UC San Diego

DSC 102
Systems for Scalable Analytics

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PA0 Discussion Session: Setting up AWS and Dask

Miscellaneous

- Office hours
  - **Regular OHs:** Thurs 1pm to 2pm
  - **Extra in PA0 interval:**
    - 10am to 12pm on Oct 9
    - 12pm to 2pm on Oct 11, Oct 18
    - 4pm to 6pm on Oct 13, Oct 20
  - **Location:** open area near CSE 3230
- AWS link
  - https://ets-apps.ucsd.edu/individual/DSC102_FA23_A00/

Agenda

1. Fundamentals of Dask

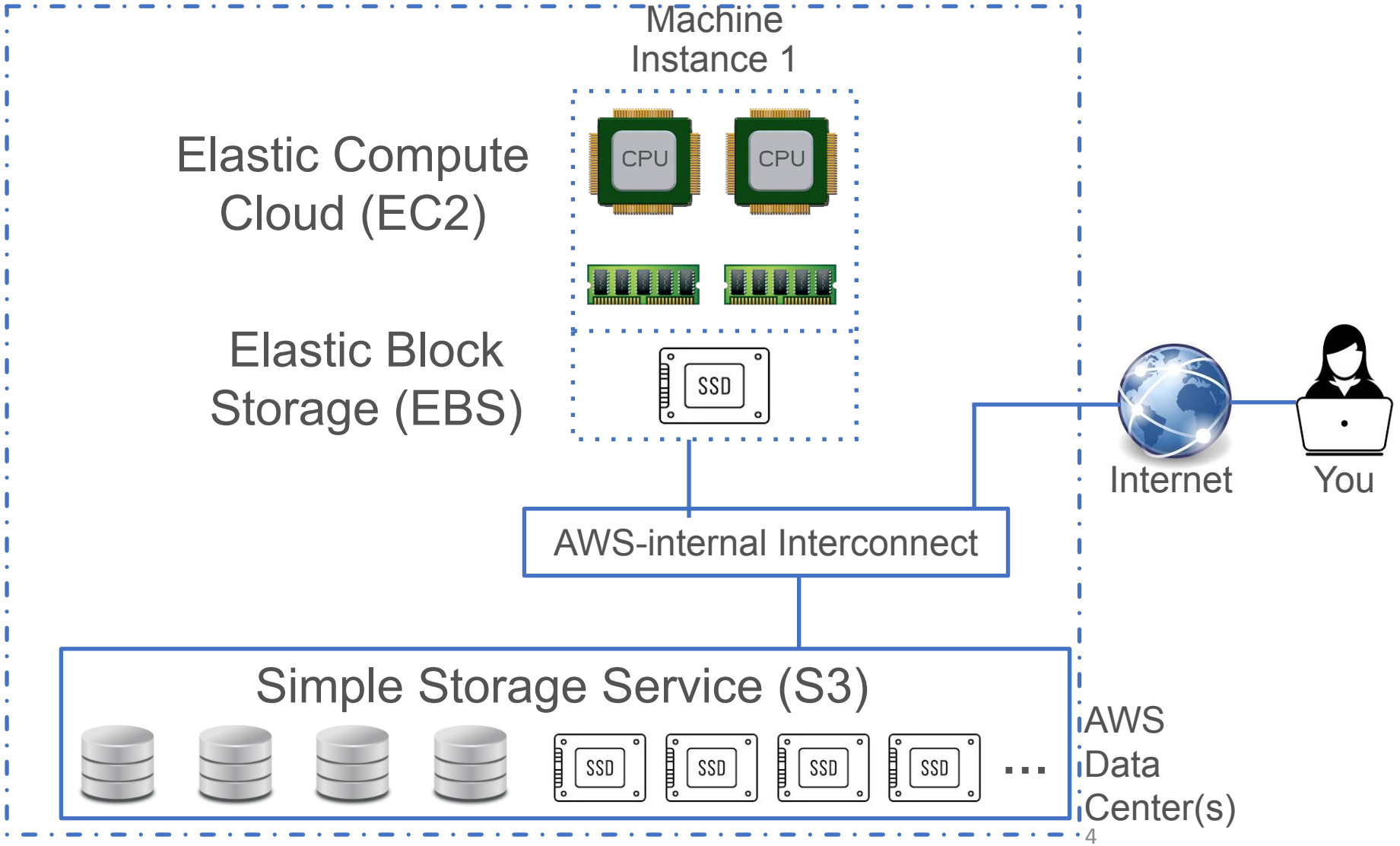
2. Demo
   a. Setting up AWS
   b. Commonly used Dask functions

