000e+01 |
| 2.30000000e+01 | 2.70000000e+01 | 3.00000000e+01  | 3.30000000e+01 |
| 3.50000000e+01 | 3.50000000e+01 | 3.00000000e+01  | 2.70000000e+01 |
| 2.30000000e+01 | 1.99000000e+01 | 1.89000000e+01  | 1.85000000e+01 |
| 1.94000000e+01 | 2.00000000e+01 | 2.00000000e+01  | 2.20000000e+01 |
| 2.40000000e+01 | 2.60000000e+01 | 3.00000000e+01  | 3.30000000e+01 |
| 3.40000000e+01 | 3.00000000e+01 | 2.80000000e+01  | 2.60000000e+01 |
| 2.60000000e+01 | 2.90000000e+01 | 3.40000000e+01  | 3.50000000e+01 |
| 3.90000000e+01 | 4.40000000e+01 | 6.60000000e+01  | 1.22000000e+02 |
| 2.48000000e+02 | 1.72400000e+03 | 2.03600000e+03  | 2.03600000e+03 |
| 2.05500000e+03 | 2.09300000e+03 | 2.11300000e+03  | 2.11300000e+03 |
| 2.11300000e+03 | 2.09300000e+03 | 1.63100000e+03  | 7.51000000e+02 |
| 2.50000000e+02 | 2.16000000e+02 | 1.99000000e+02  | 1.76000000e+02 |
| 1.30000000e+02 | 9.50000000e+01 | 6.90000000e+01  | 4.70000000e+01 |
| 3.10000000e+01 | 2.10000000e+01 | 1.75000000e+01  | 1.61000000e+01 |
| 1.61000000e+01 | 1.61000000e+01 | 1.75000000e+01  | 1.80000000e+01 |
| 1.83000000e+01 | 1.83000000e+01 | 1.83000000e+01  | 1.83000000e+01 |
| 1.82000000e+01 | 1.74000000e+01 | 1.63000000e+01  | 1.54000000e+01 |
| 1.40000000e+01 | 1.27000000e+01 | 1.10000000e+01  | 9.00000000e+00 |
| 7.50000000e+00 | 6.70000000e+00 | 6.10000000e+00  | 5.70000000e+00 |
| 5.60000000e+00 | 5.30000000e+00 | 5.00000000e+00  | 4.50000000e+00 |
| 4.00000000e+00 | 3.50000000e+00 | 3.20000000e+00  | 2.80000000e+00 |
| 2.50000000e+00 | 2.20000000e+00 | 1.94000000e+00  | 1.72000000e+00 |
| 1.59000000e+00 | 1.50000000e+00 | 1.43000000e+00  | 1.37000000e+00 |
| 1.34000000e+00 | 1.34000000e+00 | 1.38000000e+00  | 1.59000000e+00 |
| 2.00000000e+00 | 2.90000000e+00 | 3.30000000e+00  | 3.80000000e+00 |
| 4.50000000e+00 | 5.00000000e+00 | 5.30000000e+00  | 5.50000000e+00 |
| 5.60000000e+00 | 5.60000000e+00 | 5.70000000e+00  | 5.70000000e+00 |
| 5.70000000e+00 | 5.70000000e+00 | 5.80000000e+00  | 6.30000000e+00 |
| 7.20000000e+00 | 8.10000000e+00 | 8.30000000e+00  | 8.30000000e+00 |
| 8.10000000e+00 | 8.00000000e+00 | 8.80000000e+00  | 1.00000000e+01 |
| 1.01000000e+01 | 9.20000000e+00 | 8.60000000e+00  | 8.50000000e+00 |
| 9.40000000e+00 | 1.14000000e+01 | 1.48000000e+01  | 1.90000000e+01 |
| 4.00000000e+01 | 8.90000000e+01 | 1.34000000e+02  | 2.20000000e+02 |
| 1.93000000e+02 | 1.22000000e+02 | 9.60000000e+01  | 8.10000000e+01 |
| 7.50000000e+01 | 7.50000000e+01 | 9.70000000e+01  | 1.67000000e+02 |
| 3.15000000e+02 | 1.69300000e+03 | 1.87400000e+03  | 1.87400000e+03 |
| 1.87400000e+03 | 5.91000000e+02 | 2.08000000e+02  | 1.34000000e+02 |
| 1.16000000e+02 | 1.13000000e+02 | 1.56000000e+02] |                |
| SP             |                |                 |                |
| MV             |                |                 |                |
| [              | 45.6           | 49.             | 53.            |
|                | 73.7           | 75.7            | 76.7           |
|                | 75.9           | 74.7            | 73.7           |
|                | 42.9           | 37.9            | 34.5           |
|                | 55.6           | 58.4            | 62.5           |
|                | 77.1           | 77.5            | 77.5           |
|                | 71.1           | 67.3            | 63.7           |
|                | 31.7           | 30.1            | 28.5           |
|                | 58.4           | 62.5            | 64.7           |
|                | 77.5           | 77.5            | 77.5           |
|                | 67.3           | 63.7            | 60.6           |
|                | 30.1           | 27.2            | 26.            |
|                | 62.5           | 64.7            | 66.9           |
|                | 77.5           | 77.5            | 77.5           |
|                | 60.6           | 57.8            | 53.2           |
|                | 27.2           | 26.             | 24.4           |
|                | 66.9           | 69.3            | 71.3           |
|                | 77.5           | 77.1            | 76.5           |
|                | 57.8           | 53.2            | 48.2           |
|                | 26.            | 24.4            | 23.4           |

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|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 22.2  | 21.2  | 20.8  | 20.2  | 19.8  | 19.2  | 19.   | 19.   | 18.8  | 18.6  |
| 18.4  | 18.2  | 18.2  | 18.2  | 18.2  | 18.2  | 18.8  | 19.4  | 20.4  | 21.6  |
| 22.4  | 23.8  | 25.   | 26.4  | 28.   | 29.3  | 30.5  | 31.3  | 32.7  | 33.5  |
| 34.3  | 34.9  | 35.7  | 36.1  | 36.1  | 36.3  | 36.3  | 36.3  | 36.3  | 36.3  |
| 36.3  | 36.3  | 36.3  | 36.3  | 36.9  | 37.9  | 38.5  | 39.7  | 40.1  | 40.5  |
| 40.5  | 40.7  | 40.9  | 40.9  | 41.1  | 41.1  | 41.1  | 41.3  | 41.7  | 42.1  |
| 42.9  | 43.9  | 44.7  | 45.6  | 46.6  | 47.2  | 48.   | 48.6  | 50.2  | 51.2  |
| 52.8  | 54.2  | 55.2  | 56.   | 57.2  | 58.   | 59.   | 59.6  | 60.8  | 62.3  |
| 63.5  | 64.7  | 66.3  | 67.7  | 68.9  | 70.7  | 72.1  | 73.1  | 74.5  | 75.9  |
| 77.3  | 78.8  | 80.8  | 83.4  | 85.4  | 87.6  | 89.8  | 91.4  | 93.4  | 94.2  |
| 95.1  | 95.5  | 95.5  | 95.5  | 95.5  | 95.7  | 96.5  | 96.7  | 96.9  | 97.1  |
| 97.1  | 96.7  | 95.9  | 95.1  | 94.8  | 94.8  | 94.8  | 94.8  | 95.5  | 96.3  |
| 97.1  | 98.1  | 99.1  | 99.5  | 99.9  | 100.1 | 100.1 | 100.1 | 99.9  | 99.9  |
| 100.1 | 101.9 | 102.1 | 103.9 | 104.9 | 105.7 | 106.1 | 106.3 | 106.5 | 106.5 |
| 106.5 | 106.5 | 106.5 | 105.9 | 105.3 | 104.7 | 104.7 | 104.5 | 104.5 | 104.5 |
| 104.5 | 104.7 | 105.9 | 106.9 | 109.1 | 109.7 | 108.7 | 107.9 | 107.3 | 106.9 |
| 106.7 | 106.7 | 106.5 | 105.9 | 105.1 | 102.7 | 87.6  | 78.8  | 76.5  | 76.5  |
| 76.5  | 76.5  | 76.5  | 76.5  | 75.5  | 74.1  | 72.1  | 70.5  | 68.9  | 67.5  |
| 66.7  | 65.7  | 65.1  | 64.1  | 63.3  | 63.1  | 62.7  | 62.5  | 62.5  | 62.5  |
| 62.5  | 62.5  | 62.9  | 64.3  | 65.9] |       |       |       |       |       |

GR

GAPI

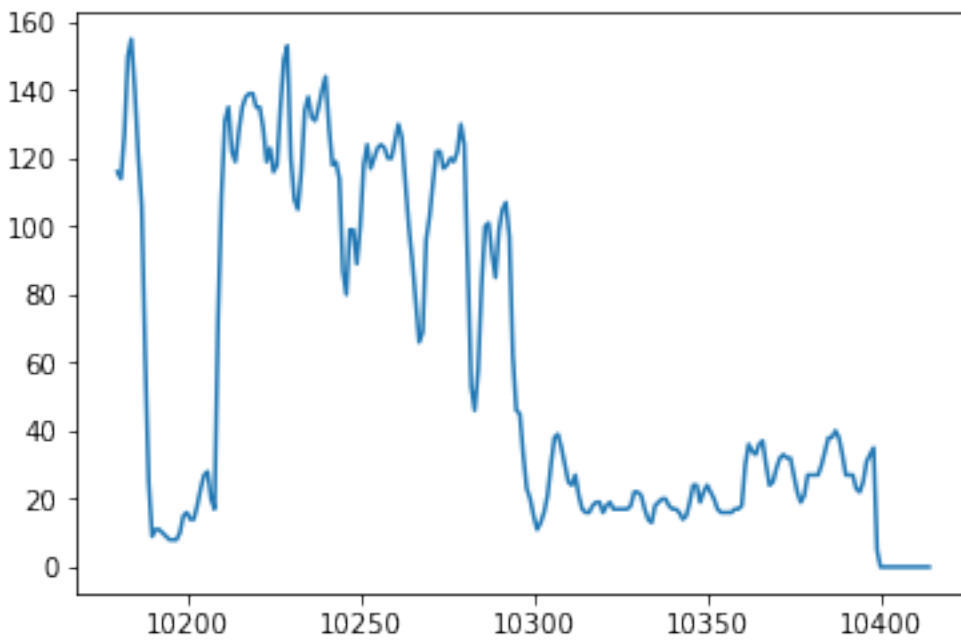
[ 116. 114. 127. 150. 155. 140. 121. 106. 62. 25. 9. 11.  
11. 10. 9. 8. 8. 8. 10. 15. 16. 14. 14. 18.  
23. 27. 28. 20. 17. 72. 109. 131. 135. 122. 119. 128.  
135. 138. 139. 139. 135. 135. 129. 119. 123. 116. 118. 135.  
149. 153. 120. 108. 105. 116. 134. 138. 132. 131. 135. 140.  
144. 129. 118. 119. 114. 87. 80. 99. 99. 89. 100. 118.  
124. 117. 120. 123. 124. 123. 120. 120. 125. 130. 126. 113.  
100. 90. 78. 66. 69. 96. 103. 113. 122. 122. 117. 118.  
120. 119. 122. 130. 124. 87. 53. 46. 58. 83. 100. 101.  
92. 85. 99. 105. 107. 97. 62. 46. 45. 33. 23. 20.  
15. 11. 13. 16. 21. 30. 38. 39. 35. 30. 25. 24.  
27. 21. 17. 16. 16. 18. 19. 19. 16. 18. 19. 17.  
17. 17. 17. 17. 18. 22. 22. 21. 17. 14. 13. 18.  
19. 20. 20. 18. 17. 17. 16. 14. 15. 19. 24. 24.  
19. 22. 24. 22. 20. 17. 16. 16. 16. 16. 17. 17.  
18. 30. 36. 34. 33. 36. 37. 30. 24. 25. 29. 32.  
33. 32. 32. 27. 22. 19. 21. 27. 27. 27. 27. 30.  
34. 38. 38. 40. 38. 33. 27. 27. 27. 23. 22. 25.  
31. 33. 35. 5. 0. 0. 0. 0. 0. 0. 0. 0.  
0. 0. 0. 0. 0. 0. 0.]

In [36]: import matplotlib.pyplot as plt

In [37]: %matplotlib inline

In [38]: plt.plot(las.index, las["GR"])

Out[38]: [<matplotlib.lines.Line2D at 0xb9dc1d0>]



---

## Integration with pandas.DataFrame

---

The `lasio.LASFile.df()` method converts the LAS data to a `pandas.DataFrame`.

Any changes that you make to the `DataFrame` can be brought back into the `LASFile` object with `lasio.LASFile.set_data()`.

```
In [168]: las = lasio.read('tests/examples/6038187_v1.2.las')
In [169]: df = las.df()
```

There are some summary methods handy for data exploration:

```
In [170]: df.head(10)
Out[170]:
```

|      | CALI   | DFAR  | DNEAR | GAMN     | NEUT | PR      | SP     | COND     |
|------|--------|-------|-------|----------|------|---------|--------|----------|
| DEPT |        |       |       |          |      |         |        |          |
| 0.05 | 49.765 | 4.587 | 3.382 | NaN      | NaN  | NaN     | NaN    | NaN      |
| 0.10 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.15 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.20 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.25 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.30 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.35 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.40 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.45 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |
| 0.50 | 49.765 | 4.587 | 3.382 | -2324.28 | NaN  | 115.508 | -3.049 | -116.998 |

```
In [171]: df.tail(40)
Out[171]:
```

|        | CALI    | DFAR  | DNEAR | GAMN     | NEUT  | PR      | SP     | COND    |
|--------|---------|-------|-------|----------|-------|---------|--------|---------|
| DEPT   |         |       |       |          |       |         |        |         |
| 134.65 | 100.983 | 1.563 | 1.357 | -2324.28 | 158.0 | 115.508 | -3.049 | 578.643 |
| 134.70 | 100.833 | 1.570 | 1.357 | NaN      | NaN   | NaN     | NaN    | 571.233 |
| 134.75 | 93.760  | 1.582 | 1.378 | NaN      | NaN   | NaN     | NaN    | 565.552 |
| 134.80 | 88.086  | 1.561 | 1.361 | NaN      | NaN   | NaN     | NaN    | 570.490 |

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|        |         |       |       |     |     |     |     |         |
|--------|---------|-------|-------|-----|-----|-----|-----|---------|
| 134.85 | 86.443  | 1.516 | 1.338 | NaN | NaN | NaN | NaN | 574.937 |
| 134.90 | 79.617  | 5.989 | 1.356 | NaN | NaN | NaN | NaN | 579.137 |
| 134.95 | 65.236  | 4.587 | 1.397 | NaN | NaN | NaN | NaN | NaN     |
| 135.00 | 55.833  | 4.587 | 1.351 | NaN | NaN | NaN | NaN | NaN     |
| 135.05 | 49.061  | 4.587 | 1.329 | NaN | NaN | NaN | NaN | NaN     |
| 135.10 | 49.036  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.15 | 49.024  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.20 | 49.005  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.25 | 48.999  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.30 | 48.987  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.35 | 48.980  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.40 | 48.962  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.45 | 48.962  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.50 | 48.925  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.55 | 48.931  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.60 | 48.919  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.65 | 48.900  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.70 | 48.882  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.75 | 48.863  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.80 | 48.857  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.85 | 48.839  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.90 | 48.808  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 135.95 | 48.802  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.00 | 48.789  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.05 | 48.771  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.10 | 48.765  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.15 | 48.752  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.20 | 48.734  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.25 | 48.684  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.30 | 48.666  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.35 | 48.647  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.40 | 48.604  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.45 | 48.555  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.50 | 48.555  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.55 | 48.438  | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |
| 136.60 | -56.275 | NaN   | NaN   | NaN | NaN | NaN | NaN | NaN     |

In [172]: df.describe()

Out [172]:

|       | CALI        | DFAR        | DNEAR       | GAMN         | NEUT \      |
|-------|-------------|-------------|-------------|--------------|-------------|
| count | 2732.000000 | 2701.000000 | 2701.000000 | 2691.000000  | 2492.000000 |
| mean  | 97.432002   | 1.767922    | 1.729209    | -102.330033  | 441.600013  |
| std   | 13.939547   | 0.480333    | 0.372412    | 630.106420   | 370.138208  |
| min   | -56.275000  | 0.725000    | 0.657001    | -2324.280000 | 81.001800   |
| 25%   | 101.077500  | 1.526000    | 1.535000    | 55.783000    | 158.002000  |
| 50%   | 101.426000  | 1.758000    | 1.785000    | 74.376900    | 256.501500  |
| 75%   | 101.582000  | 1.993000    | 1.948000    | 88.326900    | 680.500250  |
| max   | 103.380000  | 5.989000    | 3.382000    | 169.672000   | 1665.990000 |

|       | PR           | SP          | COND        |
|-------|--------------|-------------|-------------|
| count | 2692.000000  | 2692.000000 | 2697.000000 |
| mean  | 17940.522307 | 90.393464   | 478.670791  |
| std   | 22089.297212 | 26.725547   | 753.869866  |
| min   | 115.508000   | -3.049000   | -116.998000 |
| 25%   | 2652.470000  | 93.495500   | 200.981000  |
| 50%   | 2709.345000  | 99.994000   | 266.435000  |
| 75%   | 50499.900000 | 100.623000  | 505.530000  |

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```
max      50499.900000    102.902000    4978.160000
```

There's obviously a problem with the GAMN log: -2324.28 is not a valid value. Let's fix that.

