Using Dask DataFrames

PARALLEL COMPUTING WITH DASK

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Reading CSV

```
import dask.dataframe as dd
```

- `dd.read_csv()` function
  - Accepts single filename or *glob* pattern (with wildcard `*`)
  - Does not read file immediately (*lazy evaluation*)
  - File(s) need not fit in memory

Reading multiple CSV files

```
%ls
```

```
quarter1.csv  quarter2.csv  quarter3.csv  quarter4.csv
```

```
transactions = dd.read_csv('*.csv')
```

```
transactions.head()

transactions.tail()
```

```
    id    names  amount        date
0  131  Norbert   -1159  2016-01-01
1  342    Jerry    1149  2016-01-01
2  485      Dan    1380  2016-01-01
3  513   Xavier    1555  2016-01-02
4  849  Michael     363  2016-01-02
```

```
      id      names  amount        date
195  838      Wendy      87  2016-12-28
196  915        Bob     852  2016-12-30
197  749   Patricia    1741  2016-12-31
198  743    Michael    1191  2016-12-31
199  889      Wendy     336  2016-12-31
```

Building delayed pipelines

```
is_wendy = (transactions['names'] == 'Wendy')

wendy_amounts = transactions.loc[is_wendy, 'amount']

wendy_amounts
```

```
Dask Series Structure:
npartitions=4
None    int64
None      ...
None      ...
None      ...
None      ...
Name: amount, dtype: int64
Dask Name: loc-series, 24 tasks
```

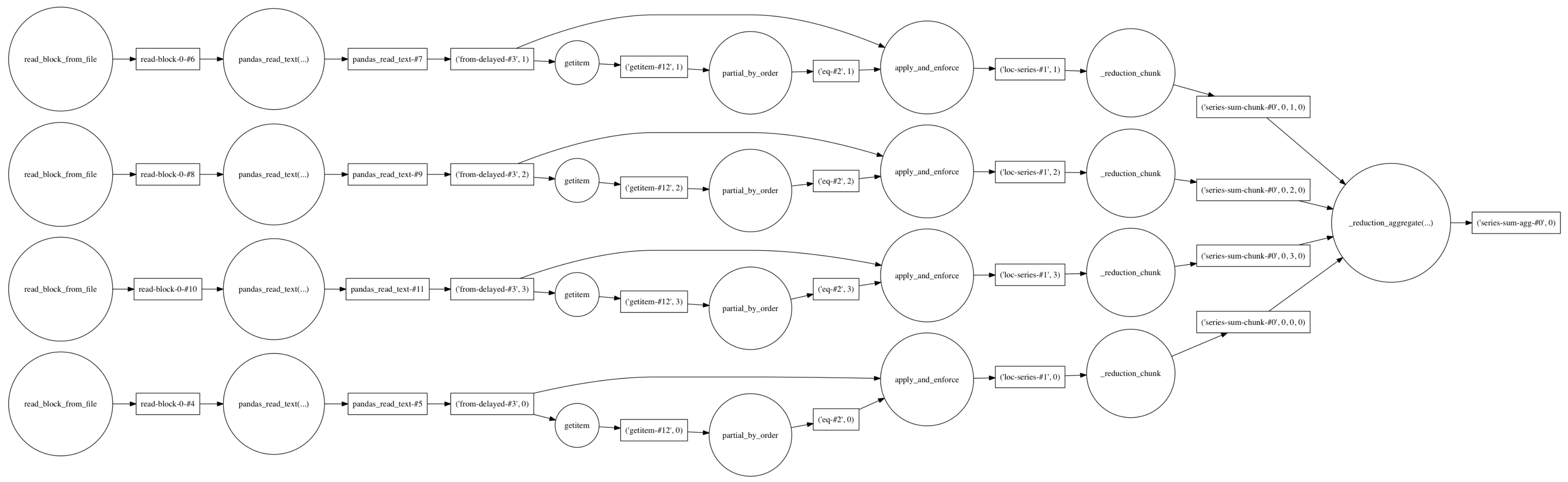
Building delayed pipelines

```
wendy_diff = wendy_amounts.sum()
wendy_diff
```

```
dd.Scalar<series-..., dtype=int64>
```

```
wendy_diff.visualize(rankdir='LR')
```

