CS 327E Class 10

Nov 20, 2020

Announcements

- Feedback on Test 3
- Extra credit opportunities
- Milestones 3 and 4

Motivations for Dataflow

- A system for processing arbitrary computations on large amounts of data
- Can process batch data and streaming data using the same code
- Uses Apache Beam, an open-source programming model
- Designed to be very scalable, millions of QPS

Apache Beam Concepts

- A model for describing data and data processing operations:
  - `Pipeline`: a data processing task from start to finish
  - `PCollection`: a collection of data elements
  - `PTransform`: a data transformation operation
- Supported languages: Java, Python and Go
- Executed in the cloud on Dataflow, Spark, Flink, etc.
- Executed locally with Direct Runner for dev/testing

Beam Pipeline

- Pipeline = A directed acyclic graph where the nodes are PTransforms and the edges are PCollections
- General Structure of a Pipeline:
  - Reads one or more data sources as input PCollections
  - Applies one or more PTransforms on PCollections
  - Outputs resulting PCollection as one or more data sinks
- Executed as a single unit
- Runs in batch or streaming mode

PCollection

- A collection of data elements, either bounded or unbounded
- Elements can be made up primitive and complex types
- Distributed across machines
- PCollections are immutable
- Created from a data source or a PTransform
- Written to a data sink or passed to another PTransform

PTransforms

All operations on data are different kinds of PTransforms

- Element-wise:
  - maps 1 input to (1, 0, many) outputs
  - Examples: `ParDo`, `Map`, `FlatMap`
- Aggregation:
  - reduces many inputs to (1, fewer) outputs
  - Examples: `GroupByKey, CoGroupByKey, Flatten`
- Composite: combines element-wise and aggregation
  - `GroupByKey -> ParDo`

PTransform Properties

- Serializable
- Parallelizable
- Idempotent

ParDo Transform

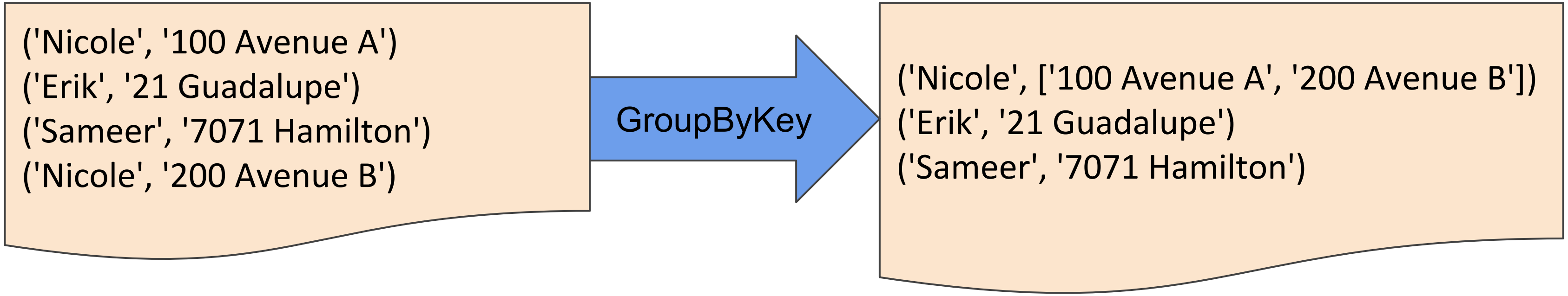
- ParDo = "Parallel Do"
- Maps 1 input to (0, 1, many) outputs
- Takes as input a PCollection
- Applies the user-defined ParDo to the input
- Outputs results as new PCollection
- Typical usage: filtering, formatting, extracting parts of data, performing computations on data elements

Hello World Example 1

```python
class Multiply(beam.DoFn):
  def process(self, element):
     return [element * 10]


p = beam.Pipeline('DirectRunner', options=opts)

in_pcoll = p | beam.Create([1, 2, 3, 4, 5])

out_pcoll = in_pcoll | 'Multiply' >> beam.ParDo(Multiply())

out_pcoll | 'Write results' >> WriteToText('multiplied.txt')
```

GroupByKey Transform

- Input: PCollection where each element is a (key, value) pair
- Groups the values by unique key
- Output: PCollection where each element is a (key, list(value)) pair



('Nicole', '100 Avenue A')
('Erik', '21 Guadalupe')
('Sameer', '7071 Hamilton')
('Nicole', '200 Avenue B')

GroupByKey

('Nicole', ['100 Avenue A', '200 Avenue B'])
('Erik', '21 Guadalupe')
('Sameer', '7071 Hamilton')

Hello World Example 2

```
class SplitWords(beam.DoFn):
  def process(self, element):
     results = []
     words = element.split()

     for word in words:
        results.append((word, 1))

     return results


p = beam.Pipeline('DirectRunner', options=opts)

in_pcoll = p | beam.Create(['here are some words', 'here a few more words'])

split_pcoll = in_pcoll | 'Split Words' >> beam.ParDo(SplitWords())

out_pcoll = split_pcoll | 'Group Words' >> beam.GroupByKey()
```

Beam + Dataflow Setup

https://github.com/cs327e-fall2020/snippets/wiki/Apache-Beam-and-Dataflow-Setup-Guide

Hands-on Exercises

```
git clone https://github.com/cs327e-fall2020/snippets.git
```

How to develop Beam pipelines:

1. Start with a working code example and incrementally add to it.
2. Test and debug one transform at a time.
3. Write temporary and final PCollections to log files.
4. You may encounter jupyter notebook issues.
5. Start on the assignment **as early as possible**. The Beam Python documentation is sparse and learning Beam requires **patience**, **perseverance**, and **experimentation**.
6. Piazza won’t be a good way to debug.
7. If you get stuck, go to OHs. If you can’t make OHs, make an appointment with the TAs.

Milestone 3

http://www.cs.utexas.edu/~scohen/milestones/Milestone3.pdf