```
In [44]: import numpy as np

In [173]: df['GAMN'][df['GAMN'] == -2324.28] = np.nan

In [174]: df.describe()['GAMN']
Out[174]:
count      2491.000000
mean         76.068198
std          23.120160
min          13.946000
25%          60.434100
50%          76.700700
75%          90.647500
max          169.672000
Name: GAMN, dtype: float64
```

Let's create a new log with the moving average of the GAMN log, over 1 m. This is easy enough to do with the pandas `pandas.Series.rolling()` method and the LAS file's STEP value:

```
In [175]: df['GAMN_avg'] = df['GAMN'].rolling(int(1 / las.well.STEP.value),
↪center=True).mean()
```

Now we want to apply this DataFrame `df` back to the `las` LASFile object, and check that it's all there:

```
In [176]: las.set_data(df)

In [177]: las.curves
Out[177]:
[CurveItem(mnemonic=DEPT, unit=M, value=, descr=DEPTH, original_mnemonic=DEPT, data.
↪shape=(2732,)),
 CurveItem(mnemonic=CALI, unit=MM, value=, descr=CALI, original_mnemonic=CALI, data.
↪shape=(2732,)),
 CurveItem(mnemonic=DFAR, unit=G/CM3, value=, descr=DFAR, original_mnemonic=DFAR,
↪data.shape=(2732,)),
 CurveItem(mnemonic=DNEAR, unit=G/CM3, value=, descr=DNEAR, original_mnemonic=DNEAR,
↪data.shape=(2732,)),
 CurveItem(mnemonic=GAMN, unit=GAPI, value=, descr=GAMN, original_mnemonic=GAMN, data.
↪shape=(2732,)),
 CurveItem(mnemonic=NEUT, unit=CPS, value=, descr=NEUT, original_mnemonic=NEUT, data.
↪shape=(2732,)),
 CurveItem(mnemonic=PR, unit=OHM/M, value=, descr=PR, original_mnemonic=PR, data.
↪shape=(2732,)),
 CurveItem(mnemonic=SP, unit=MV, value=, descr=SP, original_mnemonic=SP, data.
↪shape=(2732,)),
 CurveItem(mnemonic=COND, unit=MS/M, value=, descr=COND, original_mnemonic=COND, data.
↪shape=(2732,)),
 CurveItem(mnemonic=GAMN_avg, unit=, value=, descr=, original_mnemonic=GAMN_avg, data.
↪shape=(2732,))]

In [178]: las.df().describe()
Out[178]:
```

|  |      |      |       |      |      |   |
|--|------|------|-------|------|------|---|
|  | CALI | DFAR | DNEAR | GAMN | NEUT | \ |
|--|------|------|-------|------|------|---|

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|       |             |             |             |             |             |
|-------|-------------|-------------|-------------|-------------|-------------|
| count | 2732.000000 | 2701.000000 | 2701.000000 | 2491.000000 | 2492.000000 |
| mean  | 97.432002   | 1.767922    | 1.729209    | 76.068198   | 441.600013  |
| std   | 13.939547   | 0.480333    | 0.372412    | 23.120160   | 370.138208  |
| min   | -56.275000  | 0.725000    | 0.657001    | 13.946000   | 81.001800   |
| 25%   | 101.077500  | 1.526000    | 1.535000    | 60.434100   | 158.002000  |
| 50%   | 101.426000  | 1.758000    | 1.785000    | 76.700700   | 256.501500  |
| 75%   | 101.582000  | 1.993000    | 1.948000    | 90.647500   | 680.500250  |
| max   | 103.380000  | 5.989000    | 3.382000    | 169.672000  | 1665.990000 |

|       |              |             |             |             |
|-------|--------------|-------------|-------------|-------------|
|       | PR           | SP          | COND        | GAMN_avg    |
| count | 2692.000000  | 2692.000000 | 2697.000000 | 2472.000000 |
| mean  | 17940.522307 | 90.393464   | 478.670791  | 76.326075   |
| std   | 22089.297212 | 26.725547   | 753.869866  | 18.208038   |
| min   | 115.508000   | -3.049000   | -116.998000 | 24.753655   |
| 25%   | 2652.470000  | 93.495500   | 200.981000  | 64.848379   |
| 50%   | 2709.345000  | 99.994000   | 266.435000  | 77.747517   |
| 75%   | 50499.900000 | 100.623000  | 505.530000  | 88.323376   |
| max   | 50499.900000 | 102.902000  | 4978.160000 | 120.049300  |

All good, the new curve is in there.

See the [pandas documentation](#) for more information!

---

## Header section metadata

---

### 4.1 Tutorial

One of the primary motivations in writing lasio was to be able to reliably parse LAS header sections. This is working fairly well for LAS 1.2 and 2.0 files, and lasio does not require LAS files to be strictly compliant with either standard.

```
In [179]: import lasio
In [180]: las = lasio.read('tests/examples/6038187_v1.2_short.las')
```

The header sections are stored in the dictionary `las.sections`:

```
In [206]: type(las.sections)
Out[206]: dict

In [207]: las.sections.keys()
Out[207]: dict_keys(['Version', 'Well', 'Curves', 'Parameter', 'Other'])
```

These are special names reserved for LAS 1.2 and 2.0 files, as defined by the standard. Non-standard header sections are also allowed but not fully parsed.

| LAS file       | Read in as                                | References in LASFile                                                                |
|----------------|-------------------------------------------|--------------------------------------------------------------------------------------|
| ~v or ~V       | <code>lasio.las_items.SectionItems</code> | <code>LASFile.version</code> and <code>LASFile.sections['Version']</code>            |
| ~w or ~W       | <code>lasio.las_items.SectionItems</code> | <code>LASFile.well</code> and <code>LASFile.sections['Well']</code>                  |
| ~c or ~C       | <code>lasio.las_items.SectionItems</code> | <code>LASFile.curves</code> and <code>LASFile.sections['Curves']</code>              |
| ~p or ~P       | <code>lasio.las_items.SectionItems</code> | <code>LASFile.params</code> and <code>LASFile.sections['Parameter']</code>           |
| ~o or ~O       | <code>str</code>                          | <code>LASFile.other</code> and <code>LASFile.sections['Other']</code>                |
| ~extra section | <code>str</code>                          | <code>LASFile.sections['extra section']</code>                                       |
| ~a or ~A       | <code>numpy.ndarray</code>                | <code>LASFile.data</code> or each column is in <code>LASFile.curves[...].data</code> |

For example:

```
In [208]: las.sections['Version']
Out[208]: [HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS LOG ASCII STANDARD - VERSION,
↳2.0, original_mnemonic=VERS),
HeaderItem(mnemonic=WRAP, unit=, value=NO, descr=ONE LINE PER DEPTH STEP, original_
↳mnemonic=WRAP)]

In [182]: las.version
Out[182]: [HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS LOG ASCII STANDARD - VERSION,
↳2.0, original_mnemonic=VERS),
HeaderItem(mnemonic=WRAP, unit=, value=NO, descr=ONE LINE PER DEPTH STEP, original_
↳mnemonic=WRAP)]
```

Sections themselves are represented by `lasio.las_items.SectionItems` objects. This is a list which has been extended to allow you to access the items within by their mnemonic:

```
In [209]: las.version.VERS
Out[209]: HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS LOG ASCII STANDARD -
↳VERSION 2.0, original_mnemonic=VERS)

In [210]: las.version['VERS']
Out[210]: HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS LOG ASCII STANDARD -
↳VERSION 2.0, original_mnemonic=VERS)

In [211]: las.version[0]
Out[211]: HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS LOG ASCII STANDARD -
↳VERSION 2.0, original_mnemonic=VERS)

In [212]: id(Out[209]), id(Out[210]), id(Out[211])
Out[212]: (250964032, 250964032, 250964032)
```

As you can see, either attribute-style or item-style access is fine - with one exception, see below.

Let's take a look at the next special section, ~W:

```
In [188]: las.well
Out[188]:
```

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```
[HeaderItem(mnemonic=STRT, unit=M, value=0.05, descr=FIRST INDEX VALUE, original_
↳mnemonic=STRT),
HeaderItem(mnemonic=STOP, unit=M, value=136.6, descr=LAST INDEX VALUE, original_
↳mnemonic=STOP),
HeaderItem(mnemonic=STEP, unit=M, value=0.05, descr=STEP, original_mnemonic=STEP),
HeaderItem(mnemonic=NULL, unit=, value=-99999, descr=NULL VALUE, original_
↳mnemonic=NULL),
HeaderItem(mnemonic=COMP, unit=, value=, descr=COMP, original_mnemonic=COMP),
HeaderItem(mnemonic=WELL, unit=, value=Scorpio E1, descr=WELL, original_
↳mnemonic=WELL),
HeaderItem(mnemonic=FLD, unit=, value=, descr=, original_mnemonic=FLD),
HeaderItem(mnemonic=LOC, unit=, value=Mt Eba, descr=LOC, original_mnemonic=LOC),
HeaderItem(mnemonic=SRVC, unit=, value=, descr=, original_mnemonic=SRVC),
HeaderItem(mnemonic=CTRY, unit=, value=, descr=, original_mnemonic=CTRY),
HeaderItem(mnemonic=STAT, unit=, value=SA, descr=STAT, original_mnemonic=STAT),
HeaderItem(mnemonic=CNTY, unit=, value=, descr=, original_mnemonic=CNTY),
HeaderItem(mnemonic=DATE, unit=, value=15/03/2015, descr=DATE, original_
↳mnemonic=DATE),
HeaderItem(mnemonic=UWI, unit=, value=6038-187, descr=WUNT, original_mnemonic=UWI)]
```

The CTRY item is blank. We will set it:

```
In [190]: las.well.CTRY = 'Australia'

In [191]: las.well.CTRY
Out[191]: HeaderItem(mnemonic=CTRY, unit=, value=Australia, descr=, original_
↳mnemonic=CTRY)
```

Notice that `SectionItems` plays a little trick here. It actually sets the `header_item.value` attribute, instead of replacing the entire `HeaderItem` object.

You can set any of the attributes directly. Let's take an example from the `~C` section:

```
In [192]: las.curves
Out[192]:
[CurveItem(mnemonic=DEPT, unit=M, value=, descr=DEPTH, original_mnemonic=DEPT, data.
↳shape=(121,)),
CurveItem(mnemonic=CALI, unit=MM, value=, descr=CALI, original_mnemonic=CALI, data.
↳shape=(121,)),
CurveItem(mnemonic=DFAR, unit=G/CM3, value=, descr=DFAR, original_mnemonic=DFAR,
↳data.shape=(121,)),
CurveItem(mnemonic=DNEAR, unit=G/CM3, value=, descr=DNEAR, original_mnemonic=DNEAR,
↳data.shape=(121,)),
CurveItem(mnemonic=GAMN, unit=GAPI, value=, descr=GAMN, original_mnemonic=GAMN, data.
↳shape=(121,)),
CurveItem(mnemonic=NEUT, unit=CPS, value=, descr=NEUT, original_mnemonic=NEUT, data.
↳shape=(121,)),
CurveItem(mnemonic=PR, unit=OHM/M, value=, descr=PR, original_mnemonic=PR, data.
↳shape=(121,)),
CurveItem(mnemonic=SP, unit=MV, value=, descr=SP, original_mnemonic=SP, data.
↳shape=(121,)),
CurveItem(mnemonic=COND, unit=MS/M, value=, descr=COND, original_mnemonic=COND, data.
↳shape=(121,)))]

In [193]: las.curves.PR.unit = 'ohmm'

In [194]: las.curves.PR
```

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```
Out [194]: CurveItem(mnemonic=PR, unit=ohmm, value=, descr=PR, original_mnemonic=PR,
↳data.shape=(121,))
```

Now let's look more closely at how to manipulate and add or remove items from a section.

```
In [195]: las.params
Out [195]:
[HeaderItem(mnemonic=BS, unit=, value=216 mm, descr=BS, original_mnemonic=BS),
 HeaderItem(mnemonic=JOBN, unit=, value=, descr=JOBN, original_mnemonic=JOBN),
 HeaderItem(mnemonic=WPMT, unit=, value=, descr=WPMT, original_mnemonic=WPMT),
 HeaderItem(mnemonic=AGL, unit=, value=, descr=AGL, original_mnemonic=AGL),
 HeaderItem(mnemonic=PURP, unit=, value=Cased hole stratigraphy, descr=PURP, original_
↳mnemonic=PURP),
 HeaderItem(mnemonic=X, unit=, value=560160, descr=X, original_mnemonic=X),
 HeaderItem(mnemonic=CSGL, unit=, value=0 m - 135 m, descr=CSGL, original_
↳mnemonic=CSGL),
 HeaderItem(mnemonic=UNIT, unit=, value=, descr=UNIT, original_mnemonic=UNIT),
 HeaderItem(mnemonic=Y, unit=, value=6686430, descr=Y, original_mnemonic=Y),
 HeaderItem(mnemonic=TDL, unit=, value=135.2 m, descr=TDL, original_mnemonic=TDL),
 HeaderItem(mnemonic=PROD, unit=, value=, descr=PROD, original_mnemonic=PROD),
 HeaderItem(mnemonic=MUD, unit=, value=Water, descr=MUD, original_mnemonic=MUD),
 HeaderItem(mnemonic=CSGS, unit=, value=100 mm, descr=CSGS, original_mnemonic=CSGS),
 HeaderItem(mnemonic=ENG, unit=, value=, descr=ENG, original_mnemonic=ENG),
 HeaderItem(mnemonic=STEP, unit=, value=5 cm, descr=STEP, original_mnemonic=STEP),
 HeaderItem(mnemonic=FluidLevel, unit=, value=54 m, descr=FluidLevel, original_
↳mnemonic=FluidLevel),
 HeaderItem(mnemonic=CSGT, unit=, value=PVC, descr=CSGT, original_mnemonic=CSGT),
 HeaderItem(mnemonic=WIT, unit=, value=, descr=WIT, original_mnemonic=WIT),
 HeaderItem(mnemonic=EREF, unit=, value=, descr=EREF, original_mnemonic=EREF),
 HeaderItem(mnemonic=PROJ, unit=, value=, descr=PROJ, original_mnemonic=PROJ),
 HeaderItem(mnemonic=ZONE, unit=, value=53J, descr=ZONE, original_mnemonic=ZONE),
 HeaderItem(mnemonic=DREF, unit=, value=GL, descr=DREF, original_mnemonic=DREF),
 HeaderItem(mnemonic=TDD, unit=, value=136 m, descr=TDD, original_mnemonic=TDD)]
```

We want to rename the DREF mnemonic as LMF. We can do so by changing the `header_item.mnemonic` attribute.

```
In [197]: las.params.DREF.mnemonic = 'LMF'
In [198]: las.params
Out [198]:
[HeaderItem(mnemonic=BS, unit=, value=216 mm, descr=BS, original_mnemonic=BS),
 HeaderItem(mnemonic=JOBN, unit=, value=, descr=JOBN, original_mnemonic=JOBN),
 HeaderItem(mnemonic=WPMT, unit=, value=, descr=WPMT, original_mnemonic=WPMT),
 HeaderItem(mnemonic=AGL, unit=, value=, descr=AGL, original_mnemonic=AGL),
 HeaderItem(mnemonic=PURP, unit=, value=Cased hole stratigraphy, descr=PURP, original_
↳mnemonic=PURP),
 HeaderItem(mnemonic=X, unit=, value=560160, descr=X, original_mnemonic=X),
 HeaderItem(mnemonic=CSGL, unit=, value=0 m - 135 m, descr=CSGL, original_
↳mnemonic=CSGL),
 HeaderItem(mnemonic=UNIT, unit=, value=, descr=UNIT, original_mnemonic=UNIT),
 HeaderItem(mnemonic=Y, unit=, value=6686430, descr=Y, original_mnemonic=Y),
 HeaderItem(mnemonic=TDL, unit=, value=135.2 m, descr=TDL, original_mnemonic=TDL),
 HeaderItem(mnemonic=PROD, unit=, value=, descr=PROD, original_mnemonic=PROD),
 HeaderItem(mnemonic=MUD, unit=, value=Water, descr=MUD, original_mnemonic=MUD),
 HeaderItem(mnemonic=CSGS, unit=, value=100 mm, descr=CSGS, original_mnemonic=CSGS),
```

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```
HeaderItem(mnemonic=ENG, unit=, value=, descr=ENG, original_mnemonic=ENG),
HeaderItem(mnemonic=STEP, unit=, value=5 cm, descr=STEP, original_mnemonic=STEP),
HeaderItem(mnemonic=FluidLevel, unit=, value=54 m, descr=FluidLevel, original_
↳mnemonic=FluidLevel),
HeaderItem(mnemonic=CSGT, unit=, value=PVC, descr=CSGT, original_mnemonic=CSGT),
HeaderItem(mnemonic=WIT, unit=, value=, descr=WIT, original_mnemonic=WIT),
HeaderItem(mnemonic=EREF, unit=, value=, descr=EREF, original_mnemonic=EREF),
HeaderItem(mnemonic=PROJ, unit=, value=, descr=PROJ, original_mnemonic=PROJ),
HeaderItem(mnemonic=ZONE, unit=, value=53J, descr=ZONE, original_mnemonic=ZONE),
HeaderItem(mnemonic=LMF, unit=, value=GL, descr=DREF, original_mnemonic=LMF),
HeaderItem(mnemonic=TDD, unit=, value=136 m, descr=TDD, original_mnemonic=TDD)]
```

And now we need to add a new mnemonic. Adding via an attribute **will not work**. You need to use the item-style access.

```
In [201]: las.params['DRILL'] = lasio.HeaderItem(mnemonic='DRILL', value='John Smith',
↳ descr='Driller on site')
```

```
In [202]: las.params
```

```
Out[202]:
```

```
[HeaderItem(mnemonic=BS, unit=, value=216 mm, descr=BS, original_mnemonic=BS),
HeaderItem(mnemonic=JOBN, unit=, value=, descr=JOBN, original_mnemonic=JOBN),
HeaderItem(mnemonic=WPMT, unit=, value=, descr=WPMT, original_mnemonic=WPMT),
HeaderItem(mnemonic=AGL, unit=, value=, descr=AGL, original_mnemonic=AGL),
HeaderItem(mnemonic=PURP, unit=, value=Cased hole stratigraphy, descr=PURP, original_
↳mnemonic=PURP),
HeaderItem(mnemonic=X, unit=, value=560160, descr=X, original_mnemonic=X),
HeaderItem(mnemonic=CSGL, unit=, value=0 m - 135 m, descr=CSGL, original_
↳mnemonic=CSGL),
HeaderItem(mnemonic=UNIT, unit=, value=, descr=UNIT, original_mnemonic=UNIT),
HeaderItem(mnemonic=Y, unit=, value=6686430, descr=Y, original_mnemonic=Y),
HeaderItem(mnemonic=TDL, unit=, value=135.2 m, descr=TDL, original_mnemonic=TDL),
HeaderItem(mnemonic=PROD, unit=, value=, descr=PROD, original_mnemonic=PROD),
HeaderItem(mnemonic=MUD, unit=, value=Water, descr=MUD, original_mnemonic=MUD),
HeaderItem(mnemonic=CSGS, unit=, value=100 mm, descr=CSGS, original_mnemonic=CSGS),
HeaderItem(mnemonic=ENG, unit=, value=, descr=ENG, original_mnemonic=ENG),
HeaderItem(mnemonic=STEP, unit=, value=5 cm, descr=STEP, original_mnemonic=STEP),
HeaderItem(mnemonic=FluidLevel, unit=, value=54 m, descr=FluidLevel, original_
↳mnemonic=FluidLevel),
HeaderItem(mnemonic=CSGT, unit=, value=PVC, descr=CSGT, original_mnemonic=CSGT),
HeaderItem(mnemonic=WIT, unit=, value=, descr=WIT, original_mnemonic=WIT),
HeaderItem(mnemonic=EREF, unit=, value=, descr=EREF, original_mnemonic=EREF),
HeaderItem(mnemonic=PROJ, unit=, value=, descr=PROJ, original_mnemonic=PROJ),
HeaderItem(mnemonic=ZONE, unit=, value=53J, descr=ZONE, original_mnemonic=ZONE),
HeaderItem(mnemonic=LMF, unit=, value=GL, descr=DREF, original_mnemonic=LMF),
HeaderItem(mnemonic=TDD, unit=, value=136 m, descr=TDD, original_mnemonic=TDD),
HeaderItem(mnemonic=DRILL, unit=, value=John Smith, descr=Driller on site, original_
↳mnemonic=DRILL)]
```

Bingo.