3. Assignment task and Grading scheme

4. Best Practices and tips for PA0

5. Questions

AWS Services



Dask: Overview

- Parallel computing framework that scales existing Python ecosystems


```
np.zeros((10000,10000,10000)) -> OOM!
dask.array.zeros((10000,10000,10000))) -> SUCCESS!
```

- Breaks up work into tasks and executes them in task parallel manner
- Dask provides APIs (called collections) to create a task graph
- Dask also provides a scheduler that runs the task graph by assigning tasks to workers

Dask: APIs

High-level APIs:

- Dask Array (Parallel NumPy)
- Dask DataFrame (Parallel Pandas)
- Dask Bag (Parallel Dictionary)
- Dask ML (Parallel Scikit-Learn)

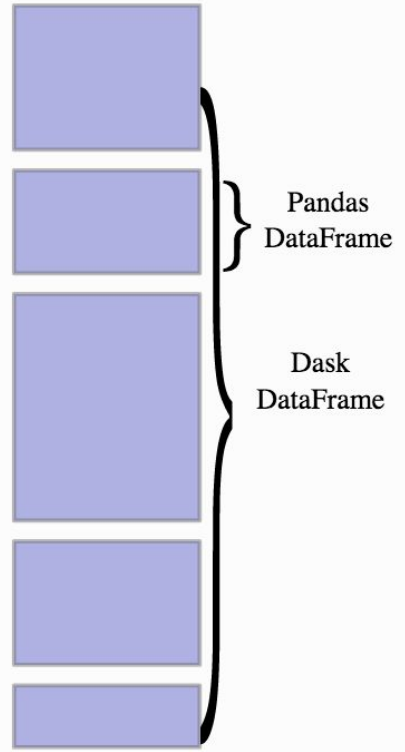
Only the DataFrame API is used for the assignments, feel free to check out other APIs if needed

Low-level APIs:

- Dask Delayed (Parallel lazy objects)
- Dask Futures (Parallel eager objects)

Dask: DataFrame API

- A Pandas DataFrame needs the dataframe(data) to fit entirely in RAM.
- A Dask DataFrame consists of multiple smaller Pandas DFs called “partitions”. These partitions reside on the disk.
- Operations on a Dask DF trigger operations on each partition (smaller Pandas DF) in a way that is mindful of potential parallelism and memory constraints.
- Dask handles staging of partitions between disk and RAM.
- The number of partitions is often automatically determined based on available memory and the number of cores, but can also be manually specified.
- Each partition should fit comfortably in memory (RAM).