Visualizing pipelines



Compatibility with Pandas API

Unavailable in `dask.dataframe` :

- some unsupported file formats (e.g., `.xls` , `.zip` , `.gz`)
- sorting

Available in `dask.dataframe` :

- indexing, selection, & reindexing
- aggregations: `.sum()` , `.mean()` , `.std()` , `.min()` , `.max()` etc.
- grouping with `.groupby()`
- datetime conversion with `dd.to_datetime()`

Let's practice!

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Timing DataFrame Operations

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How big is big data?

Data size M	Required hardware
$M < 8\,\mathrm{GB}$	RAM (single machine)
$8\,\mathrm{GB} < M < 10\,\mathrm{TB}$	hard disk (single machine)
$M > 10\,\mathrm{TB}$:	*specialized hardware*

Two key questions:

- Data fits in RAM (random access memory)?
- Data fits on hard disk?

Taxi CSV files

```
%ll -h yellow_tripdata_2015-*.csv
```

```
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.6G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.6G 31 Jul 16:43 yellow_tripdata_2015-0
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-1
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-1
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-1
```

Timing I/O & computation: Pandas

```python
import time, pandas as pd
t_start = time.time();
df = pd.read_csv('yellow_tripdata_2015-01.csv');
t_end = time.time();
print('pd.read_csv(): {} s'.format(t_end-t_start)) # time [s]
```

```
pd.read_csv: 43.820565938949585 s
```

```python
t_start = time.time();
m = df['trip_distance'].mean();
t_end = time.time();
print('.mean(): {} ms'.format((t_end-t_start)*1000)) # time [ms]
```

```
.mean(): 17.752885818481445 ms
```

Timing I/O & computation: Dask

```
import dask.dataframe as dd, time
t_start = time.time();
df = dd.read_csv('yellow_tripdata_2015-*.csv');
t_end = time.time();
print('dd.read_csv: {} ms'.format((t_end-t_start)*1000))  # time [ms
```

```
dd.read_csv: 404.7999382019043 ms
```

```
t_start = time.time();
m = df['trip_distance'].mean();
t_end = time.time();
print('.mean(): {} ms'.format((t_end-t_start)*1000))  # time [ms]
```

```
.mean(): 2.289295196533203 ms
```

Timing I/O & computation: Dask

```
t_start = time.time();
result = m.compute();
t_end = time.time();
print('.compute(): {} min'.format((t_end-t_start)/60)) # time [min]
```

```
.compute(): 3.4004417498906454 min
```

Timing in the IPython shell

```python
m = df['trip_distance'].mean()

%time result = m.compute()
```

```
CPU times: user 9min 50s, sys: 1min 16s, total: 11min 7s
Wall time: 3min 1s
```

Is Dask or Pandas appropriate?

- How big is dataset?
- How much RAM available?
- How many threads/cores/CPUs available?
- Are Pandas computations/formats supported in Dask API?
- Is computation *I/O-bound* (disk-intensive) or *CPU-bound* (processor intensive)?

Best use case for Dask

- Computations from Pandas API available in Dask
- Problem size close to limits of RAM, fits on disk

Let's practice!