## 4.2 Handling errors

lasio will do its best to read every line from the header section. If it can make sense of it, it will parse it into a mnemonic, unit, value, and description.

However often there are problems in LAS files. For example, a header section might contain something like:

```
COUNTY: RUSSELL
```

(missing period, should be COUNTY. : RUSSELL). Or:

```
API      .                               : API Number      (required if_
↳ CTRY = US)
"# Surface Coords: 1,000' FNL & 2,000' FWL"
LATI     .DEG                           : Latitude   - see Surface Coords_
↳ comment above
LONG     .DEG                           : Longitude  - see Surface Coords_
↳ comment above
```

Obviously the line with " causes an error.

All these (and any other kind of error in the header section) can be turned from `LASHeaderError` exceptions into `logger.warning()` calls instead by using `lasio.read(..., ignore_header_errors=True)`.

Here is an example. First we try reading a file without this argument:

```
In [2]: las = lasio.read('tests/examples/dodgy_param_sect.las', ignore_header_
↳ errors=False)
-----
AttributeError                                Traceback (most recent call last)
~\Code\lasio\lasio\reader.py in parse_header_section(sectdict, version, ignore_header_
↳ errors, mnemonic_case)
    458         try:
--> 459             values = read_line(line)
    460         except:

~\Code\lasio\lasio\reader.py in read_line(*args, **kwargs)
    625     '''
--> 626     return read_header_line(*args, **kwargs)
    627

~\Code\lasio\lasio\reader.py in read_header_line(line, pattern)
    656     m = re.match(pattern, line)
--> 657     mdict = m.groupdict()
    658     for key, value in mdict.items():

AttributeError: 'NoneType' object has no attribute 'groupdict'

During handling of the above exception, another exception occurred:

LASHeaderError                                Traceback (most recent call last)
<ipython-input-2-3c0606fe7dc1> in <module>()
----> 1 las = lasio.read('tests/examples/dodgy_param_sect.las', ignore_header_
↳ errors=False)

~\Code\lasio\lasio\__init__.py in read(file_ref, **kwargs)
    41
    42     '''
--> 43     return LASFile(file_ref, **kwargs)

~\Code\lasio\lasio\las.py in __init__(self, file_ref, **read_kwargs)
    76
    77     if not (file_ref is None):
--> 78         self.read(file_ref, **read_kwargs)
```

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```

79
80     def read(self, file_ref,

~\Code\lasio\lasio\las.py in read(self, file_ref, ignore_data, read_policy, null_
→policy, ignore_header_errors, mnemonic_case, **kwargs)
185         add_section("~P", "Parameter", version=version,
186                     ignore_header_errors=ignore_header_errors,
--> 187                     mnemonic_case=mnemonic_case)
188         s = self.match_raw_section("~O")
189

~\Code\lasio\lasio\las.py in add_section(pattern, name, **sect_kws)
122         if raw_section:
123             self.sections[name] = reader.parse_header_section(raw_section,
--> 124                                                         **sect_kws)
125             drop.append(raw_section["title"])
126         else:

~\Code\lasio\lasio\reader.py in parse_header_section(sectdict, version, ignore_header_
→errors, mnemonic_case)
465             logger.warning(message)
466         else:
--> 467             raise exceptions.LASHeaderError(message)
468     else:
469         if mnemonic_case == 'upper':

LASHeaderError: line 31 (section ~PARAMETER INFORMATION): "DEPTH      DT      RHOB      _
→ NPHI      SFLU      SFLA      ILM      ILD"

```

Now if we use ignore\_header\_errors=True:

```

In [3]: las = lasio.read('tests/examples/dodgy_param_sect.las', ignore_header_
→errors=True)
line 31 (section ~PARAMETER INFORMATION): "DEPTH      DT      RHOB      NPHI      SFLU      _
→ SFLA      ILM      ILD"

In [4]: las.params
[]

In [5]: las.curves
Out[5]:
[CurveItem(mnemonic=DEPT, unit=M, value=, descr=1 DEPTH, original_mnemonic=DEPT, _
→data.shape=(3,)),
CurveItem(mnemonic=DT, unit=US/M, value=, descr=2 SONIC TRANSIT TIME, original_
→mnemonic=DT, data.shape=(3,)),
CurveItem(mnemonic=RHOB, unit=K/M3, value=, descr=3 BULK DENSITY, original_
→mnemonic=RHOB, data.shape=(3,)),
CurveItem(mnemonic=NPHI, unit=V/V, value=, descr=4 NEUTRON POROSITY, original_
→mnemonic=NPHI, data.shape=(3,)),
CurveItem(mnemonic=SFLU, unit=OHMM, value=, descr=5 RXO RESISTIVITY, original_
→mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=SFLA, unit=OHMM, value=, descr=6 SHALLOW RESISTIVITY, original_
→mnemonic=SFLA, data.shape=(3,)),
CurveItem(mnemonic=ILM, unit=OHMM, value=, descr=7 MEDIUM RESISTIVITY, original_
→mnemonic=ILM, data.shape=(3,)),
CurveItem(mnemonic=ILD, unit=OHMM, value=, descr=8 DEEP RESISTIVITY, original_
→mnemonic=ILD, data.shape=(3,))]

```

Only a warning is issued, and the rest of the LAS file loads OK.

## 4.3 Handling duplicate mnemonics

Take this LAS file as an example, containing this ~C section:

```
~CURVE INFORMATION
DEPT.M                : 1  DEPTH
DT  .US/M            : 2  SONIC TRANSIT TIME
RHOB.K/M3            : 3  BULK DENSITY
NPHI.V/V             : 4  NEUTRON POROSITY
RXO.OHMM             : 5  RXO RESISTIVITY
RES.OHMM             : 6  SHALLOW RESISTIVITY
RES.OHMM             : 7  MEDIUM RESISTIVITY
RES.OHMM             : 8  DEEP RESISTIVITY
```

Notice there are three curves with the mnemonic RES.

When we load the file in, lasio distinguishes between these duplicates:

```
In [2]: las = lasio.read('tests/examples/mnemonic_duplicate2.las')

In [3]: las.curves
Out[3]:
[CurveItem(mnemonic=DEPT, unit=M, value=, descr=1  DEPTH, original_mnemonic=DEPT, ↵
↵data.shape=(3,)),
CurveItem(mnemonic=DT, unit=US/M, value=, descr=2  SONIC TRANSIT TIME, original_
↵mnemonic=DT, data.shape=(3,)),
CurveItem(mnemonic=RHOB, unit=K/M3, value=, descr=3  BULK DENSITY, original_
↵mnemonic=RHOB, data.shape=(3,)),
CurveItem(mnemonic=NPHI, unit=V/V, value=, descr=4  NEUTRON POROSITY, original_
↵mnemonic=NPHI, data.shape=(3,)),
CurveItem(mnemonic=RXO, unit=OHMM, value=, descr=5  RXO RESISTIVITY, original_
↵mnemonic=RXO, data.shape=(3,)),
CurveItem(mnemonic=RES:1, unit=OHMM, value=, descr=6  SHALLOW RESISTIVITY, original_
↵mnemonic=RES, data.shape=(3,)),
CurveItem(mnemonic=RES:2, unit=OHMM, value=, descr=7  MEDIUM RESISTIVITY, original_
↵mnemonic=RES, data.shape=(3,)),
CurveItem(mnemonic=RES:3, unit=OHMM, value=, descr=8  DEEP RESISTIVITY, original_
↵mnemonic=RES, data.shape=(3,))]

In [4]: las.curves['RES:2']
Out[4]: CurveItem(mnemonic=RES:2, unit=OHMM, value=, descr=7  MEDIUM RESISTIVITY, ↵
↵original_mnemonic=RES, data.shape=(3,))
```

It remembers the original mnemonic, so when you write the file back out, they come back:

```
In [6]: import sys

In [7]: las.write(sys.stdout)
~Version -----
VERS. 1.2 : CWLS LOG ASCII STANDARD - VERSION 1.2
WRAP. NO : ONE LINE PER DEPTH STEP
~Well -----
STRT.M      1670.0 :
STOP.M      1669.75 :
```

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```

STEP.M          -0.125 :
NULL.           -999.25 :
COMP.           COMPANY : # ANY OIL COMPANY LTD.
WELL.           WELL : ANY ET AL OIL WELL #12
FLD .           FIELD : EDAM
LOC .           LOCATION : A9-16-49-20W3M
PROV.           PROVINCE : SASKATCHEWAN
SRVC. SERVICE COMPANY : ANY LOGGING COMPANY LTD.
DATE.           LOG DATE : 25-DEC-1988
UWI .  UNIQUE WELL ID : 100091604920W300
~Curves -----
DEPT.M          : 1  DEPTH
DT .US/M        : 2  SONIC TRANSIT TIME
RHOB.K/M3       : 3  BULK DENSITY
NPHI.V/V        : 4  NEUTRON POROSITY
RXO .OHMM       : 5  RXO RESISTIVITY
RES .OHMM       : 6  SHALLOW RESISTIVITY
RES .OHMM       : 7  MEDIUM RESISTIVITY
RES .OHMM       : 8  DEEP RESISTIVITY
~Params -----
BHT .DEGC       35.5 : BOTTOM HOLE TEMPERATURE
BS .MM          200.0 : BIT SIZE
FD .K/M3        1000.0 : FLUID DENSITY
MATR.           0.0 : NEUTRON MATRIX(0=LIME,1=SAND,2=DOLO)
MDEN.           2710.0 : LOGGING MATRIX DENSITY
RMF .OHMM       0.216 : MUD FILTRATE RESISTIVITY
DFD .K/M3       1525.0 : DRILL FLUID DENSITY
~Other -----
Note: The logging tools became stuck at 625 meters causing the data
between 625 meters and 615 meters to be invalid.
~ASCII -----
      1670      123.45      2550      0.45      123.45      123.45      110.2      105.6
      1669.9      123.45      2550      0.45      123.45      123.45      110.2      105.
↪ 6
      1669.8      123.45      2550      0.45      123.45      123.45      110.2      105.
↪ 6

```

### 4.3.1 Normalising mnemonic case

If there is a mix of upper and lower case characters in the mnemonics, by default lasio will convert all mnemonics to uppercase to avoid problems with producing the :1, :2, :3, and so on. There is a keyword argument which will preserve the original formatting if that is what you prefer.

```

In [8]: las = lasio.read('tests/examples/mnemonic_case.las')

In [9]: las.curves
Out[9]:
[CurveItem(mnemonic=DEPT, unit=M, value=, descr=1  DEPTH, original_mnemonic=DEPT,
↪data.shape=(3,)),
CurveItem(mnemonic=SFLU:1, unit=K/M3, value=, descr=3  BULK DENSITY, original_
↪mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=NPHI, unit=V/V, value=, descr=4  NEUTRON POROSITY, original_
↪mnemonic=NPHI, data.shape=(3,)),
CurveItem(mnemonic=SFLU:2, unit=OHMM, value=, descr=5  RXO RESISTIVITY, original_
↪mnemonic=SFLU, data.shape=(3,)),

```

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```
CurveItem(mnemonic=SFLU:3, unit=OHMM, value=, descr=6 SHALLOW RESISTIVITY, original_
↳mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=SFLU:4, unit=OHMM, value=, descr=7 MEDIUM RESISTIVITY, original_
↳mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=SFLU:5, unit=OHMM, value=, descr=8 DEEP RESISTIVITY, original_
↳mnemonic=SFLU, data.shape=(3,))]
```

```
In [10]: las = lasio.read('tests/examples/mnemonic_case.las', mnemonic_case='preserve
↳')
```

```
In [11]: las.curves
Out[11]:
[CurveItem(mnemonic=Dept, unit=M, value=, descr=1 DEPTH, original_mnemonic=Dept,
↳data.shape=(3,)),
CurveItem(mnemonic=Sflu, unit=K/M3, value=, descr=3 BULK DENSITY, original_
↳mnemonic=Sflu, data.shape=(3,)),
CurveItem(mnemonic=NPHI, unit=V/V, value=, descr=4 NEUTRON POROSITY, original_
↳mnemonic=NPHI, data.shape=(3,)),
CurveItem(mnemonic=SFLU:1, unit=OHMM, value=, descr=5 RXO RESISTIVITY, original_
↳mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=SFLU:2, unit=OHMM, value=, descr=6 SHALLOW RESISTIVITY, original_
↳mnemonic=SFLU, data.shape=(3,)),
CurveItem(mnemonic=sflu, unit=OHMM, value=, descr=7 MEDIUM RESISTIVITY, original_
↳mnemonic=sflu, data.shape=(3,)),
CurveItem(mnemonic=SfLu, unit=OHMM, value=, descr=8 DEEP RESISTIVITY, original_
↳mnemonic=SfLu, data.shape=(3,))]
```

## 5.1 Handling errors

`lasio` has a flexible way of handling “errors” in the ~ASCII data section to accommodate how strict or flexible you want to be.

### 5.1.1 Example errors

Here are some examples of errors.

- Files could contain a variety of indicators for an invalid data point other than that defined by the NULL line in the LAS header (usually -999.25).

- Fixed-width columns could run into each other:

|          |          |        |       |        |            |        |        |        |
|----------|----------|--------|-------|--------|------------|--------|--------|--------|
| 7686.500 | 64.932   | 0.123  | 0.395 | 12.403 | 156.271    | 10.649 | -0.005 | 193.   |
| ↪223     | 327.902  | -0.023 | 4.491 | 2.074  | 29.652     |        |        |        |
| 7686.000 | 67.354   | 0.140  | 0.415 | 9.207  | 4648.011   | 10.609 | -0.004 | 3778.  |
| ↪709     | 1893.751 | -0.048 | 4.513 | 2.041  | 291.910    |        |        |        |
| 7685.500 | 69.004   | 0.151  | 0.412 | 7.020  | 101130.188 | 10.560 | -0.004 | 60000. |
| ↪000     | 2901.317 | -0.047 | 4.492 | 2.046  | 310.119    |        |        |        |
| 7685.000 | 68.809   | 0.150  | 0.411 | 7.330  | 109508.961 | 10.424 | -0.005 | 60000. |
| ↪000     | 2846.619 | -0.042 | 4.538 | 2.049  | 376.968    |        |        |        |
| 7684.500 | 68.633   | 0.149  | 0.402 | 7.345  | 116238.453 | 10.515 | -0.005 | 60000. |
| ↪000     | 2290.275 | -0.051 | 4.543 | 2.063  | 404.972    |        |        |        |
| 7684.000 | 68.008   | 0.144  | 0.386 | 7.682  | 4182.679   | 10.515 | -0.004 | 3085.  |
| ↪681     | 1545.842 | -0.046 | 4.484 | 2.089  | 438.195    |        |        |        |

- Odd text such as `(null)`:

|          |         |         |         |   |   |   |
|----------|---------|---------|---------|---|---|---|
| 8090.00  | -999.25 | -999.25 | -999.25 | 0 |   |   |
| ↪0       | 0       | 0       | 0       | 0 | 0 | ↪ |
| ↪        | 0       |         |         |   |   | ↪ |
| 8091.000 | 0.70    | 337.70  | (null)  | 0 |   |   |
| ↪0       | 0       | 0       | 0       | 0 | 0 | ↪ |
| ↪        | 0       |         |         |   |   | ↪ |
| 8092.000 | -999.25 | -999.25 | -999.25 | 0 |   |   |
| ↪0       | 0       | 0       | 0       | 0 | 0 | ↪ |
| ↪        | 0       |         |         |   |   | ↪ |

## 5.1.2 Handling run-on errors

lasio detects and handles these problems by default using `lasio.read(f, read_policy='default')`. For example a file with this data section:

```
~A
 7686.000    67.354    0.140    0.415    9.207  4648.011    10.609
 7685.500    69.004    0.151    0.412    7.020101130.188    10.560
 7685.000    68.809    0.150    0.411    7.330-19508.961    10.424
 7684.500    68.633    0.149    0.402    7.345116238.453    10.515
 7684.000    68.008    0.144    0.386    7.682  4182.679    10.515
```

is loaded by default as the following:

```
In [9]: las = lasio.read('tests/examples/null_policy_runon.las')

In [12]: las.data
Out[12]:
array([[7686.0, 67.354, 0.14, 0.415, 9.207, 4648.011, 10.609],
       [7685.5, 69.004, 0.151, 0.412, nan, nan, 10.56],
       [7685.0, 68.809, 0.15, 0.411, 7.33, -19508.961, 10.424],
       [7684.5, 68.633, 0.149, 0.402, nan, nan, 10.515],
       [7684.0, 68.008, 0.144, 0.386, 7.682, 4182.679, 10.515]])
```

## 5.1.3 Handling invalid data indicators automatically

These are detected by lasio to a degree which you can control with the `null_policy` keyword argument.

You can specify a policy of 'none', 'strict', 'common', 'aggressive', or 'all'. These policies all include a subset of pre-defined substitutions. Or you can give your own list of substitutions. Here is the list of predefined policies and substitutions from `lasio.defaults`.

Policies that you can pick with e.g. `null_policy='common'`:

```
NULL_POLICIES = {
    'none': [],
    'strict': ['NULL', ],
    'common': ['NULL', '(null)', '-',
               '9999.25', '999.25', 'NA', 'INF', 'IO', 'IND'],
    'aggressive': ['NULL', '(null)', '--',
                   '9999.25', '999.25', 'NA', 'INF', 'IO', 'IND',
                   '999', '999.99', '9999', '9999.99', '2147483647', '32767',
                   '-0.0', ],
    'all': ['NULL', '(null)', '-',
```

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```

'9999.25', '999.25', 'NA', 'INF', 'IO', 'IND',
'999', '999.99', '9999', '9999.99' '2147483647', '32767', '-0.0',
'numbers-only', ],
'numbers-only': ['numbers-only', ]
}

```

Or substitutions you could specify with e.g. `null_policy=['NULL', '999.25', 'INF']`:

```

NULL_SUBS = {
    'NULL': [None, ],                                     # special case to be handled
    '999.25': [-999.25, 999.25],
    '9999.25': [-9999.25, 9999.25],
    '999.99': [-999.99, 999.99],
    '9999.99': [-9999.99, 9999.99],
    '999': [-999, 999],
    '9999': [-9999, 9999],
    '2147483647': [-2147483647, 2147483647],
    '32767': [-32767, 32767],
    'NA': [(re.compile(r'(#N/A)[ ]'), ' NaN '),
            (re.compile(r'[ ](#N/A)'), ' NaN '), ],
    'INF': [(re.compile(r'(-?1\.#INF)[ ]'), ' NaN '),
            (re.compile(r'[ ](-?1\.#INF)'), ' NaN '), ],
    'IO': [(re.compile(r'(-?1\.#IO)[ ]'), ' NaN '),
            (re.compile(r'[ ](-?1\.#IO)'), ' NaN '), ],
    'IND': [(re.compile(r'(-?1\.#IND)[ ]'), ' NaN '),
            (re.compile(r'[ ](-?1\.#IND)'), ' NaN '), ],
    '-0.0': [(re.compile(r'(-?0\.0+)[ ]'), ' NaN '),
            (re.compile(r'[ ](-?0\.0+)'), ' NaN '), ],
    'numbers-only': [(re.compile(r'([^\d0-9.\-+]+)[ ]'), ' NaN '),
                     (re.compile(r'[ ]([^\d0-9.\-+]+)'), ' NaN '), ],
}

```

You can also specify substitutions directly. E.g. for a file with this data section:

| ~A       | DEPTH | DT       | RHOB  | NPHI    | SFLU    | SFLA    | ILM     | ILD |
|----------|-------|----------|-------|---------|---------|---------|---------|-----|
| 1670.000 | 9998  | 2550.000 | 0.450 | 123.450 | 123.450 | 110.200 | 105.600 |     |
| 1669.875 | 9999  | 2550.000 | 0.450 | 123.450 | 123.450 | 110.200 | 105.600 |     |
| 1669.750 | 10000 | ERR      | 0.450 | 123.450 | -999.25 | 110.200 | 105.600 |     |

Ordinarily it would raise an exception:

```

In [13]: las = lasio.read('tests/examples/null_policy_ERR.las')
-----
ValueError                                Traceback (most recent call last)
~\Code\lasio\lasio\reader.py in read_file_contents(file_obj, regexp_subs, value_null_
↳subs, ignore_data)
    271         try:
--> 272             data = read_data_section_iterative(file_obj, regexp_subs,
↳value_null_subs)
    273         except:

~\Code\lasio\lasio\reader.py in read_data_section_iterative(file_obj, regexp_subs,
↳value_null_subs)
    348
--> 349     array = np.fromiter(items(file_obj), np.float64, -1)
    350     for value in value_null_subs:

```

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```

ValueError: could not convert string to float: 'ERR'

During handling of the above exception, another exception occurred:

LASDataError                                Traceback (most recent call last)
<ipython-input-13-0cb27623119d> in <module>()
----> 1 las = lasio.read('tests/examples/null_policy_ERR.las')

~\Code\lasio\lasio\__init__.py in read(file_ref, **kwargs)
    41
    42     '''
--> 43     return LASFile(file_ref, **kwargs)

~\Code\lasio\lasio\las.py in __init__(self, file_ref, **read_kwargs)
    76
    77     if not (file_ref is None):
--> 78         self.read(file_ref, **read_kwargs)
    79
    80     def read(self, file_ref,

~\Code\lasio\lasio\las.py in read(self, file_ref, ignore_data, read_policy, null_
-> policy, ignore_header_errors, **kwargs)
    106
    107         self.raw_sections = reader.read_file_contents(
--> 108             file_obj, regexp_subs, value_null_subs, ignore_data=ignore_data, )
    109
    110         if hasattr(file_obj, "close"):

~\Code\lasio\lasio\reader.py in read_file_contents(file_obj, regexp_subs, value_null_
-> subs, ignore_data)
    274             raise exceptions.LASDataError(
    275                 traceback.format_exc()[:-1] +
--> 276                 ' in data section beginning line {}'.format(i + 1))
    277         sections[line] = {
    278             "section_type": "data",

LASDataError: Traceback (most recent call last):
  File "C:\Users\kent\Code\lasio\lasio\reader.py", line 272, in read_file_contents
    data = read_data_section_iterative(file_obj, regexp_subs, value_null_subs)
  File "C:\Users\kent\Code\lasio\lasio\reader.py", line 349, in read_data_section_
-> iterative
    array = np.fromiter(items(file_obj), np.float64, -1)
ValueError: could not convert string to float: 'ERR' in data section beginning line 43

```

But if we specify the regular expression to use with `re.sub()`, we can easily load it:

```

In [14]: las = lasio.read('tests/examples/null_policy_ERR.las', null_policy=[('ERR',
-> ' NaN '), ])

In [16]: las.data
Out[16]:
array([[1670.0, 9998.0, 2550.0, 0.45, 123.45, 123.45, 110.2, 105.6],
       [1669.875, 9999.0, 2550.0, 0.45, 123.45, 123.45, 110.2, 105.6],
       [1669.75, 10000.0, nan, 0.45, 123.45, -999.25, 110.2, 105.6]])

In [17]:

```

See `tests/test_null_policy.py` ([link](#)) for some examples.



# CHAPTER 6

## Writing LAS files

Any LASFile object can be written to a new LAS file using the `lasio.LASFile.write()` method.

### 6.1 Converting between v1.2 and v2.0

Take this sample LAS 2.0 file:

```
1 ~VERSION INFORMATION
2  VERS.                      2.0 :   CWLS LOG ASCII STANDARD -VERSION 2.0
3  WRAP.                      NO  :   ONE LINE PER DEPTH STEP
4 ~WELL INFORMATION
5 #MNEM.UNIT                DATA                DESCRIPTION
6 #-----
7 STRT      .M              1670.0000             :START DEPTH
8 STOP      .M              1660.0000             :STOP DEPTH
9 STEP      .M              -0.1250              :STEP
10 NULL     .               -999.25              :NULL VALUE
11 COMP     .               ANY OIL COMPANY INC.   :COMPANY
12 WELL     .               AAAAA_2               :WELL
13 FLD      .               WILDCAT              :FIELD
14 LOC      .               12-34-12-34W5M        :LOCATION
15 PROV     .               ALBERTA              :PROVINCE
16 SRVC     .               ANY LOGGING COMPANY INC. :SERVICE COMPANY
17 DATE     .               13-DEC-86            :LOG DATE
18 UWI      .               100123401234W500      :UNIQUE WELL ID
19 ~CURVE INFORMATION
20 #MNEM.UNIT                API CODES            CURVE DESCRIPTION
21 #-----
22 DEPT      .M              :   1  DEPTH
23 DT        .US/M          60 520 32 00          :   2  SONIC TRANSIT TIME
24 RHOB      .K/M3          45 350 01 00          :   3  BULK DENSITY
25 NPHI      .V/V           42 890 00 00          :   4  NEUTRON POROSITY
26 SFLU      .OHMM          07 220 04 00          :   5  SHALLOW RESISTIVITY
```

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```

27 SFLA .OHMM      07 222 01 00      : 6  SHALLOW RESISTIVITY
28 ILM  .OHMM      07 120 44 00      : 7  MEDIUM RESISTIVITY
29 ILD  .OHMM      07 120 46 00      : 8  DEEP RESISTIVITY
30 ~PARAMETER INFORMATION
31 #MNEM.UNIT      VALUE      DESCRIPTION
32 #-----
33 MUD  .          GEL CHEM      :  MUD TYPE
34 BHT  .DEGC      35.5000      :  BOTTOM HOLE TEMPERATURE
35 BS   .MM        200.0000      :  BIT SIZE
36 FD   .K/M3      1000.0000     :  FLUID DENSITY
37 MATR .          SAND         :  NEUTRON MATRIX
38 MDEN .          2710.0000     :  LOGGING MATRIX DENSITY
39 RMF  .OHMM      0.2160       :  MUD FILTRATE RESISTIVITY
40 DFD  .K/M3      1525.0000     :  DRILL FLUID DENSITY
41 ~OTHER
42     Note: The logging tools became stuck at 625 metres causing the data
43     between 625 metres and 615 metres to be invalid.
44 ~A DEPTH      DT      RHOB      NPHI      SFLU      SFLA      ILM      ILD
45 1670.000     123.450 2550.000    0.450    123.450    123.450    110.200    105.600
46 1669.875     123.450 2550.000    0.450    123.450    123.450    110.200    105.600
47 1669.750     123.450 2550.000    0.450    123.450    123.450    110.200    105.600

```

And we can use lasio to convert it to LAS 1.2:

```

In [31]: las = lasio.read("tests/examples/2.0/sample_2.0.las")
In [33]: las.write('example-as-v1.2.las', version=1.2)

```

```

1 ~Version -----
2 VERS. 1.2 : CWLS LOG ASCII STANDARD - VERSION 1.2
3 WRAP. NO : ONE LINE PER DEPTH STEP
4 ~Well -----
5 STRT.M      1670.0 : START DEPTH
6 STOP.M      1669.75 : STOP DEPTH
7 STEP.M      -0.125 : STEP
8 NULL.      -999.25 : NULL VALUE
9 COMP.      COMPANY : ANY OIL COMPANY INC.
10 WELL.      WELL : AAAAA_2
11 FLD .      FIELD : WILDCAT
12 LOC .      LOCATION : 12-34-12-34W5M
13 PROV.      PROVINCE : ALBERTA
14 SRVC. SERVICE COMPANY : ANY LOGGING COMPANY INC.
15 DATE.      LOG DATE : 13-DEC-86
16 UWI .      UNIQUE WELL ID : 100123401234W500
17 ~Curves -----
18 DEPT.M      : 1  DEPTH
19 DT .US/M 60 520 32 00 : 2  SONIC TRANSIT TIME
20 RHOB.K/M3 45 350 01 00 : 3  BULK DENSITY
21 NPHI.V/V 42 890 00 00 : 4  NEUTRON POROSITY
22 SFLU.OHMM 07 220 04 00 : 5  SHALLOW RESISTIVITY
23 SFLA.OHMM 07 222 01 00 : 6  SHALLOW RESISTIVITY
24 ILM .OHMM 07 120 44 00 : 7  MEDIUM RESISTIVITY
25 ILD .OHMM 07 120 46 00 : 8  DEEP RESISTIVITY
26 ~Params -----
27 MUD .      GEL CHEM : MUD TYPE

```

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```

28 BHT .DEGC    35.5 : BOTTOM HOLE TEMPERATURE
29 BS  .MM      200.0 : BIT SIZE
30 FD  .K/M3    1000.0 : FLUID DENSITY
31 MATR.        SAND : NEUTRON MATRIX
32 MDEN.        2710.0 : LOGGING MATRIX DENSITY
33 RMF .OHMM    0.216 : MUD FILTRATE RESISTIVITY
34 DFD .K/M3    1525.0 : DRILL FLUID DENSITY
35 ~Other -----
36 Note: The logging tools became stuck at 625 metres causing the data
37 between 625 metres and 615 metres to be invalid.
38 ~ASCII -----
39      1670      123.45      2550      0.45      123.45      123.45      110.2      ]
↪105.6
40      1669.9      123.45      2550      0.45      123.45      123.45      110.2      ]
↪105.6
41      1669.8      123.45      2550      0.45      123.45      123.45      110.2      ]
↪105.6

```

## 6.2 Converting between wrapped/unwrapped

Here is an example using this file to convert a wrapped data section to unwrapped.

```

1 ~Version Information
2  VERS.          1.20:  CWLS log ASCII Standard -VERSION 1.20
3  WRAP.          YES:  Multiple lines per depth step
4 ~Well Information
5 #MNEM.UNIT      Data Type      Information
6 #-----
7  STRT.M          910.000:
8  STOP.M          901.000:
9  STEP.M          -0.1250:
10 NULL.          -999.2500:  Null value
11 COMP.          COMPANY:  ANY OIL COMPANY INC.
12 WELL.          WELL:    ANY ET AL XX-XX-XX-XX
13 FLD .          FIELD:    WILDCAT
14 LOC .          LOCATION:  XX-XX-XX-XXW3M
15 PROV.          PROVINCE:  SASKATCHEWAN
16 SRVC.          SERVICE COMPANY:  ANY LOGGING COMPANY INC.
17 SON .          SERVICE ORDER :  142085
18 DATE.          LOG DATE:   13-DEC-86
19 UWI .          UNIQUE WELL ID:
20 ~Curve Information
21 #MNEM.UNIT      API CODE      Curve Description
22 #-----
23  DEPT.M          :          Depth
24  DT .US/M        :          1 Sonic Travel Time
25  RHOB.K/M        :          2 Density-Bulk Density
26  NPFI.V/V        :          3 Porosity -Neutron
27  RX0 .OHMM       :          4 Resistivity -Rxo
28  RESS.OHMM       :          5 Resistivity -Shallow
29  RESM.OHMM       :          6 Resistivity -Medium
30  RESD.OHMM       :          7 Resistivity -Deep
31  SP .MV          :          8 Spon. Potential
32  GR .GAPI        :          9 Gamma Ray

```

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```

33 CALI.MM           : 10 Caliper
34 DRHO.K/M3        : 11 Delta-Rho
35 EATT.DBM         : 12 EPT Attenuation
36 TPL .NS/M        : 13 TP -EPT
37 PEF .            : 14 PhotoElectric Factor
38 FFI .V/V         : 15 Porosity -NML FFI
39 DCAL.MM          : 16 Caliper-Differential
40 RHGF.K/M3        : 17 Density-Formation
41 RHGA.K/M3        : 18 Density-Apparent
42 SPBL.MV          : 19 Baselined SP
43 GRC .GAPI        : 20 Gamma Ray BHC
44 PHIA.V/V         : 21 Porosity -Apparent
45 PHID.V/V         : 22 Porosity -Density
46 PHIE.V/V         : 23 Porosity -Effective
47 PHIN.V/V         : 24 Porosity -Neut BHC
48 PHIC.V/V         : 25 Porosity -Total HCC
49 R0 .OHMM         : 26 Ro
50 RWA .OHMM        : 27 Rfa
51 SW .            : 28 Sw -Effective
52 MSI .           : 29 Sh Idx -Min
53 BVW .           : 30 BVW
54 FGAS.           : 31 Flag -Gas Index
55 PIDX.           : 32 Prod Idx
56 FBH .           : 33 Flag -Bad Hole
57 FHCC.           : 34 Flag -HC Correction
58 LSWB.           : 35 Flag -Limit SWB
59 ~A Log data section
60 910.000000
61 -999.2500 2692.7075 0.3140 19.4086 19.4086 13.1709 12.2681
62 -1.5010 96.5306 204.7177 30.5822 -999.2500 -999.2500 3.2515
63 -999.2500 4.7177 3025.0264 3025.0264 -1.5010 93.1378 0.1641
64 0.0101 0.1641 0.3140 0.1641 11.1397 0.3304 0.9529
65 0.0000 0.1564 0.0000 11.1397 0.0000 0.0000 0.0000
66 909.875000
67 -999.2500 2712.6460 0.2886 23.3987 23.3987 13.6129 12.4744
68 -1.4720 90.2803 203.1093 18.7566 -999.2500 -999.2500 3.7058
69 -999.2500 3.1093 3004.6050 3004.6050 -1.4720 86.9078 0.1456
70 -0.0015 0.1456 0.2886 0.1456 14.1428 0.2646 1.0000
71 0.0000 0.1456 0.0000 14.1428 0.0000 0.0000 0.0000
72 909.750000
73 -999.2500 2692.8137 0.2730 22.5909 22.5909 13.6821 12.6146
74 -1.4804 89.8492 201.9287 3.1551 -999.2500 -999.2500 4.3124
75 -999.2500 1.9287 2976.4451 2976.4451 -1.4804 86.3465 0.1435
76 0.0101 0.1435 0.2730 0.1435 14.5674 0.2598 1.0000
77 0.0000 0.1435 0.0000 14.5674 0.0000 0.0000 0.0000
78 909.625000
79 -999.2500 2644.3650 0.2765 18.4831 18.4831 13.4159 12.6900
80 -1.5010 93.3999 201.5826 -6.5861 -999.2500 -999.2500 4.3822
81 -999.2500 1.5826 2955.3528 2955.3528 -1.5010 89.7142 0.1590
82 0.0384 0.1590 0.2765 0.1590 11.8600 0.3210 0.9667
83 0.0000 0.1538 0.0000 11.8600 0.0000 0.0000 0.0000
84 909.500000
85 -999.2500 2586.2822 0.2996 13.9187 13.9187 12.9195 12.7016
86 -1.4916 98.1214 201.7126 -4.5574 -999.2500 -999.2500 3.5967
87 -999.2500 1.7126 2953.5940 2953.5940 -1.4916 94.2670 0.1880
88 0.0723 0.1880 0.2996 0.1880 8.4863 0.4490 0.8174
89 0.0000 0.1537 0.0000 8.4863 0.0000 0.0000 0.0000

