A short presentation about reticulate & disk.frame

wzzang

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How to handle large datasets?
Eg. a 50gb sized csv file with 500k+ obs and prob. 10k+ vars while only a subset of vars is needed.

Two solutions
+ Python (pandas/dask) + R (reticulate)
+ R (disk.frame)

First, `reticulate`!

1. Install and load the package

```
if(!require(reticulate)){
    install.packages("reticulate")
}
library(reticulate)
```

2. Check Python configuration
   Note, if not specifying pre-exisitng Python env, prompt to install a `miniconda`
   r-reticulate conda env will be created using `Python3.6` and `Numpy`
   `use_python()` *to specify which Python to use!*

```
py_config()
### python:         /Users/wzzang/Library/r-miniconda/envs/r-reticulate/bin/python
### libpython:      /Users/wzzang/Library/r-miniconda/envs/r-reticulate/lib/libpython3.6m.dylib
### pythonhome:     /Users/wzzang/Library/r-miniconda/envs/r-reticulate:/Users/wzzang/Library/r-minicon
### version:        3.6.11 | packaged by conda-forge | (default, Jul 28 2020, 23:03:33)  [GCC Clang 10.
### numpy:          /Users/wzzang/Library/r-miniconda/envs/r-reticulate/lib/python3.6/site-packages/num
### numpy_version:  1.19.1
```

3. Let’s check if `pandas` is available.

```
conda_remove(’r-reticulate’, packages = ’pandas’)
py_module_available(module = ’pandas’)
### [1] FALSE
```

4. Before installing `pandas`, let’s check available conda envs.

```
conda_list()
###           name                                                         python
### 1  r-miniconda                   /Users/wzzang/Library/r-miniconda/bin/python
### 2 r-reticulate /Users/wzzang/Library/r-miniconda/envs/r-reticulate/bin/python
```

5. install the package under the *r-reticulate* env

```
py_install(packages = "pandas", envname = "r-reticulate")
```

Now, let's check again.

```
py_module_available(module = 'pandas')
### [1] TRUE
```

6. New envs can be created using `conda_create(envname = "xx", packages = "pandas")`
   Then specify the use of the newly created env using `use_condaenv(condaenv = "xx")`

7. Now let's run Python in R
   First, let's import a csv file in Python.
   Here we use Beijing PM2.5 dataset.

```
import pandas as pd
filename="~/R_Ladies/BJ_PM25.csv"
pdat = pd.read_csv(filename, sep = ',')
pdat.head()
###    No  year  month  day  hour  pm2.5  DEWP  TEMP    PRES cbwd    Iws  Is  Ir
### 0   1  2010      1    1     0    NaN   -21 -11.0  1021.0   NW   1.79   0   0
### 1   2  2010      1    1     1    NaN   -21 -12.0  1020.0   NW   4.92   0   0
### 2   3  2010      1    1     2    NaN   -21 -11.0  1019.0   NW   6.71   0   0
### 3   4  2010      1    1     3    NaN   -21 -14.0  1019.0   NW   9.84   0   0
### 4   5  2010      1    1     4    NaN   -20 -12.0  1018.0   NW  12.97   0   0
pdat.shape
### (43824, 13)
```

8. Now, let's run the same code in R.

- There are a few options. First, we can run it in string.

```
py_run_string("import pandas as pd")
dt=py$pd$read_csv(py$filename, sep = ',')
head(dt)
###   No year month day hour pm2.5 DEWP TEMP PRES cbwd   Iws Is Ir
### 1  1 2010     1   1    0   NaN  -21  -11 1021   NW  1.79  0  0
### 2  2 2010     1   1    1   NaN  -21  -12 1020   NW  4.92  0  0
### 3  3 2010     1   1    2   NaN  -21  -11 1019   NW  6.71  0  0
### 4  4 2010     1   1    3   NaN  -21  -14 1019   NW  9.84  0  0
### 5  5 2010     1   1    4   NaN  -20  -12 1018   NW 12.97  0  0
### 6  6 2010     1   1    5   NaN  -19  -10 1017   NW 16.10  0  0
dim(dt)
### [1] 43824    13
```

- Alternatively, we can run a *.py* file.

```
cat ~/R_Ladies/demo_chunk.py
### #!/usr/bin/env python
### # coding: utf-8
###
### import pandas as pd
### filename='~/Downloads/BJ_PM25.csv'
### FileReader = pd.read_csv(filename, chunksize=100, sep = ',')
### dfList=[]
###
### for df in FileReader:
###     dfList.append(df)
###
### #concatenate all chunks
### chunkdf = pd.concat(dfList,sort=False)
###
### chunkdf.head()
### chunkdf.shape
```

