Lecture 5: Data Loading, Storage and File Formats

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Parsing functions in pandas

Function	Description
`read_csv`	Load delimited data from a file, URL, or file-like object; use comma as default delimiter
`read_table`	Load delimited data from a file, URL, or file-like object; use tab (`'\t'`) as default delimiter
`read_fwf`	Read data in fixed-width column format (i.e., no delimiters)
`read_clipboard`	Version of `read_table` that reads data from the clipboard; useful for converting tables from web pages
`read_excel`	Read tabular data from an Excel XLS or XLSX file
`read_hdf`	Read HDF5 files written by pandas
`read_html`	Read all tables found in the given HTML document
`read_json`	Read data from a JSON (JavaScript Object Notation) string representation
`read_msgpack`	Read pandas data encoded using the MessagePack binary format
`read_pickle`	Read an arbitrary object stored in Python pickle format

Function	Description
`read_sas`	Read a SAS dataset stored in one of the SAS system's custom storage formats
`read_sql`	Read the results of a SQL query (using SQLAlchemy) as a pandas DataFrame
`read_stata`	Read a dataset from Stata file format
`read_feather`	Read the Feather binary file format

- *Indexing*
- Can treat one or more columns as the returned DataFrame, and whether to get column names from the file, the user, or not at all.
- *Type inference and data conversion*
- This includes the user-defined value conversions and custom list of missing value markers.
- *Datetime parsing*
- Includes combining capability, including combining date and time information spread over multiple columns into a single column in the result.
- *Iterating*
- Support for iterating over chunks of very large files.
- *Unclean data issues*
- Skipping rows or a footer, comments, or other minor things like numeric data with thousands separated by commas.

```
In [8]: !cat examples/ex1.csv
a,b,c,d,message
1,2,3,4,hello
5,6,7,8,world
9,10,11,12,foo
```

```
In [9]: df = pd.read_csv('examples/ex1.csv')

In [10]: df
Out[10]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

```
In [12]: !cat examples/ex2.csv
1,2,3,4,hello
5,6,7,8,world
9,10,11,12,foo
```

```
In [11]: pd.read_table('examples/ex1.csv', sep=',')
Out[11]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

```
In [13]: pd.read_csv('examples/ex2.csv', header=None)
Out[13]:
   0   1   2   3       4
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo

In [14]: pd.read_csv('examples/ex2.csv', names=['a', 'b', 'c', 'd', 'message'])
Out[14]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

```
In [15]: names = ['a', 'b', 'c', 'd', 'message']

In [16]: pd.read_csv('examples/ex2.csv', names=names, index_col='message')
Out[16]:
         a   b   c   d
message
hello    1   2   3   4
world    5   6   7   8
foo      9  10  11  12
```

```
In [17]: !cat examples/csv_mindex.csv
key1,key2,value1,value2
one,a,1,2
one,b,3,4
one,c,5,6
one,d,7,8
two,a,9,10
two,b,11,12
two,c,13,14
two,d,15,16
```

```
In [18]: parsed = pd.read_csv('examples/csv_mindex.csv',
   ....:                       index_col=['key1', 'key2'])

In [19]: parsed
Out[19]:
           value1  value2
key1 key2
one  a          1       2
     b          3       4
     c          5       6
     d          7       8
two  a          9      10
     b         11      12
     c         13      14
     d         15      16
```

```
In [20]: list(open('examples/ex3.txt'))
Out[20]:
['            A         B         C\n',
 'aaa -0.264438 -1.026059 -0.619500\n',
 'bbb  0.927272  0.302904 -0.032399\n',
 'ccc -0.264273 -0.386314 -0.217601\n',
 'ddd -0.871858 -0.348382  1.100491\n']
```

```
In [21]: result = pd.read_table('examples/ex3.txt', sep='\s+')
```

```
In [22]: result
Out[22]:
            A         B         C
aaa -0.264438 -1.026059 -0.619500
bbb  0.927272  0.302904 -0.032399
ccc -0.264273 -0.386314 -0.217601
ddd -0.871858 -0.348382  1.100491
```