```

We will change the wrap by adjusting the relevant header section in the LASFile header:

```
In [26]: las.version
Out [26]:
[HeaderItem(mnemonic=VERS, unit=, value=1.2, descr=CWLS log ASCII Standard -VERSION 1.
↳20, original_mnemonic=VERS),
 HeaderItem(mnemonic=WRAP, unit=, value=YES, descr=Multiple lines per depth step,
↳original_mnemonic=WRAP)]

In [27]: las.version.WRAP = 'NO'

In [28]: las.version.WRAP
Out [28]: HeaderItem(mnemonic=WRAP, unit=, value=NO, descr=Multiple lines per depth
↳step, original_mnemonic=WRAP)

In [29]: las.write('example-unwrapped.las')
WARNING:lasio.writer:[v1.2] line #58 has 396 chars (>256)
WARNING:lasio.writer:[v1.2] line #59 has 396 chars (>256)
WARNING:lasio.writer:[v1.2] line #60 has 396 chars (>256)
WARNING:lasio.writer:[v1.2] line #61 has 396 chars (>256)
WARNING:lasio.writer:[v1.2] line #62 has 396 chars (>256)
```

We get warnings because the LAS 1.2 standard doesn't allow writing lines longer than 256 characters. `lasio` provides the warning but still produces the long lines:

```
1 ~Version -----
2 VERS. 1.2 : CWLS LOG ASCII STANDARD - VERSION 1.2
3 WRAP. NO : Multiple lines per depth step
4 ~Well -----
5 STRT.M      910.0 :
6 STOP.M      909.5 :
7 STEP.M      -0.125 :
8 NULL.      -999.25 : Null value
9 COMP.      COMPANY : ANY OIL COMPANY INC.
10 WELL.      WELL : ANY ET AL XX-XX-XX-XX
11 FLD .      FIELD : WILDCAT
12 LOC .      LOCATION : XX-XX-XX-XXW3M
13 PROV.      PROVINCE : SASKATCHEWAN
14 SRVC. SERVICE COMPANY : ANY LOGGING COMPANY INC.
15 SON .      SERVICE ORDER : 142085
16 DATE.      LOG DATE : 13-DEC-86
17 UWI .      UNIQUE WELL ID :
18 ~Curves -----
19 DEPT.M      : Depth
20 DT .US/M    : 1 Sonic Travel Time
21 RHOB.K/M    : 2 Density-Bulk Density
22 NPHI.V/V    : 3 Porosity -Neutron
23 RX0 .OHMM   : 4 Resistivity -Rxo
24 RESS.OHMM   : 5 Resistivity -Shallow
25 RESM.OHMM   : 6 Resistivity -Medium
26 RESD.OHMM   : 7 Resistivity -Deep
27 SP .MV      : 8 Spon. Potential
28 GR .GAPI    : 9 Gamma Ray
29 CALI.MM     : 10 Caliper
30 DRHO.K/M3   : 11 Delta-Rho
31 EATT.DBM    : 12 EPT Attenuation
32 TPL .NS/M   : 13 TP -EPT
33 PEF .       : 14 PhotoElectric Factor
```

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```

34 FFI .V/V      : 15 Porosity -NML FFI
35 DCAL.MM      : 16 Caliper-Differential
36 RHGF.K/M3    : 17 Density-Formation
37 RHGA.K/M3    : 18 Density-Apparent
38 SPBL.MV      : 19 Baselined SP
39 GRC .GAPI    : 20 Gamma Ray BHC
40 PHIA.V/V     : 21 Porosity -Apparent
41 PHID.V/V     : 22 Porosity -Density
42 PHIE.V/V     : 23 Porosity -Effective
43 PHIN.V/V     : 24 Porosity -Neut BHC
44 PHIC.V/V     : 25 Porosity -Total HCC
45 R0 .OHMM     : 26 Ro
46 RWA .OHMM    : 27 Rfa
47 SW .         : 28 Sw -Effective
48 MSI .        : 29 Sh Idx -Min
49 BVW .        : 30 BVW
50 FGAS.        : 31 Flag -Gas Index
51 PIDX.        : 32 Prod Idx
52 FBH .        : 33 Flag -Bad Hole
53 FHCC.        : 34 Flag -HC Correction
54 LSWB.        : 35 Flag -Limit SWB
55 ~Params -----
56 ~Other -----
57 ~ASCII -----
58      910      -999.25      2692.7      0.314      19.409      19.409      13.171      12.
→268      -1.501      96.531      204.72      30.582      -999.25      -999.25      3.2515      1
→-999.25      4.7177      3025      3025      -1.501      93.138      0.1641      0.
→0101      0.1641      0.314      0.1641      11.14      0.3304      0.9529      0      1
→ 0.1564      0      11.14      0      0      0      0
59      909.88      -999.25      2712.6      0.2886      23.399      23.399      13.613      12.
→474      -1.472      90.28      203.11      18.757      -999.25      -999.25      3.7058      1
→-999.25      3.1093      3004.6      3004.6      -1.472      86.908      0.1456      -0.
→0015      0.1456      0.2886      0.1456      14.143      0.2646      1      0      1
→ 0.1456      0      14.143      0      0      0      0
60      909.75      -999.25      2692.8      0.273      22.591      22.591      13.682      12.
→615      -1.4804      89.849      201.93      3.1551      -999.25      -999.25      4.3124      1
→-999.25      1.9287      2976.4      2976.4      -1.4804      86.347      0.1435      0.
→0101      0.1435      0.273      0.1435      14.567      0.2598      1      0      1
→ 0.1435      0      14.567      0      0      0      0
61      909.62      -999.25      2644.4      0.2765      18.483      18.483      13.416      12.
→69      -1.501      93.4      201.58      -6.5861      -999.25      -999.25      4.3822      -
→999.25      1.5826      2955.4      2955.4      -1.501      89.714      0.159      0.0384      1
→ 0.159      0.2765      0.159      11.86      0.321      0.9667      0      0.
→1538      0      11.86      0      0      0      0
62      909.5      -999.25      2586.3      0.2996      13.919      13.919      12.919      12.
→702      -1.4916      98.121      201.71      -4.5574      -999.25      -999.25      3.5967      1
→-999.25      1.7126      2953.6      2953.6      -1.4916      94.267      0.188      0.
→0723      0.188      0.2996      0.188      8.4863      0.449      0.8174      0      1
→ 0.1537      0      8.4863      0      0      0      0

```

If we decide to write the file in LAS 2.0 format, the warnings will go away:

```
In [23]: las.write('example-version-2.0.las', version=2.0)
```

```
In [24]:
```

```

1 ~Version -----
2 VERS. 2.0 : CWLS log ASCII Standard -VERSION 2.0
3 WRAP. NO : Multiple lines per depth step
4 ~Well -----
5 STRT.M           910.0 :
6 STOP.M           909.5 :
7 STEP.M           -0.125 :
8 NULL.            -999.25 : Null value
9 COMP.    ANY OIL COMPANY INC. : COMPANY
10 WELL.    ANY ET AL XX-XX-XX-XX : WELL
11 FLD .            WILDCAT : FIELD
12 LOC .            XX-XX-XX-XXW3M : LOCATION
13 PROV.            SASKATCHEWAN : PROVINCE
14 SRVC. ANY LOGGING COMPANY INC. : SERVICE COMPANY
15 SON .            142085 : SERVICE ORDER
16 DATE.            13-DEC-86 : LOG DATE
17 UWI .            : UNIQUE WELL ID
18 ~Curves -----
19 DEPT.M : Depth
20 DT .US/M : 1 Sonic Travel Time
21 RHOB.K/M : 2 Density-Bulk Density
22 NPHI.V/V : 3 Porosity -Neutron
23 RX0 .OHMM : 4 Resistivity -Rxo
24 RESS.OHMM : 5 Resistivity -Shallow
25 RESM.OHMM : 6 Resistivity -Medium
26 RESD.OHMM : 7 Resistivity -Deep
27 SP .MV : 8 Spon. Potential
28 GR .GAPI : 9 Gamma Ray
29 CALI.MM : 10 Caliper
30 DRHO.K/M3 : 11 Delta-Rho
31 EATT.DBM : 12 EPT Attenuation
32 TPL .NS/M : 13 TP -EPT
33 PEF . : 14 PhotoElectric Factor
34 FFI .V/V : 15 Porosity -NML FFI
35 DCAL.MM : 16 Caliper-Differential
36 RHGF.K/M3 : 17 Density-Formation
37 RHGA.K/M3 : 18 Density-Apparent
38 SPBL.MV : 19 Baselined SP
39 GRC .GAPI : 20 Gamma Ray BHC
40 PHIA.V/V : 21 Porosity -Apparent
41 PHID.V/V : 22 Porosity -Density
42 PHIE.V/V : 23 Porosity -Effective
43 PHIN.V/V : 24 Porosity -Neut BHC
44 PHIC.V/V : 25 Porosity -Total HCC
45 R0 .OHMM : 26 Ro
46 RWA .OHMM : 27 Rfa
47 SW . : 28 Sw -Effective
48 MSI . : 29 Sh Idx -Min
49 BVW . : 30 BVW
50 FGAS. : 31 Flag -Gas Index
51 PIDX. : 32 Prod Idx
52 FBH . : 33 Flag -Bad Hole
53 FHCC. : 34 Flag -HC Correction
54 LSBW. : 35 Flag -Limit SWB
55 ~Params -----
56 ~Other -----
57 ~ASCII -----

```

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|    |          |         |         |        |         |         |         |        |     |
|----|----------|---------|---------|--------|---------|---------|---------|--------|-----|
| 58 |          | 910     | -999.25 | 2692.7 | 0.314   | 19.409  | 19.409  | 13.171 | 12. |
|    | ↪268     | -1.501  | 96.531  | 204.72 | 30.582  | -999.25 | -999.25 | 3.2515 | ↪   |
|    | ↪-999.25 | 4.7177  | 3025    | 3025   | -1.501  | 93.138  | 0.1641  | 0.     |     |
|    | ↪0101    | 0.1641  | 0.314   | 0.1641 | 11.14   | 0.3304  | 0.9529  | 0      | ↪   |
|    | ↪        | 0.1564  | 0       | 11.14  | 0       | 0       | 0       |        |     |
| 59 |          | 909.88  | -999.25 | 2712.6 | 0.2886  | 23.399  | 23.399  | 13.613 | 12. |
|    | ↪474     | -1.472  | 90.28   | 203.11 | 18.757  | -999.25 | -999.25 | 3.7058 | ↪   |
|    | ↪-999.25 | 3.1093  | 3004.6  | 3004.6 | -1.472  | 86.908  | 0.1456  | -0.    |     |
|    | ↪0015    | 0.1456  | 0.2886  | 0.1456 | 14.143  | 0.2646  | 1       | 0      | ↪   |
|    | ↪        | 0.1456  | 0       | 14.143 | 0       | 0       | 0       |        |     |
| 60 |          | 909.75  | -999.25 | 2692.8 | 0.273   | 22.591  | 22.591  | 13.682 | 12. |
|    | ↪615     | -1.4804 | 89.849  | 201.93 | 3.1551  | -999.25 | -999.25 | 4.3124 | ↪   |
|    | ↪-999.25 | 1.9287  | 2976.4  | 2976.4 | -1.4804 | 86.347  | 0.1435  | 0.     |     |
|    | ↪0101    | 0.1435  | 0.273   | 0.1435 | 14.567  | 0.2598  | 1       | 0      | ↪   |
|    | ↪        | 0.1435  | 0       | 14.567 | 0       | 0       | 0       |        |     |
| 61 |          | 909.62  | -999.25 | 2644.4 | 0.2765  | 18.483  | 18.483  | 13.416 | 12. |
|    | ↪69      | -1.501  | 93.4    | 201.58 | -6.5861 | -999.25 | -999.25 | 4.3822 | -   |
|    | ↪999.25  | 1.5826  | 2955.4  | 2955.4 | -1.501  | 89.714  | 0.159   | 0.0384 | ↪   |
|    | ↪        | 0.159   | 0.2765  | 0.159  | 11.86   | 0.321   | 0.9667  | 0      | 0.  |
|    | ↪1538    | 0       | 11.86   | 0      | 0       | 0       |         |        |     |
| 62 |          | 909.5   | -999.25 | 2586.3 | 0.2996  | 13.919  | 13.919  | 12.919 | 12. |
|    | ↪702     | -1.4916 | 98.121  | 201.71 | -4.5574 | -999.25 | -999.25 | 3.5967 | ↪   |
|    | ↪-999.25 | 1.7126  | 2953.6  | 2953.6 | -1.4916 | 94.267  | 0.188   | 0.     |     |
|    | ↪0723    | 0.188   | 0.2996  | 0.188  | 8.4863  | 0.449   | 0.8174  | 0      | ↪   |
|    | ↪        | 0.1537  | 0       | 8.4863 | 0       | 0       | 0       |        |     |

## CHAPTER 7

### Exporting to other formats

The following examples all use `sample.las`:

```
1 ~VERSION INFORMATION
2 VERS.                1.2:  CWLS LOG ASCII STANDARD -VERSION 1.2
3 WRAP.                NO:   ONE LINE PER DEPTH STEP
4 ~WELL INFORMATION BLOCK
5 #MNEM.UNIT          DATA TYPE      INFORMATION
6 #-----
7 STRT.M              1670.000000:
8 STOP.M              1660.000000:
9 STEP.M              -0.1250:
10 NULL.              -999.2500:
11 COMP.               COMPANY:      # ANY OIL COMPANY LTD.
12 WELL.               WELL:         ANY ET AL OIL WELL #12
13 FLD .               FIELD:        EDAM
14 LOC .               LOCATION:     A9-16-49-20W3M
15 PROV.               PROVINCE:     SASKATCHEWAN
16 SRVC.               SERVICE COMPANY: ANY LOGGING COMPANY LTD.
17 DATE.               LOG DATE:     25-DEC-1988
18 UWI .               UNIQUE WELL ID: 100091604920W300
19 ~CURVE INFORMATION
20 #MNEM.UNIT          API CODE      CURVE DESCRIPTION
21 #-----
22 DEPT.M              : 1  DEPTH
23 DT .US/M            : 2  SONIC TRANSIT TIME
24 RHOB.K/M3           : 3  BULK DENSITY
25 NPHI.V/V            : 4  NEUTRON POROSITY
26 SFLU.OHMM           : 5  RXO RESISTIVITY
27 SFLA.OHMM           : 6  SHALLOW RESISTIVITY
28 ILM .OHMM           : 7  MEDIUM RESISTIVITY
29 ILD .OHMM           : 8  DEEP RESISTIVITY
30 ~PARAMETER INFORMATION
31 #MNEM.UNIT          VALUE         DESCRIPTION
32 #-----
```

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```

33 BHT .DEGC          35.5000:  BOTTOM HOLE TEMPERATURE
34 BS  .MM           200.0000:  BIT SIZE
35 FD  .K/M3         1000.0000:  FLUID DENSITY
36 MATR.             0.0000:  NEUTRON MATRIX(0=LIME,1=SAND,2=DOLO)
37 MDEN.            2710.0000:  LOGGING MATRIX DENSITY
38 RMF .OHMM         0.2160:  MUD FILTRATE RESISTIVITY
39 DFD .K/M3         1525.0000:  DRILL FLUID DENSITY
40 ~Other
41     Note: The logging tools became stuck at 625 meters causing the data
42         between 625 meters and 615 meters to be invalid.
43 ~A DEPTH      DT      RHOB      NPHI      SFLU      SFLA      ILM      ILD
44 1670.000    123.450 2550.000    0.450   123.450   123.450   110.200   105.600
45 1669.875    123.450 2550.000    0.450   123.450   123.450   110.200   105.600
46 1669.750    123.450 2550.000    0.450   123.450   123.450   110.200   105.600

```

## 7.1 Comma-separated values (CSV)

LASFile objects can be converted to CSV files with a few options for how mnemonics and units are included (or not). It uses the `lasio.las.LASFile.to_csv()` method.

```

In [3]: import lasio

In [4]: las = lasio.read('tests/examples/sample.las')

In [6]: las.to_csv('sample.csv')

```

```

1 DEPT,DT,RHOB,NPHI,SFLU,SFLA,ILM,ILD
2 M,US/M,K/M3,V/V,OHMM,OHMM,OHMM,OHMM
3 1670.0,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
4 1669.875,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
5 1669.75,123.45,2550.0,0.45,123.45,123.45,110.2,105.6

```

There are options for putting the units together with mnemonics:

```

In [7]: las.to_csv('sample.csv', units_loc='[]')

```

```

1 DEPT [M],DT [US/M],RHOB [K/M3],NPHI [V/V],SFLU [OHMM],SFLA [OHMM],ILM [OHMM],ILD_
  ↳ [OHMM]
2 1670.0,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
3 1669.875,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
4 1669.75,123.45,2550.0,0.45,123.45,123.45,110.2,105.6

```

Or leaving things out altogether:

```

In [11]: las.to_csv('sample.csv', mnemonics=False, units=False)

```

```

1 1670.0,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
2 1669.875,123.45,2550.0,0.45,123.45,123.45,110.2,105.6
3 1669.75,123.45,2550.0,0.45,123.45,123.45,110.2,105.6

```

## 7.2 Excel spreadsheet (XLSX)

You can easily convert LAS files into Excel, retaining the header information.

If we are working in Python, you export like this:

```
In [58]: las = lasio.read('tests/examples/sample.las')
In [59]: las.to_excel('sample.xlsx')
```

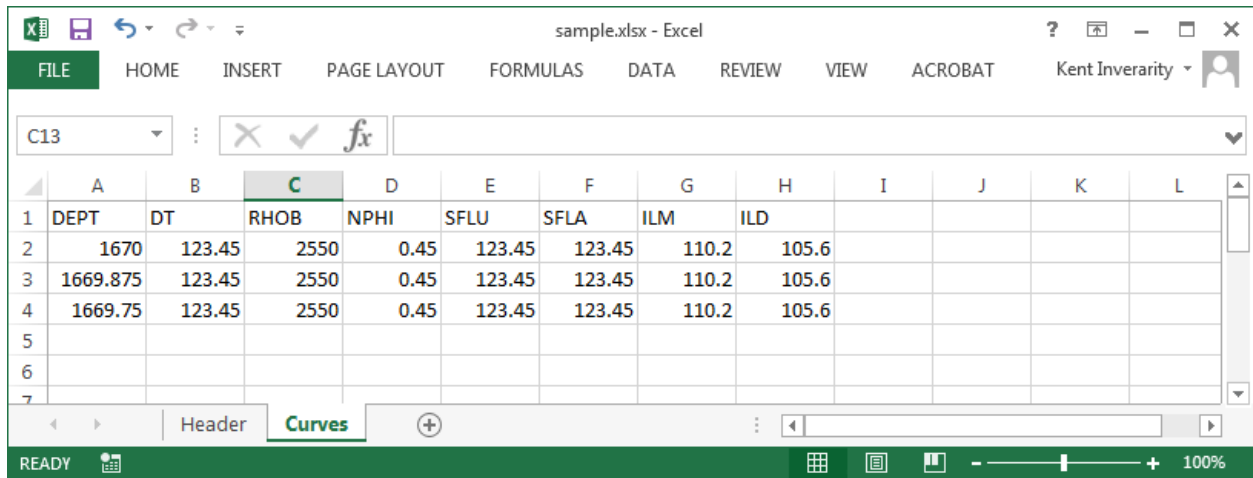
You will need to have `openpyxl` installed (`$ pip install openpyxl`).