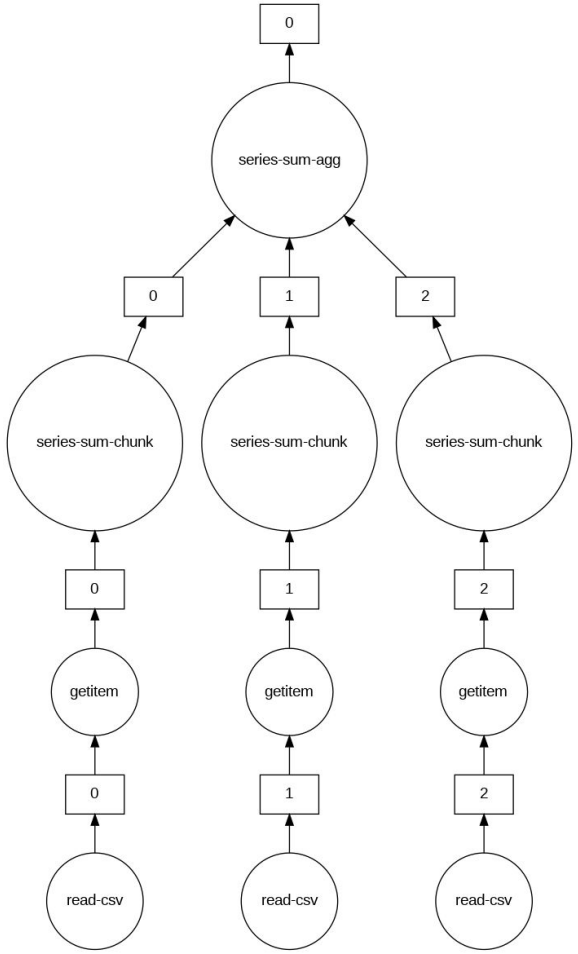
Dask: DataFrame API

- Dask operations are evaluated ***lazily:*** Dask constructs the logic (called task graph) of the computation immediately but “evaluates” them only when necessary.
- Use *.compute()* method to trigger computation

```
import dask.dataframe as dd
df = dd.read_csv(“my_huge_file.csv”)
s = df.column.sum()

# visualize task graph
s.visualize()

# trigger computation to
# calculate sum of column
s.compute()
```



AWS and Dask Demo

Assignment: Dataset Description

Amazon Reviews table

Column name	Column description	Example
reviewerID	ID of the reviewer	A32DT10X9WS4D0
asin	ID of the product	B003VX9DJM
reviewerName	name of the reviewer	Slade
helpful	helpfulness rating of the review	[0, 0]
reviewText	text of the review	this was a gift for my friend who loves touch lamps.
overall	rating of the product	1
summary	summary of the review	broken piece
unixReviewTime	summary of the review	1397174400
reviewTime	time of the review (raw)	04 11, 2014

Assignment Task:

We will be using Dask library to explore secondary storage aware data access on a single machine.

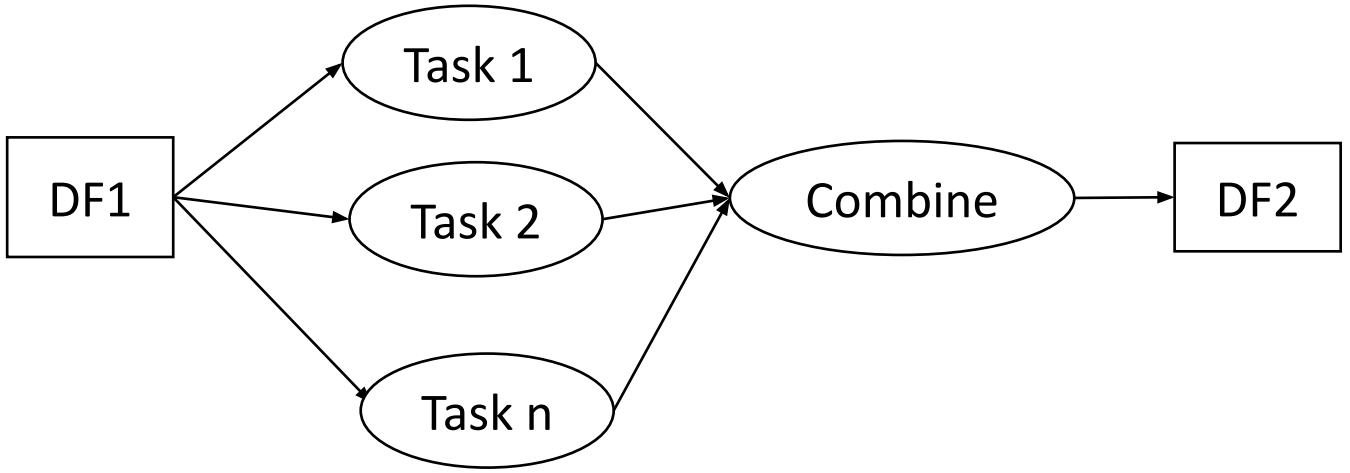
Create a new *users* table using only the *reviews* table with the following schema:

Column name	**Column description**
reviewerID (PRIMARY KEY)	ID of the reviewer
number_products_rated	Total number of products rated by the reviewer
avg_ratings	Average rating given by the reviewer across all the reviewed products
reviewing_since	The year in which the user gave their first review
helpful_votes	Total number of helpful votes received for the users' reviews
total_votes	Total number of votes received for the users' reviews

Assignment Approach

Break up the “task” (creating a new *users* dataframe) into multiple sub-tasks (creating columns of the *users* dataframe)

Specify operations using Dask DataFrame APIs, which generates the task graph



Given the task graph, Dask scheduler will take care of computing them in a task-parallel manner

Grading Scheme

Accuracy(80)

- 5 columns
- If all the descriptive stats (mean, std dev, min, and max) rounded to 2 decimal points match the ground truth with a **1% error margin**, then **16 points awarded per column**

Runtime(20)

Absolute single node runtimes	**Points**
Under 20 mins	20
Between 20 mins and 30 mins	12
Between 30 mins and 1 hr	8
Anything above 1 hr	0

- Run function thrice and take average for getting the runtime measurement
- If accuracy points ≥ 40, runtime evaluation is automated (grading is based on above table)
- If accuracy points < 40, then partial credit based on manual inspection by TAs

Files and Submission

All files necessary for the assignment are provided in the s3://dsc102-public bucket

- **user_reviews.csv** – Amazon reviews dataset
- **PA0.py** – function signature
- **expected_results_PA0.json** – expected result on the user_reviews.csv dataset

Files used in this discussion session are provided in the s3://dsc102-demo bucket

- **demo_data.csv** – small subset of user_reviews.csv used for the demo in this discussion session
- **dask_demo_notebook.ipynb** – Jupyter notebook used for the demo in this discussion session

Submit your source code as <**YOUR-TEAM-ID>.py** on Canvas.

Your source code must confirm to the function signatures provided to you.

Make sure that your code is writing results to **results_PA0.json**.

Best Practices for PA0

- Since the development data set is large, **consider working on a smaller subset first** (use the demo_data.csv (3.5 GB) and move to the full dataset user_reviews.csv (28.5 GB) later).

- Some helpful Dask APIs: groupby(), map_partitions(), apply(), str.split(), .agg()

- While performing **groupby()** aggregations on large no. of groups, use **split_out** to split output into multiple partitions to avoid memory error. (see this and this for tuning **split_out**)

- Call **.compute()** only once in your code (avoid computing intermediate dataframes).

Best Practices for PA0

- **AWS budget for both PA0 and PA1: 50 USD**
  Terminate the AWS instance every time that you pause working; launch again & read from S3 again next time to save budget.
  (**Backup your code** at regular intervals/before terminating by downloading the code to your laptop).

- **Daily Limit: 3 USD**
  You CANNOT use more than 3 USD worth of AWS resources on a single day.
  START EARLY !

Other Helpful Links

- https://tutorial.dask.org/01_dataframe.html
- https://docs.dask.org/en/latest/dataframe-best-practices.html
- https://docs.dask.org/en/latest/dataframe-design.html
- https://examples.dask.org/dataframes/03-from-pandas-to-dask.html
- https://docs.dask.org/en/latest/dataframe-indexing.html
- https://docs.dask.org/en/stable/generated/dask.dataframe.DataFrame.reset_index.html
- https://docs.dask.org/en/latest/generated/dask.dataframe.groupby.DataFrameGroupBy.aggregate.html

Questions