```
In [23]: !cat examples/ex4.csv
# hey!
a,b,c,d,message
# just wanted to make things more difficult for you
# who reads CSV files with computers, anyway?
1,2,3,4,hello
5,6,7,8,world
9,10,11,12,foo
In [24]: pd.read_csv('examples/ex4.csv', skiprows=[0, 2, 3])
Out[24]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

```
In [25]: !cat examples/ex5.csv
something,a,b,c,d,message
one,1,2,3,4,NA
two,5,6,,8,world
three,9,10,11,12,foo
In [26]: result = pd.read_csv('examples/ex5.csv')
```

```
In [27]: result
Out[27]:
  something  a   b     c   d message
0       one  1   2   3.0   4     NaN
1       two  5   6   NaN   8   world
2     three  9  10  11.0  12     foo
```

```
In [28]: pd.isnull(result)
Out[28]:
   something      a      b      c      d  message
0      False  False  False  False  False     True
1      False  False  False   True  False    False
2      False  False  False  False  False    False
```

```
In [29]: result = pd.read_csv('examples/ex5.csv', na_values=['NULL'])

In [30]: result
Out[30]:
  something  a   b     c   d message
0       one  1   2   3.0   4     NaN
1       two  5   6   NaN   8   world
2     three  9  10  11.0  12     foo
```

```
In [31]: sentinels = {'message': ['foo', 'NA'], 'something': ['two']}

In [32]: pd.read_csv('examples/ex5.csv', na_values=sentinels)
Out[32]:
  something  a   b     c   d message
0       one  1   2   3.0   4     NaN
1       NaN  5   6   NaN   8   world
2     three  9  10  11.0  12     NaN
```

read_csv/read_table function arguments

Argument	Description
`path`	String indicating filesystem location, URL, or file-like object
`sep` or `delimiter`	Character sequence or regular expression to use to split fields in each row
`header`	Row number to use as column names; defaults to 0 (first row), but should be None if there is no header row
`index_col`	Column numbers or names to use as the row index in the result; can be a single name/number or a list of them for a hierarchical index
`names`	List of column names for result, combine with `header=None`

Argument	Description
skiprows	Number of rows at beginning of file to ignore or list of row numbers (starting from 0) to skip.
na_values	Sequence of values to replace with NA.
comment	Character(s) to split comments off the end of lines.
parse_dates	Attempt to parse data to datetime; False by default. If True, will attempt to parse all columns. Otherwise can specify a list of column numbers or name to parse. If element of list is tuple or list, will combine multiple columns together and parse to date (e.g., if date/time split across two columns).
keep_date_col	If joining columns to parse date, keep the joined columns; False by default.
converters	Dict containing column number of name mapping to functions (e.g., {'foo': f} would apply the function f to all values in the 'foo' column).
dayfirst	When parsing potentially ambiguous dates, treat as international format (e.g., 7/6/2012 -> June 7, 2012); False by default.
date_parser	Function to use to parse dates.
nrows	Number of rows to read from beginning of file.
iterator	Return a TextParser object for reading file piecemeal.
chunksize	For iteration, size of file chunks.
skip_footer	Number of lines to ignore at end of file.
verbose	Print various parser output information, like the number of missing values placed in non-numeric columns.
encoding	Text encoding for Unicode (e.g., 'utf-8' for UTF-8 encoded text).
squeeze	If the parsed data only contains one column, return a Series.
thousands	Separator for thousands (e.g., ',' or '.').