### 7.2.1 Format of exported Excel file

The exported spreadsheet has two sheets named “Header” and “Curves”. The “Header” sheet has five columns named “Section”, “Mnemonic”, “Unit”, “Value”, and “Description”, containing the information from all the sections in the header.

|    | A          | B        | C    | D                        | E                                    | F |
|----|------------|----------|------|--------------------------|--------------------------------------|---|
|    | Section    | Mnemonic | Unit | Value                    | Description                          |   |
| 2  | ~Version   | VERS     |      | 1.2                      | CWLS LOG ASCII STANDARD -VERSION 1.2 |   |
| 3  | ~Version   | WRAP     |      | NO                       | ONE LINE PER DEPTH STEP              |   |
| 4  | ~Well      | STRT     | M    | 1670                     |                                      |   |
| 5  | ~Well      | STOP     | M    | 1660                     |                                      |   |
| 6  | ~Well      | STEP     | M    | -0.125                   |                                      |   |
| 7  | ~Well      | NULL     |      | -999.25                  |                                      |   |
| 8  | ~Well      | COMP     |      | # ANY OIL COMPANY LTD.   | COMPANY                              |   |
| 9  | ~Well      | WELL     |      | ANY ET AL OIL WELL #12   | WELL                                 |   |
| 10 | ~Well      | FLD      |      | EDAM                     | FIELD                                |   |
| 11 | ~Well      | LOC      |      | A9-16-49-20W3M           | LOCATION                             |   |
| 12 | ~Well      | PROV     |      | SASKATCHEWAN             | PROVINCE                             |   |
| 13 | ~Well      | SRVC     |      | ANY LOGGING COMPANY LTD. | SERVICE COMPANY                      |   |
| 14 | ~Well      | DATE     |      | 25-DEC-1988              | LOG DATE                             |   |
| 15 | ~Well      | UWI      |      | 100091604920W300         | UNIQUE WELL ID                       |   |
| 16 | ~Parameter | BHT      | DEGC | 35.5                     | BOTTOM HOLE TEMPERATURE              |   |
| 17 | ~Parameter | BS       | MM   | 200                      | BIT SIZE                             |   |
| 18 | ~Parameter | FD       | K/M3 | 1000                     | FLUID DENSITY                        |   |
| 19 | ~Parameter | MATR     |      | 0                        | NEUTRON MATRIX(0=LIME,1=SAND,2=DOLO) |   |
| 20 | ~Parameter | MDEN     |      | 2710                     | LOGGING MATRIX DENSITY               |   |
| 21 | ~Parameter | RMF      | OHMM | 0.216                    | MUD FILTRATE RESISTIVITY             |   |
| 22 | ~Parameter | DFD      | K/M3 | 1525                     | DRILL FLUID DENSITY                  |   |
| 23 | ~Curves    | DEPT     | M    |                          | 1 DEPTH                              |   |
| 24 | ~Curves    | DT       | US/M |                          | 2 SONIC TRANSIT TIME                 |   |
| 25 | ~Curves    | RHOB     | K/M3 |                          | 3 BULK DENSITY                       |   |
| 26 | ~Curves    | NPHI     | V/V  |                          | 4 NEUTRON POROSITY                   |   |
| 27 | ~Curves    | CSH      | OHMM |                          | 5 MUD RESISTIVITY                    |   |

The “Curves” sheet contains the data as a table, with the curve mnemonics as a header row.



## 7.2.2 Script interfaces

### 7.2.2.1 Single file

```
(py36) C:\Program Files (x86)\Misc\kentcode\lasio>las2excel --help
usage: Convert LAS file to XLSX [-h] LAS_filename XLSX_filename

positional arguments:
  LAS_filename
  XLSX_filename

optional arguments:
  -h, --help            show this help message and exit

(py36) C:\Program Files (x86)\Misc\kentcode\lasio>las2excel tests\examples\sample.las_
↪c:\users\kinverarity\Desktop\sample.xlsx
```

### 7.2.2.2 Multiple files (las2excelbulk)

The better script to use is las2excelbulk:

```
(py36) C:\Windows\System32>las2excelbulk --help
usage: Convert LAS files to XLSX [-h] [-g GLOB] [-r] [-i] path

positional arguments:
  path

optional arguments:
  -h, --help            show this help message and exit
  -g GLOB, --glob GLOB  Match LAS files with this pattern (default: *.las)
  -r, --recursive        Recurse through subfolders. (default: False)
  -i, --ignore-header-errors
                        Ignore header section errors. (default: False)
```

Here is the command to create Excel versions of all the LAS files contained within the folder test\_folder, and any sub-folders:

```
(py36) C:\Users\kinverarity\Documents\scratch2017\November>las2excelbulk --recursive_
↳test_folder
Converting test_folder\~-2793 & -2746\5086\PN41497.LAS -> test_folder\~-2793 & -
↳2746\5086\pn41497.xlsx
Converting test_folder\~-2793 & -2746\5149\PN41497.LAS -> test_folder\~-2793 & -
↳2746\5149\pn41497.xlsx
Converting test_folder\~-2794\6356\66302794.las -> test_folder\~-2794\6356\66302794.xlsx
Converting test_folder\~-2794\6808\66302794.las -> test_folder\~-2794\6808\66302794.xlsx
Converting test_folder\~-2794\7608\2794HYD.LAS -> test_folder\~-2794\7608\2794hyd.xlsx
Converting test_folder\~-2794\7608\66302794.LAS -> test_folder\~-2794\7608\66302794.xlsx
Failed to convert file. Error message:
Traceback (most recent call last):
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\excel.py", line 133, in main_
↳bulk
    l = las.LASFile(lasfn)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 77, in __init__
    self.read(file_ref, **read_kwargs)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 204, in read
    data = np.reshape(arr, (-1, n_arr_cols))
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-
↳packages\numpy\core\fromnumeric.py", line 232, in reshape
    return _wrapfunc(a, 'reshape', newshape, order=order)
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-
↳packages\numpy\core\fromnumeric.py", line 57, in _wrapfunc
    return getattr(obj, method)(*args, **kwds)
ValueError: cannot reshape array of size 25708 into shape (11)

Converting test_folder\~-2794\7627\clr105.las -> test_folder\~-2794\7627\clr105.xlsx
Converting test_folder\~-2839 &c\4830\PN36385.LAS -> test_folder\~-2839 &c\4830\pn36385.
↳xlsx
Converting test_folder\~-2874\6375\66302874.las -> test_folder\~-2874\6375\66302874.xlsx
Converting test_folder\~-2874\7607\2874HYD.LAS -> test_folder\~-2874\7607\2874hyd.xlsx
Converting test_folder\~-2874\7607\66302874.LAS -> test_folder\~-2874\7607\66302874.xlsx
Failed to convert file. Error message:
Traceback (most recent call last):
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\excel.py", line 133, in main_
↳bulk
    l = las.LASFile(lasfn)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 77, in __init__
    self.read(file_ref, **read_kwargs)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 204, in read
    data = np.reshape(arr, (-1, n_arr_cols))
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-
↳packages\numpy\core\fromnumeric.py", line 232, in reshape
    return _wrapfunc(a, 'reshape', newshape, order=order)
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-
↳packages\numpy\core\fromnumeric.py", line 57, in _wrapfunc
    return getattr(obj, method)(*args, **kwds)
ValueError: cannot reshape array of size 31666 into shape (16)

Converting test_folder\~-2874\7626\clr121.las -> test_folder\~-2874\7626\clr121.xlsx
Converting test_folder\~-2875\5220\1cm\PN44456.LAS -> test_folder\~-
↳2875\5220\1cm\pn44456.xlsx
Converting test_folder\~-2875\5220\5cm\PN44456.LAS -> test_folder\~-
↳2875\5220\5cm\pn44456.xlsx
Converting test_folder\~-2875\5220\980402\PN44456.LAS -> test_folder\~-
↳2875\5220\980402\pn44456.xlsx
```

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```

Converting test_folder\2875\5220\980403_0\PN44456.LAS -> test_folder\2875\5220\980403_0\pn44456.xlsx
Converting test_folder\2875\5220\980403_1\PN44456.LAS -> test_folder\2875\5220\980403_1\pn44456.xlsx
Converting test_folder\2875\5220\callcm\PN44456.LAS -> test_folder\2875\5220\callcm\pn44456.xlsx
Converting test_folder\2875\5220\cal5cm\PN44456.LAS -> test_folder\2875\5220\cal5cm\pn44456.xlsx
Converting test_folder\2875\5220\tm2\PN44456.LAS -> test_folder\2875\5220\tm2\pn44456.xlsx
Converting test_folder\2875\6813\2875HYD.LAS -> test_folder\2875\6813\2875hyd.xlsx
Header section Parameter regexp=~P was not found.
Converting test_folder\2875\6813\66302875.LAS -> test_folder\2875\6813\66302875.xlsx
Converting test_folder\2876\5219\PN44457.LAS -> test_folder\2876\5219\pn44457.xlsx
Converting test_folder\2876\5219\PN44457H.LAS -> test_folder\2876\5219\pn44457h.xlsx
Converting test_folder\2876\5219\PN44457I.LAS -> test_folder\2876\5219\pn44457i.xlsx
Converting test_folder\2876\7609\2876H.LAS -> test_folder\2876\7609\2876h.xlsx
Converting test_folder\2876\7609\66302876.LAS -> test_folder\2876\7609\66302876.xlsx
Failed to convert file. Error message:
Traceback (most recent call last):
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\excel.py", line 133, in main_bulk
    l = las.LASFile(lasfn)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 77, in __init__
    self.read(file_ref, **read_kwargs)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 204, in read
    data = np.reshape(arr, (-1, n_arr_cols))
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-packages\numpy\core\fromnumeric.py", line 232, in reshape
    return _wrapfunc(a, 'reshape', newshape, order=order)
  File "C:\Program Files (x86)\Miniconda3\envs\py36\lib\site-packages\numpy\core\fromnumeric.py", line 57, in _wrapfunc
    return getattr(obj, method)(*args, **kwds)
ValueError: cannot reshape array of size 19791 into shape (11)

Converting test_folder\2876\7629\clr120.las -> test_folder\2876\7629\clr120.xlsx
Converting test_folder\2877\7597\CLR118.LAS -> test_folder\2877\7597\clr118.xlsx
Converting test_folder\2877\7628\clr118.las -> test_folder\2877\7628\clr118.xlsx
Converting test_folder\3066\6372\66303066.las -> test_folder\3066\6372\66303066.xlsx
Converting test_folder\3066\6810\3066HYD.LAS -> test_folder\3066\6810\3066hyd.xlsx
Converting test_folder\3066\6810\66303066.LAS -> test_folder\3066\6810\66303066.xlsx
Converting test_folder\3067\6373\66303067.las -> test_folder\3067\6373\66303067.xlsx
Converting test_folder\3067\6811\3067HYD.LAS -> test_folder\3067\6811\3067hyd.xlsx
Converting test_folder\3067\6811\66303067.LAS -> test_folder\3067\6811\66303067.xlsx
Header section Parameter regexp=~P was not found.
Converting test_folder\3068\6374\66303068.las -> test_folder\3068\6374\66303068.xlsx
Converting test_folder\3068\6812\3068HYD.LAS -> test_folder\3068\6812\3068hyd.xlsx
Converting test_folder\3068\6812\66303068.LAS -> test_folder\3068\6812\66303068.xlsx

```

Notice that some LAS files raised exceptions (in this case, `ValueError`) and were not converted. In some cases these will relate to errors in the header sections:

```

(py36) Q:\>las2excelbulk.exe -r .
Converting .\4424\PN31769.LAS -> .\4424\pn31769.xlsx
Converting .\4424\PN31769L.LAS -> .\4424\pn31769l.xlsx
Converting .\4424\PN31769R.LAS -> .\4424\pn31769r.xlsx

```

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```

Converting .\4428\pn31769.las -> .\4428\pn31769.xlsx
Failed to convert file. Error message:
Traceback (most recent call last):
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\reader.py", line 366, in _
↳ parse_header_section
    values = read_line(line)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\reader.py", line 522, in _
↳ read_line
    return read_header_line(*args, **kwargs)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\reader.py", line 548, in _
↳ read_header_line
    mdict = m.groupdict()
AttributeError: 'NoneType' object has no attribute 'groupdict'

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\excel.py", line 133, in main_
↳ bulk
    l = las.LASFile(lasfn, ignore_header_errors=args.ignore_header_errors)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 77, in __init__
    self.read(file_ref, **read_kwargs)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 156, in read
    ignore_header_errors=ignore_header_errors)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\las.py", line 110, in add_
↳ section
    **sect_kws)
  File "c:\program files (x86)\misc\kentcode\lasio\lasio\reader.py", line 375, in _
↳ parse_header_section
    raise exceptions.LASHeaderError(message)
lasio.exceptions.LASHeaderError: Line #21 - failed in ~Well Information section on_
↳ line:
PN      PERMIT NUMBER: 31769AttributeError: 'NoneType' object has no attribute
↳ 'groupdict'

Converting .\4526\PENRICE.LAS -> .\4526\penrice.xlsx

```

But in this case I'm happy to lose that single corrupted line in the header in the conversion. In order to force lasio to ignore the error and continue to convert the file, use the `--ignore-header-errors` flag (`-i` for short):

```

(py36) Q:> las2excelbulk.exe -r -i .
Converting .\4424\PN31769.LAS -> .\4424\pn31769.xlsx
Converting .\4424\PN31769L.LAS -> .\4424\pn31769l.xlsx
Converting .\4424\PN31769R.LAS -> .\4424\pn31769r.xlsx
Converting .\4428\pn31769.las -> .\4428\pn31769.xlsx
Line #21 - failed in ~Well Information section on line:
PN      PERMIT NUMBER: 31769AttributeError: 'NoneType' object has no attribute
↳ 'groupdict'
Converting .\4526\PENRICE.LAS -> .\4526\penrice.xlsx

```

lasio still reports the problem, but ignores it and continues the conversion of the file.



---

## Building a LAS file from scratch

---

When you create a LASFile from scratch, it comes with some default metadata:

```
In [5]: import lasio

In [6]: las = lasio.LASFile()

In [7]: las.header
Out[7]:
{'Curves': [],
 'Other': '',
 'Parameter': [],
 'Version': [HeaderItem(mnemonic=VERS, unit=, value=2.0, descr=CWLS log ASCII,
↳ Standard -VERSION 2.0, original_mnemonic=VERS),
  HeaderItem(mnemonic=WRAP, unit=, value=NO, descr=One line per depth step, original_
↳ mnemonic=WRAP),
  HeaderItem(mnemonic=DLM, unit=, value=SPACE, descr=Column Data Section Delimiter,
↳ original_mnemonic=DLM)],
 'Well': [HeaderItem(mnemonic=STRT, unit=m, value=nan, descr=START DEPTH, original_
↳ mnemonic=STRT),
  HeaderItem(mnemonic=STOP, unit=m, value=nan, descr=STOP DEPTH, original_
↳ mnemonic=STOP),
  HeaderItem(mnemonic=STEP, unit=m, value=nan, descr=STEP, original_mnemonic=STEP),
  HeaderItem(mnemonic=NULL, unit=, value=-9999.25, descr=NULL VALUE, original_
↳ mnemonic=NULL),
  HeaderItem(mnemonic=COMP, unit=, value=, descr=COMPANY, original_mnemonic=COMP),
  HeaderItem(mnemonic=WELL, unit=, value=, descr=WELL, original_mnemonic=WELL),
  HeaderItem(mnemonic=FLD, unit=, value=, descr=FIELD, original_mnemonic=FLD),
  HeaderItem(mnemonic=LOC, unit=, value=, descr=LOCATION, original_mnemonic=LOC),
  HeaderItem(mnemonic=PROV, unit=, value=, descr=PROVINCE, original_mnemonic=PROV),
  HeaderItem(mnemonic=CNTY, unit=, value=, descr=COUNTY, original_mnemonic=CNTY),
  HeaderItem(mnemonic=STAT, unit=, value=, descr=STATE, original_mnemonic=STAT),
  HeaderItem(mnemonic=CTRY, unit=, value=, descr=COUNTRY, original_mnemonic=CTRY),
  HeaderItem(mnemonic=SRVC, unit=, value=, descr=SERVICE COMPANY, original_
↳ mnemonic=SRVC),
```

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```
HeaderItem(mnemonic=DATE, unit=, value=, descr=DATE, original_mnemonic=DATE),
HeaderItem(mnemonic=UWI, unit=, value=, descr=UNIQUE WELL ID, original_
↪mnemonic=UWI),
HeaderItem(mnemonic=API, unit=, value=, descr=API NUMBER, original_mnemonic=API)}}
```

In our case, let's set the correct date:

```
In [8]: from datetime import datetime

In [9]: las.well.DATE = str(datetime.today())
```

And add some new header fields:

```
In [10]: las.params['ENG'] = lasio.HeaderItem('ENG', value='Kent Inverarity')

In [11]: las.params['LMF'] = lasio.HeaderItem('LMF', value='GL')

In [12]: las.other = 'Example of how to create a LAS file from scratch using lasio'
```

We will invent some data for a curve:

```
In [1]: import numpy as np

In [2]: depths = np.arange(10, 50, 0.5)

In [3]: synth = np.log10(depths)*5+np.random.random(len(depths))

In [4]: synth[:8] = np.nan
```

...add these to the LASFile object:

```
In [13]: las.add_curve('DEPT', depths, unit='m')

In [14]: las.add_curve('SYNTH', synth, descr='fake data')
```

And write the result to files:

```
In [16]: las.write('scratch_v1.2.las', version=1.2)

In [15]: las.write('scratch_v2.las', version=2)
```

Here is the resulting scratch\_v1.2.las:

```
1 ~Version -----
2 VERS.   1.2 : CWLS LOG ASCII STANDARD - VERSION 1.2
3 WRAP.    NO : One line per depth step
4 DLM . SPACE : Column Data Section Delimiter
5 ~Well -----
6 STRT.m      10.0 : START DEPTH
7 STOP.m      49.5 : STOP DEPTH
8 STEP.m       0.5 : STEP
9 NULL.     -9999.25 : NULL VALUE
10 COMP.      COMPANY :
11 WELL.      WELL :
12 FLD .      FIELD :
13 LOC .      LOCATION :
```

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```

14 PROV.          PROVINCE :
15 CNTY.          COUNTY  :
16 STAT.          STATE   :
17 CTRY.          COUNTRY  :
18 SRVC. SERVICE COMPANY :
19 DATE.          DATE    : 2017-11-04 15:33:20.963287
20 UWI .  UNIQUE WELL ID :
21 API .    API NUMBER  :
22 ~Curves -----
23 DEPT .m   :
24 SYNTH.    : fake data
25 ~Params -----
26 ENG. Kent Inverarity :
27 LMF.          GL      :
28 ~Other -----
29 Example of how to create a LAS file from scratch using lasio
30 ~ASCII -----
31      10      -9999.25
32      10.5    -9999.25
33      11      -9999.25
34      11.5    -9999.25
35      12      -9999.25
36      12.5    -9999.25
37      13      -9999.25
38      13.5    -9999.25
39      14       5.799
40      14.5     6.3938
41      15       6.4122
42      15.5     6.4605
43      16       6.9518
44      16.5     6.567
45      17       6.3816
46      17.5     6.2872
47      18       6.4336
48      18.5     7.0252
49      19       6.7988
50      19.5     6.7172
51      20       6.6929
52      20.5     7.0971
53      21       7.145
54      21.5     6.7192
55      22       7.6034
56      22.5     7.3078
57      23       7.2213
58      23.5     7.668
59      24       7.853
60      24.5     7.4073
61      25       7.4238
62      25.5     7.9173
63      26       7.1282
64      26.5     7.4131
65      27       7.8014
66      27.5     7.348
67      28       7.9
68      28.5     7.6294
69      29       8.1244
70      29.5     7.9835

```

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|     |      |        |
|-----|------|--------|
| 71  | 30   | 7.4759 |
| 72  | 30.5 | 8.3766 |
| 73  | 31   | 7.4717 |
| 74  | 31.5 | 7.6432 |
| 75  | 32   | 8.2327 |
| 76  | 32.5 | 7.6541 |
| 77  | 33   | 8.4481 |
| 78  | 33.5 | 7.8811 |
| 79  | 34   | 8.2332 |
| 80  | 34.5 | 8.4302 |
| 81  | 35   | 7.7218 |
| 82  | 35.5 | 8.71   |
| 83  | 36   | 8.3965 |
| 84  | 36.5 | 8.4355 |
| 85  | 37   | 8.6836 |
| 86  | 37.5 | 8.2236 |
| 87  | 38   | 8.4997 |
| 88  | 38.5 | 8.6656 |
| 89  | 39   | 8.8295 |
| 90  | 39.5 | 8.1707 |
| 91  | 40   | 8.9034 |
| 92  | 40.5 | 8.681  |
| 93  | 41   | 8.1698 |
| 94  | 41.5 | 8.3001 |
| 95  | 42   | 9.0266 |
| 96  | 42.5 | 8.4398 |
| 97  | 43   | 8.7562 |
| 98  | 43.5 | 8.2673 |
| 99  | 44   | 8.4682 |
| 100 | 44.5 | 8.5801 |
| 101 | 45   | 8.9065 |
| 102 | 45.5 | 8.8392 |
| 103 | 46   | 8.661  |
| 104 | 46.5 | 9.2355 |
| 105 | 47   | 9.0468 |
| 106 | 47.5 | 8.8249 |
| 107 | 48   | 9.0298 |
| 108 | 48.5 | 8.6864 |
| 109 | 49   | 8.5745 |
| 110 | 49.5 | 8.6143 |

and scratch\_v2.las:

```

1 ~Version -----
2 VERS. 2.0 : CWLS log ASCII Standard -VERSION 2.0
3 WRAP. NO : One line per depth step
4 DLM . SPACE : Column Data Section Delimiter
5 ~Well -----
6 STRT.m 10.0 : START DEPTH
7 STOP.m 49.5 : STOP DEPTH
8 STEP.m 0.5 : STEP
9 NULL. -9999.25 : NULL VALUE
10 COMP. : COMPANY
11 WELL. : WELL
12 FLD . : FIELD
13 LOC . : LOCATION
14 PROV. : PROVINCE

```

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```

15 CNTY.                : COUNTY
16 STAT.               : STATE
17 CTRY.               : COUNTRY
18 SRVC.               : SERVICE COMPANY
19 DATE. 2017-11-04 15:33:20.963287 : DATE
20 UWI .               : UNIQUE WELL ID
21 API .               : API NUMBER
22 ~Curves -----
23 DEPT .m :
24 SYNTH. : fake data
25 ~Params -----
26 ENG. Kent Inverarity :
27 LMF.           GL :
28 ~Other -----
29 Example of how to create a LAS file from scratch using lasio
30 ~ASCII -----
31      10      -9999.25
32      10.5    -9999.25
33      11      -9999.25
34      11.5    -9999.25
35      12      -9999.25
36      12.5    -9999.25
37      13      -9999.25
38      13.5    -9999.25
39      14       5.799
40      14.5     6.3938
41      15      6.4122
42      15.5     6.4605
43      16      6.9518
44      16.5     6.567
45      17      6.3816
46      17.5     6.2872
47      18      6.4336
48      18.5     7.0252
49      19      6.7988
50      19.5     6.7172
51      20      6.6929
52      20.5     7.0971
53      21      7.145
54      21.5     6.7192
55      22      7.6034
56      22.5     7.3078
57      23      7.2213
58      23.5     7.668
59      24      7.853
60      24.5     7.4073
61      25      7.4238
62      25.5     7.9173
63      26      7.1282
64      26.5     7.4131
65      27      7.8014
66      27.5     7.348
67      28       7.9
68      28.5     7.6294
69      29      8.1244
70      29.5     7.9835
71      30      7.4759

```

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|     |      |        |
|-----|------|--------|
| 72  | 30.5 | 8.3766 |
| 73  | 31   | 7.4717 |
| 74  | 31.5 | 7.6432 |
| 75  | 32   | 8.2327 |
| 76  | 32.5 | 7.6541 |
| 77  | 33   | 8.4481 |
| 78  | 33.5 | 7.8811 |
| 79  | 34   | 8.2332 |
| 80  | 34.5 | 8.4302 |
| 81  | 35   | 7.7218 |
| 82  | 35.5 | 8.71   |
| 83  | 36   | 8.3965 |
| 84  | 36.5 | 8.4355 |
| 85  | 37   | 8.6836 |
| 86  | 37.5 | 8.2236 |
| 87  | 38   | 8.4997 |
| 88  | 38.5 | 8.6656 |
| 89  | 39   | 8.8295 |
| 90  | 39.5 | 8.1707 |
| 91  | 40   | 8.9034 |
| 92  | 40.5 | 8.681  |
| 93  | 41   | 8.1698 |
| 94  | 41.5 | 8.3001 |
| 95  | 42   | 9.0266 |
| 96  | 42.5 | 8.4398 |
| 97  | 43   | 8.7562 |
| 98  | 43.5 | 8.2673 |
| 99  | 44   | 8.4682 |
| 100 | 44.5 | 8.5801 |
| 101 | 45   | 8.9065 |
| 102 | 45.5 | 8.8392 |
| 103 | 46   | 8.661  |
| 104 | 46.5 | 9.2355 |
| 105 | 47   | 9.0468 |
| 106 | 47.5 | 8.8249 |
| 107 | 48   | 9.0298 |
| 108 | 48.5 | 8.6864 |
| 109 | 49   | 8.5745 |
| 110 | 49.5 | 8.6143 |

## CHAPTER 9

---

### Character encodings

---

There are four options:

1. Specify the encoding (internally lasio uses the `open` function from `codecs` which is part of the standard library):

```
>>> las = lasio.read('example.las', encoding='windows-1252')
```

2. Do nothing. By default `lasio.read()` uses the keyword argument `autodetect_encoding=True`. This will try to open the file with a few different encodings, like ‘ascii’, ‘windows-1252’, and ‘latin-1’. The first one to raise no `UnicodeDecodeError` exceptions will be used.

This may still result in an error, or incorrectly decoded characters.

3. Install a package like `cChardet` (faster) or `chardet` (slower) to automatically detect the character encoding. If these packages are installed then lasio will use them by default:

```
>>> import logging
>>> logging.basicConfig()
>>> logging.getLogger().setLevel(logging.DEBUG)
>>> las = lasio.read('encodings_utf8.las')
DEBUG:lasio.reader:get_encoding Using cchardet
DEBUG:lasio.reader:cchardet method detected encoding of UTF-8 at confidence 0.
↪ 9900000095367432
INFO:lasio.reader:Opening encodings_utf8.las as UTF-8 and treating errors with
↪ "replace"
DEBUG:lasio.las:n_curves=8 ncols=8
DEBUG:lasio.las:set_data data.shape = (3, 8)
DEBUG:lasio.las:set_data self.data.shape = (3, 8)
```

This may still result in an error, or incorrectly decoded characters.

If you are certain that you have no “extended characters” (or that you don’t care), you can easily speed up lasio’s performance by using:

```
>>> try:
...     las = lasio.read('example.las', autodetect_encoding=False)
```

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```
... except UnicodeDecodeError:  
...     continue
```

### 10.1 Module contents

`lasio.read(file_ref, **kwargs)`

Read a LAS file.

Note that only versions 1.2 and 2.0 of the LAS file specification are currently supported.

**Parameters** `file_ref` (*file-like object*, *str*) – either a filename, an open file object, or a string containing the contents of a file.

**Returns** A LASFile object representing the file – see above

There are a number of optional keyword arguments that can be passed to this function that control how the LAS file is opened and parsed. Any of the keyword arguments from the below functions can be used here:

- `lasio.reader.open_with_codecs()` - manage issues relate to character encodings
- `lasio.las.LASFile.read()` - control how NULL values and errors are handled during parsing

### 10.2 Submodules

### 10.3 lasio.las module

`class lasio.las.LASFile(file_ref=None, **read_kwargs)`

Bases: `object`

LAS file object.

**Keyword Arguments** `file_ref` (*file-like object*, *str*) – either a filename, an open file object, or a string containing the contents of a file.

See these routines for additional keyword arguments you can use when reading in a LAS file:

- `lasio.reader.open_with_codecs()` - manage issues relate to character encodings

- `lasio.las.LASFile.read()` - control how NULL values and errors are handled during parsing

**encoding**

the character encoding used when reading the file in from disk

Type `str` or `None`

**read** (*file\_ref*, *ignore\_data=False*, *read\_policy='default'*, *null\_policy='strict'*, *ignore\_header\_errors=False*, *mnemonic\_case='upper'*, *index\_unit=None*, *\*\*kwargs*)  
Read a LAS file.

**Parameters** *file\_ref* (*file-like object*, *str*) – either a filename, an open file object, or a string containing the contents of a file.

**Keyword Arguments**

- **null\_policy** (*str* or *list*) – see <http://lasio.readthedocs.io/en/latest/data-section.html#handling-invalid-data-indicators-automatically>
- **ignore\_data** (*bool*) – if True, do not read in any of the actual data, just the header metadata. False by default.
- **ignore\_header\_errors** (*bool*) – ignore LASHeaderErrors (False by default)
- **mnemonic\_case** (*str*) – ‘preserve’: keep the case of HeaderItem mnemonics ‘upper’: convert all HeaderItem mnemonics to uppercase ‘lower’: convert all HeaderItem mnemonics to lowercase
- **index\_unit** (*str*) – Optionally force-set the index curve’s unit to “m” or “ft”

See `lasio.reader.open_with_codecs()` for additional keyword arguments which help to manage issues relate to character encodings.

**write** (*file\_ref*, *\*\*kwargs*)  
Write LAS file to disk.

**Parameters** *file\_ref* (*open file-like object* or *str*) – a file-like object opening for writing, or a filename.

All *\*\*kwargs* are passed to `lasio.writer.write()` – please check the docstring of that function for more keyword arguments you can use here!

**Examples**

```
>>> import lasio
>>> las = lasio.read("tests/examples/sample.las")
>>> with open('test_output.las', mode='w') as f:
...     las.write(f, version=2.0)    # <-- this method
```

**to\_excel** (*filename*)  
Export LAS file to a Microsoft Excel workbook.

This function will raise an `ImportError` if `openpyxl` is not installed.

**Parameters** *filename* (*str*) –

**to\_csv** (*file\_ref*, *mnemonics=True*, *units=True*, *units\_loc='line'*, *\*\*kwargs*)  
Export to a CSV file.

**Parameters** *file\_ref* (*open file-like object* or *str*) – a file-like object opening for writing, or a filename.

**Keyword Arguments**

- **mnemonics** (*list*, *True*, *False*) – write mnemonics as a header line at the start. If list, use the supplied items as mnemonics. If True, use the curve mnemonics.
- **units** (*list*, *True*, *False*) – as for mnemonics.
- **units\_loc** (*str* or *None*) – either ‘line’, ‘[]’ or ‘()’. ‘line’ will put units on the line following the mnemonics (good for WellCAD). ‘[]’ and ‘()’ will put the units in either brackets or parentheses following the mnemonics, on the single header line (better for Excel)
- **\*\*kwargs** – passed to `csv.writer`. Note that if `lineterminator` is **not** specified here, then it will be sent to `csv.writer` as `lineterminator='\n'`.

**match\_raw\_section** (*pattern*, *re\_func*=‘match’, *flags*=<*RegexFlag.IGNORECASE: 2*>)

Find raw section with a regular expression.

**Parameters** *pattern* (*str*) – regular expression (you need to include the tilde)

**Keyword Arguments**

- **re\_func** (*str*) – either “match” or “search”, see python `re` module.
- **flags** (*int*) – flags for `re.compile()`

**Returns** dict

Intended for internal use only.

**get\_curve** (*mnemonic*)

Return CurveItem object.

**Parameters** *mnemonic* (*str*) – the name of the curve

**Returns** `lasio.las_items.CurveItem` (not just the data array)

**keys** ()

Return curve mnemonics.

**values** ()

Return data for each curve.

**items** ()

Return mnemonics and data for all curves.

**iterkeys** ()

**itervalues** ()

**iteritems** ()

**version**

Header information from the Version (~V) section.

**Returns** `lasio.las_items.SectionItems` object.

**well**

Header information from the Well (~W) section.

**Returns** `lasio.las_items.SectionItems` object.

**curves**

Curve information and data from the Curves (~C) and data section..

**Returns** `lasio.las_items.SectionItems` object.

**curvesdict**

Curve information and data from the Curves (~C) and data section..

**Returns** dict

**params**

Header information from the Parameter (~P) section.

**Returns** `lasio.las_items.SectionItems` object.

**other**

Header information from the Other (~O) section.

**Returns** str

**metadata**

All header information joined together.

**Returns** `lasio.las_items.SectionItems` object.

**header**

All header information

**Returns** dict

**df()**

Return data as a `pandas.DataFrame` structure.

The first Curve of the LASFile object is used as the `pandas.DataFrame`'s index.

**data**

**set\_data** (*array\_like*, *names=None*, *truncate=False*)

Set the data for the LAS; actually sets data on individual curves.

**Parameters** **array\_like** (*array\_like* or `pandas.DataFrame`) – 2-D data array

**Keyword Arguments**

- **names** (*list*, *optional*) – used to replace the names of the existing `lasio.las_items.CurveItem` objects.
- **truncate** (*bool*) – remove any columns which are not included in the Curves (~C) section.

Note: you can pass a `pandas.DataFrame` to this method.

**set\_data\_from\_df** (*df*, *\*\*kwargs*)

Set the LAS file data from a `pandas.DataFrame`.

**Parameters** **df** (`pandas.DataFrame`) – curve mnemonics are the column names. The depth column for the curves must be the index of the `DataFrame`.

Keyword arguments are passed to `lasio.las.LASFile.set_data()`.

**stack\_curves** (*mnemonic*, *sort\_curves=True*)

Stack multi-channel curve data to a numpy 2D ndarray. Provide a stub name (prefix shared by all curves that will be stacked) or a list of curve mnemonic strings.

**Keyword Arguments**

- **mnemonic** (*str* or *list*) – Supply the first several characters of the channel set to be stacked. Alternatively, supply a list of the curve names (mnemonics strings) to be stacked.
- **sort\_curves** (*bool*) – Natural sort curves based on mnemonic prior to stacking.

**Returns** 2-D numpy array

**index**

Return data from the first column of the LAS file data (depth/time).

**depth\_m**

Return the index as metres.

**depth\_ft**

Return the index as feet.

**add\_curve\_raw** (*mnemonic*, *data*, *unit*=", *descr*", *value*=")

Deprecated. Use `append_curve_item()` or `insert_curve_item()` instead.

**append\_curve\_item** (*curve\_item*)

Add a `CurveItem`.

**Parameters** *curve\_item* (*lasio.CurveItem*) –

**insert\_curve\_item** (*ix*, *curve\_item*)

Insert a `CurveItem`.

**Parameters**

- **ix** (*int*) – position to insert `CurveItem` i.e. 0 for start
- **curve\_item** (*lasio.CurveItem*) –

**add\_curve** (\**args*, \*\**kwargs*)

Deprecated. Use `append_curve()` or `insert_curve()` instead.

**append\_curve** (*mnemonic*, *data*, *unit*=", *descr*", *value*=")

Add a curve.

**Parameters**

- **mnemonic** (*str*) – the curve mnemonic
- **data** (*1D ndarray*) – the curve data

**Keyword Arguments**

- **unit** (*str*) – curve unit
- **descr** (*str*) – curve description
- **value** (*int/float/str*) – value e.g. API code.

**insert\_curve** (*ix*, *mnemonic*, *data*, *unit*=", *descr*", *value*=")

Insert a curve.

**Parameters**

- **ix** (*int*) – position to insert curve at i.e. 0 for start.
- **mnemonic** (*str*) – the curve mnemonic
- **data** (*1D ndarray*) – the curve data

**Keyword Arguments**

- **unit** (*str*) – curve unit
- **descr** (*str*) – curve description
- **value** (*int/float/str*) – value e.g. API code.