PARALLEL COMPUTING WITH DASK

Analyzing NYC Taxi Rides

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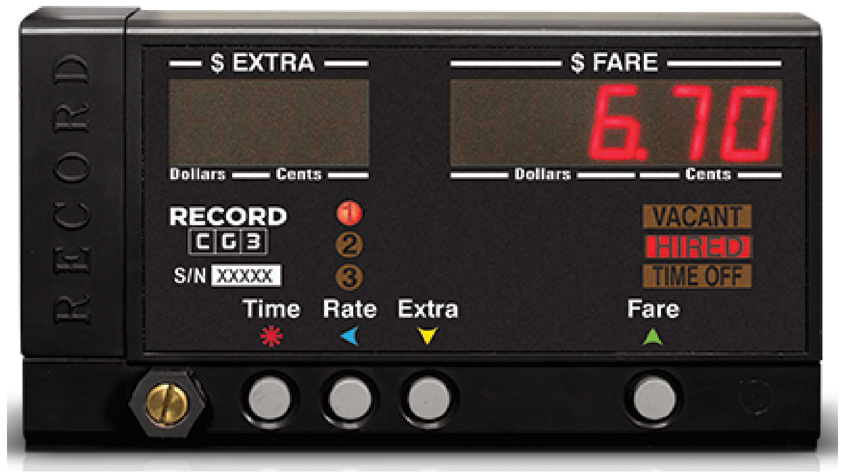
The New York taxi dataset



Taxi CSV files

```
%ll -h yellow_tripdata_2015-*.csv
```

```
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-01.csv
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-02.csv
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-03.csv
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-04.csv
-rw-r--r--  1 user  staff   1.9G 31 Jul 16:43 yellow_tripdata_2015-05.csv
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-06.csv
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-07.csv
-rw-r--r--  1 user  staff   1.6G 31 Jul 16:43 yellow_tripdata_2015-08.csv
-rw-r--r--  1 user  staff   1.6G 31 Jul 16:43 yellow_tripdata_2015-09.csv
-rw-r--r--  1 user  staff   1.8G 31 Jul 16:43 yellow_tripdata_2015-10.csv
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-11.csv
-rw-r--r--  1 user  staff   1.7G 31 Jul 16:43 yellow_tripdata_2015-12.csv
```

- Exercises use smaller files...

Taxi data features

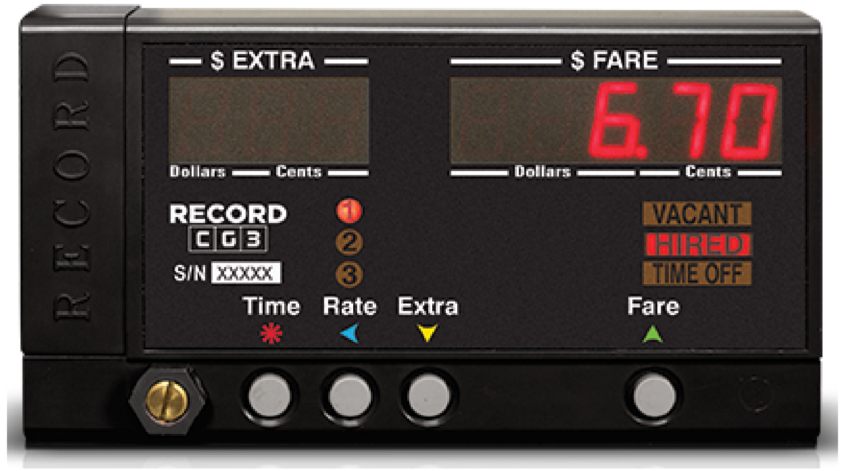
```python
import pandas as pd
df = pd.read_csv('yellow_tripdata_2015-01.csv')
df.shape

df.columns
```

```
(12748986, 19)
Index(['VendorID', 'tpep_pickup_datetime', 'tpep_dropoff_datetime',
       'passenger_count', 'trip_distance', 'pickup_longitude',
       'pickup_latitude', 'RateCodeID', 'store_and_fwd_flag',
       'dropoff_longitude', 'dropoff_latitude', 'payment_type',
       'fare_amount','extra', 'mta_tax', 'tip_amount',
       'tolls_amount','improvement_surcharge', 'total_amount'],
      dtype='object')
```

Amount paid

- How much was each ride?
  - `fare_amount` : cost of ride
  - `tolls_amount` : charges for toll roads
  - `extra` : additional charges
  - `tip_amount` : amount tipped (credit cards only)
  - `total_amount` : total amount paid by passenger



Payment type

```
df['payment_type'].value_counts()
```

```
1    7881388
2    4816992
3      38632
4      11972
5          2
Name: payment_type, dtype: int64
```

Let's practice!

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