Reading Text Files in Pieces

```
In [33]: pd.options.display.max_rows = 10

In [34]: result = pd.read_csv('examples/ex6.csv')

In [35]: result
Out[35]:
           one       two     three      four key
0     0.467976 -0.038649 -0.295344 -1.824726   L
1    -0.358893  1.404453  0.704965 -0.200638   B
2    -0.501840  0.659254 -0.421691 -0.057688   G
3     0.204886  1.074134  1.388361 -0.982404   R
4     0.354628 -0.133116  0.283763 -0.837063   Q
...        ...       ...       ...       ...  ..
9995  2.311896 -0.417070 -1.409599 -0.515821   L
9996 -0.479893 -0.650419  0.745152 -0.646038   E
9997  0.523331  0.787112  0.486066  1.093156   K
9998 -0.362559  0.598894 -1.843201  0.887292   G
9999 -0.096376 -1.012999 -0.657431 -0.573315   0
[10000 rows x 5 columns]
```

```
In [36]: pd.read_csv('examples/ex6.csv', nrows=5)
Out[36]:
        one       two     three      four key
0  0.467976 -0.038649 -0.295344 -1.824726   L
1 -0.358893  1.404453  0.704965 -0.200638   B
2 -0.501840  0.659254 -0.421691 -0.057688   G
3  0.204886  1.074134  1.388361 -0.982404   R
4  0.354628 -0.133116  0.283763 -0.837063   Q
```

```
In [37]: chunker = pd.read_csv('examples/ex6.csv', chunksize=1000)

In [38]: chunker
Out[38]: <pandas.io.parsers.TextFileReader at 0x7f6b1e2672e8>
```

```
chunker = pd.read_csv('examples/ex6.csv', chunksize=1000)

tot = pd.Series([])
for piece in chunker:
    tot = tot.add(piece['key'].value_counts(), fill_value=0)

tot = tot.sort_values(ascending=False)

In [40]: tot[:10]
Out[40]:
E    368.0
X    364.0
L    346.0
O    343.0
Q    340.0
M    338.0
J    337.0
F    335.0
K    334.0
H    330.0
dtype: float64
```

Writing Data to Text Format

```
In [41]: data = pd.read_csv('examples/ex5.csv')

In [42]: data
Out[42]:
  something  a   b     c   d message
0       one  1   2   3.0   4     NaN
1       two  5   6   NaN   8   world
2     three  9  10  11.0  12     foo

In [43]: data.to_csv('examples/out.csv')

In [44]: !cat examples/out.csv
,something,a,b,c,d,message
0,one,1,2,3.0,4,
1,two,5,6,,8,world
2,three,9,10,11.0,12,foo
```

```
In [45]: import sys

In [46]: data.to_csv(sys.stdout, sep='|')
|something|a|b|c|d|message
0|one|1|2|3.0|4|
1|two|5|6||8|world
2|three|9|10|11.0|12|foo
```

```
In [47]: data.to_csv(sys.stdout, na_rep='NULL')
,something,a,b,c,d,message
0,one,1,2,3.0,4,NULL
1,two,5,6,NULL,8,world
2,three,9,10,11.0,12,foo
```

```
In [48]: data.to_csv(sys.stdout, index=False, header=False)
one,1,2,3.0,4,
two,5,6,,8,world
three,9,10,11.0,12,foo
```

```
In [49]: data.to_csv(sys.stdout, index=False, columns=['a', 'b', 'c'])
a,b,c
1,2,3.0
5,6,
9,10,11.0

In [50]: dates = pd.date_range('1/1/2000', periods=7)

In [51]: ts = pd.Series(np.arange(7), index=dates)

In [52]: ts.to_csv('examples/tseries.csv')

In [53]: !cat examples/tseries.csv
2000-01-01,0
2000-01-02,1
2000-01-03,2
2000-01-04,3
2000-01-05,4
2000-01-06,5
2000-01-07,6
```