**delete\_curve** (*mnemonic*=None, *ix*=None)

Delete a curve.

**Keyword Arguments**

- **ix** (*int*) – index of curve in `LASFile.curves`.

- **mnemonic** (*str*) – mnemonic of curve.

The index takes precedence over the mnemonic.

#### **json**

Return object contents as a JSON string.

**class** lasio.las.Las (*file\_ref=None, \*\*read\_kwargs*)

Bases: `lasio.las.LASFile`

LAS file object.

Retained for backwards compatibility.

**class** lasio.las.JSONEncoder (\*, *skipkeys=False, ensure\_ascii=True, check\_circular=True, allow\_nan=True, sort\_keys=False, indent=None, separators=None, default=None*)

Bases: `json.encoder.JSONEncoder`

**default** (*obj*)

Implement this method in a subclass such that it returns a serializable object for `o`, or calls the base implementation (to raise a `TypeError`).

For example, to support arbitrary iterators, you could implement default like this:

```
def default(self, o):
    try:
        iterable = iter(o)
    except TypeError:
        pass
    else:
        return list(iterable)
    # Let the base class default method raise the TypeError
    return JSONEncoder.default(self, o)
```

## 10.4 lasio.las\_items module

**class** lasio.las\_items.HeaderItem (*mnemonic="", unit="", value="", descr="", data=None*)

Bases: `collections.OrderedDict`

Dictionary/namedtuple-style object for a LAS header line.

#### **Parameters**

- **mnemonic** (*str*) – the mnemonic
- **unit** (*str*) – the unit (no whitespace!)
- **value** (*str*) – value
- **descr** (*str*) – description

These arguments are available for use as either items or attributes of the object.

**\_\_init\_\_** (*mnemonic="", unit="", value="", descr="", data=None*)

Initialize self. See `help(type(self))` for accurate signature.

**set\_session\_mnemonic\_only** (*value*)

Set the mnemonic for session use.

See source comments for `lasio.las_items.HeaderItem.__init__` for a more in-depth explanation.

`__getitem__` (*key*)  
Provide item dictionary-like access.

`__setattr__` (*key*, *value*)  
Implement setattr(self, name, value).

`__repr__` ()  
Return repr(self).

`__reduce__` ()  
Return state information for pickling

**class** lasio.las\_items.CurveItem (*mnemonic*="", *unit*="", *value*="", *descr*="", *data*=None)  
Bases: `lasio.las_items.HeaderItem`

Dictionary/namedtuple-style object for a LAS curve.

See `lasio.las_items.HeaderItem`` for the (keyword) arguments.

**Keyword Arguments** *data* (*array-like*, 1-D) – the curve’s data.

`__init__` (*mnemonic*="", *unit*="", *value*="", *descr*="", *data*=None)  
Initialize self. See help(type(self)) for accurate signature.

**API\_code**  
Equivalent to the *value* attribute.

`__repr__` ()  
Return repr(self).

**class** lasio.las\_items.SectionItems (\**args*, \*\**kwargs*)  
Bases: `list`

Variant of a `list` which is used to represent a LAS section.

`__init__` (\**args*, \*\**kwargs*)  
Initialize self. See help(type(self)) for accurate signature.

`__str__` ()  
Return str(self).

`__contains__` (*testitem*)  
Check whether a header item or mnemonic is in the section.

**Parameters** *testitem* (`HeaderItem`, `CurveItem`, *str*) – either an item or a mnemonic

**Returns** `bool`

**keys** ()  
Return mnemonics of all the HeaderItems in the section.

**values** ()  
Return HeaderItems in the section.

**items** ()  
Return pairs of (mnemonic, HeaderItem) from the section.

`__getslice__` (*i0*, *i1*)  
For Python 2.7 compatibility.

`__getitem__` (*key*)  
Item-style access by either mnemonic or index.

**Parameters** *key* (*str*, *int*, *slice*) – either a mnemonic or the index to the list.

**Returns** item from the list (either `HeaderItem` or `CurveItem`)

`__delitem__` (*key*)

Delete item by either mnemonic or index.

**Parameters** *key* (*str*, *int*) – either a mnemonic or the index to the list.

`__setitem__` (*key*, *newitem*)

Either replace the item or its value.

**Parameters**

- **key** (*int*, *str*) – either the mnemonic or the index.
- **newitem** (`HeaderItem` or *str/float/int*) – the thing to be set.

If *newitem* is a `lasio.las_items.HeaderItem` then the existing item will be replaced. Otherwise the existing item's `value` attribute will be replaced.

i.e. this allows us to do

```
>>> from lasio import SectionItems, HeaderItem
>>> section = SectionItems(
...     [HeaderItem(mnemonic="OPERATOR", value="John")]
... )
>>> section.OPERATOR
HeaderItem(mnemonic=OPERATOR, unit=, value=John, descr=)
>>> section.OPERATOR = 'Kent'
>>> section.OPERATOR
HeaderItem(mnemonic=OPERATOR, unit=, value=Kent, descr=)
```

See `lasio.las_items.SectionItems.set_item()` and `lasio.las_items.SectionItems.set_item_value()`.

`__getattr__` (*key*)

Provide attribute access via `__contains__` e.g.

```
>>> from lasio import SectionItems, HeaderItem
>>> section = SectionItems(
...     [HeaderItem(mnemonic="VERS", value=1.2)]
... )
>>> section['VERS']
HeaderItem(mnemonic=VERS, unit=, value=1.2, descr=)
>>> 'VERS' in section
True
>>> section.VERS
HeaderItem(mnemonic=VERS, unit=, value=1.2, descr=)
```

`__setattr__` (*key*, *value*)

Allow access to `lasio.las_items.SectionItems.__setitem__()` via attribute access.

**set\_item** (*key*, *newitem*)

Replace an item by comparison of session mnemonics.

**Parameters**

- **key** (*str*) – the item mnemonic (or `HeaderItem` with mnemonic) you want to replace.
- **newitem** (`HeaderItem`) – the new item

If *key* is not present, it appends *newitem*.

**set\_item\_value** (*key*, *value*)

Set the `value` attribute of an item.

**Parameters**

- **key** (*str*) – the mnemonic of the item (or `HeaderItem` with the mnemonic) you want to edit
- **value** (*str*, *int*, *float*) – the new value.

**append** (*newitem*)

Append a new `HeaderItem` to the object.

**insert** (*i*, *newitem*)

Insert a new `HeaderItem` to the object.

**\_\_weakref\_\_**

list of weak references to the object (if defined)

**assign\_duplicate\_suffixes** (*test\_mnemonic=None*)

Check and re-assign suffixes for duplicate mnemonics.

**Parameters** **test\_mnemonic** (*str*, *optional*) – check for duplicates of this mnemonic. If it is `None`, check all mnemonics.

**dictview** ()

View of mnemonics and values as a dict.

**Returns** dict - keys are the mnemonics and the values are the `value` attributes.

## 10.5 lasio.reader module

**lasio.reader.check\_for\_path\_obj** (*file\_ref*)

Check if `file_ref` is a `pathlib.Path` object.

If `file_ref` is a `pathlib.Path` object, then return its absolute file path as a string so it will get processed as other string filenames.

If `pathlib` is not available, do nothing and return `file_ref`.

**lasio.reader.open\_file** (*file\_ref*, *\*\*encoding\_kwargs*)

Open a file if necessary.

If `autodetect_encoding=True` then either `cchardet` or `chardet` needs to be installed, or else an `ImportError` will be raised.

**Parameters** **file\_ref** (*file-like object*, *str*) – either a filename, an open file object, or a string containing the contents of a file.

See `lasio.reader.open_with_codecs()` for keyword arguments that can be used here.

**Returns** tuple of an open file-like object, and the encoding that was used to decode it (if it were read from disk).

**lasio.reader.open\_with\_codecs** (*filename*, *encoding=None*, *encoding\_errors='replace'*, *autodetect\_encoding=True*, *autodetect\_encoding\_chars=4000*)

Read Unicode data from file.

**Parameters** **filename** (*str*) – path to file

**Keyword Arguments**

- **encoding** (*str*) – character encoding to open `file_ref` with, using `codecs.open()`.

- **encoding\_errors** (*str*) – ‘strict’, ‘replace’ (default), ‘ignore’ - how to handle errors with encodings (see [this section](#) of the standard library’s `codecs` module for more information)
- **autodetect\_encoding** (*str or bool*) – default True to use `chardet`/`cchardet` to detect encoding. Note if set to False several common encodings will be tried but `chardet` won’t be used.
- **autodetect\_encoding\_chars** (*int/None*) – number of chars to read from LAS file for auto-detection of encoding.

**Returns** a unicode or string object

This function is called by `lasio.reader.open_file()`.

`lasio.reader.adhoc_test_encoding(filename)`

`lasio.reader.get_encoding(auto, raw)`

Automatically detect character encoding.

#### Parameters

- **auto** (*str*) – auto-detection of character encoding - can be either ‘chardet’, ‘cchardet’, False, or True (the latter will pick the fastest available option)
- **raw** (*bytes*) – array of bytes to detect from

**Returns** A string specifying the character encoding.

`lasio.reader.read_file_contents(file_obj, regexp_subs, value_null_subs, ignore_data=False)`

Read file contents into memory.

**Parameters** `file_obj` (*open file-like object*) –

#### Keyword Arguments

- **null\_subs** (*bool*) – True will substitute `numpy.nan` for invalid values
- **ignore\_data** (*bool*) – if True, do not read in the numerical data in the ~ASCII section

**Returns** `OrderedDict`

I think of the returned dictionary as a “raw section”. The keys are the first line of the LAS section, including the tilde. Each value is a dict with either:

```
{ "section_type": "header",
  "title": str,           # title of section (including the ~)
  "lines": [str, ],      # a list of the lines from the LAS file
  "line_nos": [int, ]    # line nos from the original file
}
```

or:

```
{ "section_type": "data",
  "title": str,           # title of section (including the ~)
  "start_line": int,      # location of data section (the title line)
  "ncols": int,          # no. of columns on first line of data,
  "array": ndarray        # 1-D numpy.ndarray,
}
```

`lasio.reader.read_data_section_iterative(file_obj, regexp_subs, value_null_subs)`

Read data section into memory.

#### Parameters

- **file\_obj** (*open file-like object*) – should be positioned in line-by-line reading mode, with the last line read being the title of the ~ASCII data section.
- **regex\_subs** (*list*) – each item should be a tuple of the pattern and substitution string for a call to `re.sub()` on each line of the data section. See `defaults.py` `READ_SUBS` and `NULL_SUBS` for examples.
- **value\_null\_subs** (*list*) – list of numerical values to be replaced by `numpy.nan` values.

**Returns** A 1-D numpy ndarray.

`lasio.reader.get_substitutions(read_policy, null_policy)`

Parse read and null policy definitions into a list of regexp and value substitutions.

#### Parameters

- **read\_policy** (*str, list, or substitution*) – either (1) a string defined in `defaults.READ_POLICIES`; (2) a list of substitutions as defined by the keys of `defaults.READ_SUBS`; or (3) a list of actual substitutions similar to the values of `defaults.READ_SUBS`. You can mix (2) and (3) together if you want.
- **null\_policy** (*str, list, or sub*) – as for `read_policy` but for `defaults.NULL_POLICIES` and `defaults.NULL_SUBS`

**Returns** `regex_subs`, `value_null_subs`, `version_NULL` - two lists and a bool. The first list is pairs of regexp patterns and substrs, and the second list is just a list of floats or integers. The bool is whether or not 'NULL' was located as a substitution.

`lasio.reader.parse_header_section(sectdict, version, ignore_header_errors=False, mnemonic_case='preserve')`

Parse a header section dict into a `SectionItems` containing `HeaderItems`.

#### Parameters

- **sectdict** (*dict*) – object returned from `lasio.reader.read_file_contents()`
- **version** (*float*) – either 1.2 or 2.0

#### Keyword Arguments

- **ignore\_header\_errors** (*bool*) – if True, issue `HeaderItem` parse errors as `logging.warning()` calls instead of a `lasio.exceptions.LASHeaderError` exception.
- **mnemonic\_case** (*str*) – 'preserve': keep the case of `HeaderItem` mnemonics 'upper': convert all `HeaderItem` mnemonics to uppercase 'lower': convert all `HeaderItem` mnemonics to lowercase

**Returns** `lasio.las_items.SectionItems`

**class** `lasio.reader.SectionParser(title, version=1.2)`

Bases: `object`

Parse lines from header sections.

**Parameters** **title** (*str*) – title line of section. Used to understand different order formatting across the special sections ~C, ~P, ~W, and ~V, depending on version 1.2 or 2.0.

**Keyword Arguments** **version** (*float*) – version to parse according to. Default is 1.2.

**num** (*x, default=None*)

Attempt to parse a number.

**Parameters**

- **x** (*str*, *int*, *float*) – potential number
- **default** (*int*, *float*, *None*) – fall-back option

**Returns** int, float, or **default** - from most to least preferred types.

**strip\_brackets** (*x*)

**metadata** (*\*\*keys*)

Return HeaderItem correctly formatted according to the order prescribed for LAS v 1.2 or 2.0 for the ~W section.

Keyword arguments should be the key:value pairs returned by `lasio.reader.read_header_line()`.

**curves** (*\*\*keys*)

Return CurveItem.

Keyword arguments should be the key:value pairs returned by `lasio.reader.read_header_line()`.

**params** (*\*\*keys*)

Return HeaderItem for ~P section (the same between 1.2 and 2.0 specs)

Keyword arguments should be the key:value pairs returned by `lasio.reader.read_header_line()`.

`lasio.reader.read_line(*args, **kwargs)`

Retained for backwards-compatibility.

See `lasio.reader.read_header_line()`.

`lasio.reader.read_header_line(line, pattern=None, section_name=None)`

Read a line from a LAS header section.

The line is parsed with a regular expression – see LAS file specs for more details, but it should basically be in the format:

|           |               |
|-----------|---------------|
| name.unit | value : descr |
|-----------|---------------|

**Parameters** **line** (*str*) – line from a LAS header section

**Returns** A dictionary with keys ‘name’, ‘unit’, ‘value’, and ‘descr’, each containing a string as value.

## 10.6 lasio.writer module

`lasio.writer.write(las, file_object, version=None, wrap=None, STRT=None, STOP=None, STEP=None, fmt='%0.5f', column_fmt=None, len_numeric_field=None, data_width=79, header_width=60)`

Write a LAS files.

**Parameters**

- **las** (*lasio.las.LASFile*) –
- **file\_object** (*file-like object open for writing*) – output
- **version** (*float or None*) – version of written file, either 1.2 or 2. If this is None, `las.version.VERS` value will be used.

- **wrap** (*bool* or *None*) – whether to wrap the output data section. If this is *None*, `lasio.version.WRAP` value will be used.
- **STRT** (*float* or *None*) – value to use as STRT (note the data will not be clipped). If this is *None*, the data value in the first column, first row will be used.
- **STOP** (*float* or *None*) – value to use as STOP (note the data will not be clipped). If this is *None*, the data value in the first column, last row will be used.
- **STEP** (*float* or *None*) – value to use as STEP (note the data will not be resampled and/or interpolated). If this is *None*, the STEP will be estimated from the first two rows of the first column.
- **fmt** (*str*) – Python string formatting operator for numeric data to be used.
- **column\_fmt** (*dict* or *None*) – use this to set a different format string for specific columns from the data ndarray. E.g. to use `'%.3f'` for the depth column and `'%.2f'` for all the other columns, you would use `fmt='%.2f', column_fmt={0: '%.3f'}`.
- **len\_numeric\_field** (*int*) – width of each numeric field column (must be greater than than all the formatted numeric values in the file).
- **data\_width** (79) – width of data field in characters

Creating an output file is not the only side-effect of this function. It will also modify the STRT, STOP and STEP HeaderItems so that they correctly reflect the ~Data section's units and the actual first, last, and interval values.

You should avoid calling this function directly - instead use the `lasio.las.LASFile.write()` method.

```
lasio.writer.get_formatter_function(order, left_width=None, middle_width=None)
```

Create function to format a LAS header item for output.

**Parameters** **order** – format of item, either 'descr:value' or 'value:descr'

**Keyword Arguments**

- **left\_width** (*int*) – number of characters to the left hand side of the first period
- **middle\_width** (*int*) – total number of characters minus 1 between the first period from the left and the first colon from the left.

**Returns** A function which takes a header item (e.g. `lasio.las_items.HeaderItem`) as its single argument and which in turn returns a string which is the correctly formatted LAS header line.

```
lasio.writer.get_section_order_function(section, version, order_definitions={1.2:
    {'Curves': ['value:descr'], 'Parameter':
    ['value:descr'], 'Version': ['value:descr'],
    'Well': ['descr:value', ('value:descr',
    ['STRT', 'STOP', 'STEP', 'NULL'])]}, 2.0:
    {'Curves': ['value:descr'], 'Parameter':
    ['value:descr'], 'Version': ['value:descr'],
    'Well': ['value:descr']})
```

Get a function that returns the order per the mnemonic and section.

**Parameters**

- **section** (*str*) – either 'well', 'params', 'curves', 'version'
- **version** (*float*) – either 1.2 and 2.0

**Keyword Arguments** **order\_definitions** (*dict*) – see source of defaults.py for more information

**Returns** A function which takes a mnemonic (*str*) as its only argument, and in turn returns the order ‘value:descr’ or ‘descr:value’.

`lasio.writer.get_section_widths` (*section\_name*, *items*, *version*, *order\_func*)  
Find minimum section widths fitting the content in *items*.

**Parameters**

- **section\_name** (*str*) – either ‘version’, ‘well’, ‘curves’, or ‘params’
- **items** (*SectionItems*) – section items
- **version** (*float*) – either 1.2 or 2.0
- **order\_func** (*func*) – see `lasio.writer.get_section_order_function()`

## 10.7 lasio.excel module

## 10.8 lasio.defaults module

`lasio.defaults.get_default_items()`

## 10.9 lasio.exceptions module

**exception** `lasio.exceptions.LASDataError`

Bases: `Exception`

Error during reading of numerical data from LAS file.

**exception** `lasio.exceptions.LASHeaderError`

Bases: `Exception`

Error during reading of header data from LAS file.

**exception** `lasio.exceptions.LASUnknownUnitError`

Bases: `Exception`

Error of unknown unit in LAS file.

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