- Now, we run *.py* script in R and check the *py* object in R.

```
source_python(file="~/R_Ladies/demo_chunk.py")
head(py$chunkdf)
###   No year month day hour pm2.5 DEWP TEMP PRES cbwd   Iws Is Ir
### 1  1 2010     1   1    0   NaN  -21  -11 1021   NW  1.79  0  0
### 2  2 2010     1   1    1   NaN  -21  -12 1020   NW  4.92  0  0
### 3  3 2010     1   1    2   NaN  -21  -11 1019   NW  6.71  0  0
### 4  4 2010     1   1    3   NaN  -21  -14 1019   NW  9.84  0  0
### 5  5 2010     1   1    4   NaN  -20  -12 1018   NW 12.97  0  0
### 6  6 2010     1   1    5   NaN  -19  -10 1017   NW 16.10  0  0
```

- Or, in interactive `REFL` (Python read-eval-print loop)

  ```
  file = py$filename
  repl_python()
  import pandas as pdd
  refl_df = pdd.read_csv(r.file, sep  = ',')
  refl_df.head()
  exit
  ```

`options(reticulate.traceback=T)` *to print Python stack traces for errors*

Now, `disk.frame`!

- make use of `fst` and `data.table` packages

- process data larger than RAM but smaller than Disk
- create a folder (disk.frame object) containings chunked files (in *.fst* format)

1. install and load the package

```
if(!require(disk.frame)){
    install.packages('disk.frame')
}
library(disk.frame)
```

2. configure the package setup to allow parallel processing.
   By default, `setup_disk.frame()` uses all available CUP cores.

```
setup_disk.frame(workers = 2)
```

3. load the same BJ PM2.5 dataset.

- Note, directories (disk.frame object) must have *.df* extension

```
otdir = '~/R_Ladies/tmp.df'
if(!dir.exists(otdir)){
  dir.create(otdir)
}

disk.df = as.disk.frame(df = py$pdat,
                        outdir = otdir,
                        overwrite = TRUE)
```

- There should be a series of *.fst* files/chunks in the *.df* folder
  Let's take a look.

```
list.files(otdir, all.files = T)
### [1] "."         ".."        ".metadata" "1.fst"     "2.fst"     "3.fst"
```

- *.df* also contains a meta file

```
cat ~/R_Ladies/tmp.df/.metadata/meta.json
### {"nchunks":[3],"shardkey":[""],"shardchunks":[3],"compress":[50]}
```

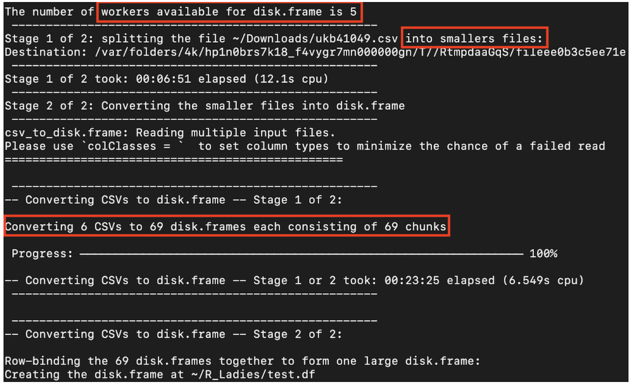
- `in_chunk_size` *can be used to specify row numbers of each reading in case of large dataset*
  "If `disk.frame` deems your CSV to be small enough to fit in RAM it will use data.table's `fread`. If the file is too large, it will use `bigreadr` to SPLIT the file into smaller files and then read the smaller files simultaneously. In practice this was found to be the fastest approach."

```
otdir = '~/R_Ladies/temp.df'
if(!dir.exists(otdir)){
  dir.create(otdir)
}

disk2.df = csv_to_disk.frame(py$filename,
                            in_chunk_size = 10000,
                            outdir = otdir,
                            overwrite = TRUE,
                                   backend = "data.table", #or 'readr'
                                   chunk_reader = "bigreadr")

list.files(otdir)
### [1] "1.fst" "2.fst" "3.fst"
```

- File split for larger sized data as shown below



```
The number of workers available for disk.frame is 5
 -----------------------------------------------------
Stage 1 of 2: splitting the file ~/Downloads/ukb41049.csv into smallers files:
Destination: /var/folders/4k/hp1n0brs7k18_f4vygr7mn000000gn/T//RtmpdaaGqS/fileee0b3c5ee71e
 -----------------------------------------------------
Stage 1 of 2 took: 00:06:51 elapsed (12.1s cpu)
 -----------------------------------------------------
Stage 2 of 2: Converting the smaller files into disk.frame
 -----------------------------------------------------
csv_to_disk.frame: Reading multiple input files.
Please use `colClasses = `  to set column types to minimize the chance of a failed read
=================================================

 -----------------------------------------------------
-- Converting CSVs to disk.frame -- Stage 1 of 2:

Converting 6 CSVs to 69 disk.frames each consisting of 69 chunks

 Progress: ──────────────────────────────────────────────────── 100%

-- Converting CSVs to disk.frame -- Stage 1 or 2 took: 00:23:25 elapsed (6.549s cpu)
 -----------------------------------------------------

 -----------------------------------------------------
-- Converting CSVs to disk.frame -- Stage 2 of 2:

Row-binding the 69 disk.frames together to form one large disk.frame:
Creating the disk.frame at ~/R_Ladies/test.df
```