Working with Delimited Formats

```
In [54]: !cat examples/ex7.csv
"a","b","c"
"1","2","3"
"1","2","3"
```

```
import csv
f = open('examples/ex7.csv')

reader = csv.reader(f)
```

```
In [56]: for line in reader:
    ....:     print(line)
['a', 'b', 'c']
['1', '2', '3']
['1', '2', '3']
```

```
In [57]: with open('examples/ex7.csv') as f:
    ....:     lines = list(csv.reader(f))

In [58]: header, values = lines[0], lines[1:]

In [59]: data_dict = {h: v for h, v in zip(header, zip(*values))}

In [60]: data_dict
Out[60]: {'a': ('1', '1'), 'b': ('2', '2'), 'c': ('3', '3')}
```

```
class my_dialect(csv.Dialect):
    lineterminator = '\n'
    delimiter = ';'
    quotechar = '"'
    quoting = csv.QUOTE_MINIMAL

reader = csv.reader(f, dialect=my_dialect)

reader = csv.reader(f, delimiter='|')
```

CSV dialect options

Argument	Description
`delimiter`	One-character string to separate fields; defaults to `','`.
`lineterminator`	Line terminator for writing; defaults to `'\r\n'`. Reader ignores this and recognizes cross-platform line terminators.
`quotechar`	Quote character for fields with special characters (like a delimiter); default is `'"'`.
`quoting`	Quoting convention. Options include `csv.QUOTE_ALL` (quote all fields), `csv.QUOTE_MINIMAL` (only fields with special characters like the delimiter), `csv.QUOTE_NONNUMERIC`, and `csv.QUOTE_NONE` (no quoting). See Python's documentation for full details. Defaults to `QUOTE_MINIMAL`.
`skipinitialspace`	Ignore whitespace after each delimiter; default is `False`.
`doublequote`	How to handle quoting character inside a field; if `True`, it is doubled (see online documentation for full detail and behavior).
`escapechar`	String to escape the delimiter if `quoting` is set to `csv.QUOTE_NONE`; disabled by default.

JSON Data

- JSON (short for JavaScript Object Notation) has become one of the standard formats for sending data by HTTP request between web browsers and other applications.
- ```
  obj = """ {"name": "Wes", "places_lived":
  ["United States", "Spain", "Germany"], "pet":
  null, "siblings": [{"name": "Scott", "age": 30,
  "pets": ["Zeus", "Zuko"]}, {"name": "Katie",
  "age": 38, "pets": ["Sixes", "Stache",
  "Cisco"]}] } """
  ```
  ```

- import json
- result = json.loads(obj)
- `{'name': 'Wes', 'places_lived': ['United States', 'Spain', 'Germany'], 'pet': None, 'siblings': [{'name': 'Scott', 'age': 30, 'pets': ['Zeus', 'Zuko']}, {'name': 'Katie', 'age': 38, 'pets': ['Sixes', 'Stache', 'Cisco']}]}`

Binary Data Formats

- One of the easiest ways to store data (also known as serialization) efficiently in binary format is using Python's built-in pickle serialization. pandas objects all have a to_pickle method that writes the data to disk in pickle format

```
In [87]: frame = pd.read_csv('examples/ex1.csv')

In [88]: frame
Out[88]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo

In [89]: frame.to_pickle('examples/frame_pickle')
```

```
In [90]: pd.read_pickle('examples/frame_pickle')
Out[90]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

Reading Microsoft Excel Files

- pandas also supports reading tabular data stored in Excel 2003 (and higher) files using either the ExcelFile class or pandas.read_excel function. Internally these tools use the add-on packages xlrd and openpyxl to read XLS and XLSX files, respectively

```
In [104]: xlsx = pd.ExcelFile('examples/ex1.xlsx')

In [105]: pd.read_excel(xlsx, 'Sheet1')
Out[105]:
   a   b   c   d message
0  1   2   3   4   hello
1  5   6   7   8   world
2  9  10  11  12     foo
```

- To write pandas data to Excel format, you must first create an ExcelWriter, then write data to it using pandas objects' to_excel method:

```
In [108]: writer = pd.ExcelWriter('examples/ex2.xlsx')

In [109]: frame.to_excel(writer, 'Sheet1')

In [110]: writer.save()
```

- You can also pass a file path to to_excel and avoid the ExcelWriter:

```
In [111]: frame.to_excel('examples/ex2.xlsx')
```