- Now, let's subset data by column names, using `dyplr` functions

```
 sub.df = disk.df %>%
   srckeep(c("year","pm2.5","TEMP"))

 sub.df %>% head
###    No year month day hour pm2.5 DEWP TEMP PRES cbwd   Iws Is Ir
### 1:  1 2010     1   1    0   NaN  -21  -11 1021   NW  1.79  0  0
### 2:  2 2010     1   1    1   NaN  -21  -12 1020   NW  4.92  0  0
### 3:  3 2010     1   1    2   NaN  -21  -11 1019   NW  6.71  0  0
### 4:  4 2010     1   1    3   NaN  -21  -14 1019   NW  9.84  0  0
### 5:  5 2010     1   1    4   NaN  -20  -12 1018   NW 12.97  0  0
### 6:  6 2010     1   1    5   NaN  -19  -10 1017   NW 16.10  0  0
```

- *using `srckeep` only load selected cols into memory whereas `select` will load all cols before filtering*
- We can get summary descriptions by cols

```
pm25.stats = disk.df %>%
  group_by(TEMP) %>%
  summarise(avrPM2.5 = mean(pm2.5, na.rm = T),
            medPM2.5 = median(pm2.5, na.rm = T)) %>%
  collect #computation executed

pm25.stats
### # A tibble: 64 x 3
###      TEMP avrPM2.5 medPM2.5
###     <dbl>    <dbl>    <dbl>
###   1   -19     27.5     27.5
###   2   -18     46.8     NA
###   3   -17     99.4     81.8
###   4   -16    105.      85
###   5   -15     92.9     65
###  6   -14     83.7     56.8
###  7   -13     73.4     66
###  8   -12     80.5     60
###  9   -11     76.4     43
### 10   -10     82.8     48
### # ... with 54 more rows
```

4. Add new data as a chunk to the existing disk frame.

```
add_chunk(disk2.df, dt) #dt: r data frame
nchunks(disk2.df)
### [1] 4
list.files(otdir)
### [1] "1.fst" "2.fst" "3.fst" "4.fst"
```

5. Apply functions to all chunks using *cmap*.

- Remember to specify `lazy=F` or to use `collect` for actual computation.

```
result = disk2.df %>%
  cmap(function(chk) {
    chk[1, ] #showing the first row of each chunk
  }, lazy=FALSE)

result
### [[1]]
###    No year month day hour pm2.5 DEWP TEMP PRES cbwd  Iws Is Ir
### 1:  1 2010     1   1    0    NA  -21  -11 1021   NW 1.79  0  0
###
### [[2]]
###      No year month day hour pm2.5 DEWP TEMP PRES cbwd  Iws Is Ir
### 1: 3334 2010     5  19   21    32   -2   28 1000   SE 8.04  0  0
###
### [[3]]
###      No year month day hour pm2.5 DEWP TEMP PRES cbwd   Iws Is Ir
### 1: 6667 2010    10   5   18    80   13   20 1012   SE 13.86  0  0
###
### [[4]]
###    No year month day hour pm2.5 DEWP TEMP PRES cbwd  Iws Is Ir
### 1:  1 2010     1   1    0   NaN  -21  -11 1021   NW 1.79  0  0
```

6. Save intermediate data as a new *.df*

```
otdir = '~/R_Ladies/selected.df'
if(!dir.exists(otdir)){
  dir.create(otdir)
}

disk.df %>%
  srckeep(c("year","pm2.5","TEMP")) %>%
  write_disk.frame(outdir = otdir, overwrite = TRUE)

list.dirs('~/R_Ladies')
### [1] "/Users/wzzang/R_Ladies"
### [2] "/Users/wzzang/R_Ladies/.metadata"
### [3] "/Users/wzzang/R_Ladies/selected.df"
### [4] "/Users/wzzang/R_Ladies/temp.df"
### [5] "/Users/wzzang/R_Ladies/temp.df/.metadata"
### [6] "/Users/wzzang/R_Ladies/tmp.df"
### [7] "/Users/wzzang/R_Ladies/tmp.df/.metadata"
```

7. **More information about `disk.frame` can be found here**