Agenda

- Announcements
- Closing the Feedback Loop
- Review/Finish: mostFrequentStart
- Recap: Nested Collections
- Practice: Search Engine

Announcements

- Programming Assignment 2 (P2) released on Friday!
  - Seriously, start early! This assignment is much more involved…
  - Due **February 15th** by 11:59 PM
- Quiz 1 on February 13th
  - Topics: ArrayLists, Reference Semantics, Stacks and Queues, Sets, Maps
- Tomorrow, Resubmission Cycle 3 (R3) form out, due February 13th by 11:59 PM
  - Available assignments: ***P0***, C1, P1

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Closing the Feedback Loop

- The Good:
  - PCMs, Sections, Resubmissions, Live coding, IPL, TAs
- Suggestions:
  - Quiz practice
    - Working with TAs to create more “quiz-like” resources
  - Spec length / organization
    - Working on this! Specs often repeat important info so it’s harder to miss
  - Pacing
    - Some said too fast, some said too slow…
- Reminders:
  - PCMs are expected to take ~20-30min
  - Use additional section problems for quiz prep!

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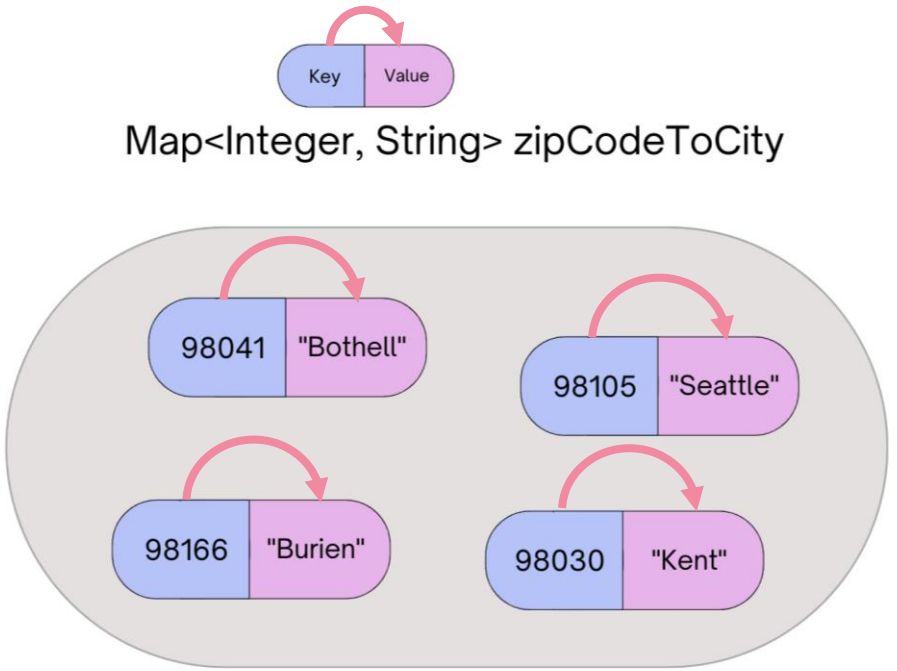
Map ADT

- Data structure to map keys to values
  - Keys can be any* type; Keys must be unique
  - Values can be any type
- Example: Mapping ticker to stock price in P0
- Operations
  - `put(key, value)`: Associate key to value
    - Overwrites duplicate keys
  - `get(key)`: Get value for key
  - `remove(key)`: Remove key/value pair



Same as Python's `dict`

mostFrequentStart

Write a method called mostFrequentStart that takes a Set of words and does the following steps:

- Organizes words into “word families” based on which letter they start with
- Selects the largest “word family” as defined as the family with the most words in it
- Returns the starting letter of the largest word family (and if time, should update the Set of words to only have words from the selected family).

mostFrequentStart

For example, if the `Set` words stored the values

```
["hello", "goodbye", "library", "literary", "little", "repel"]
```

The word families produced would be

```
'h' -> 1 word ("hello")
'g' -> 1 word ("goodbye")
'l' -> 3 words ("library", "literary", "little")
'r' -> 1 word ("repel")
```

Since 'l' has the largest word family, we return 3 and modify the `Set` to only contain `Strings` starting with 'l'.

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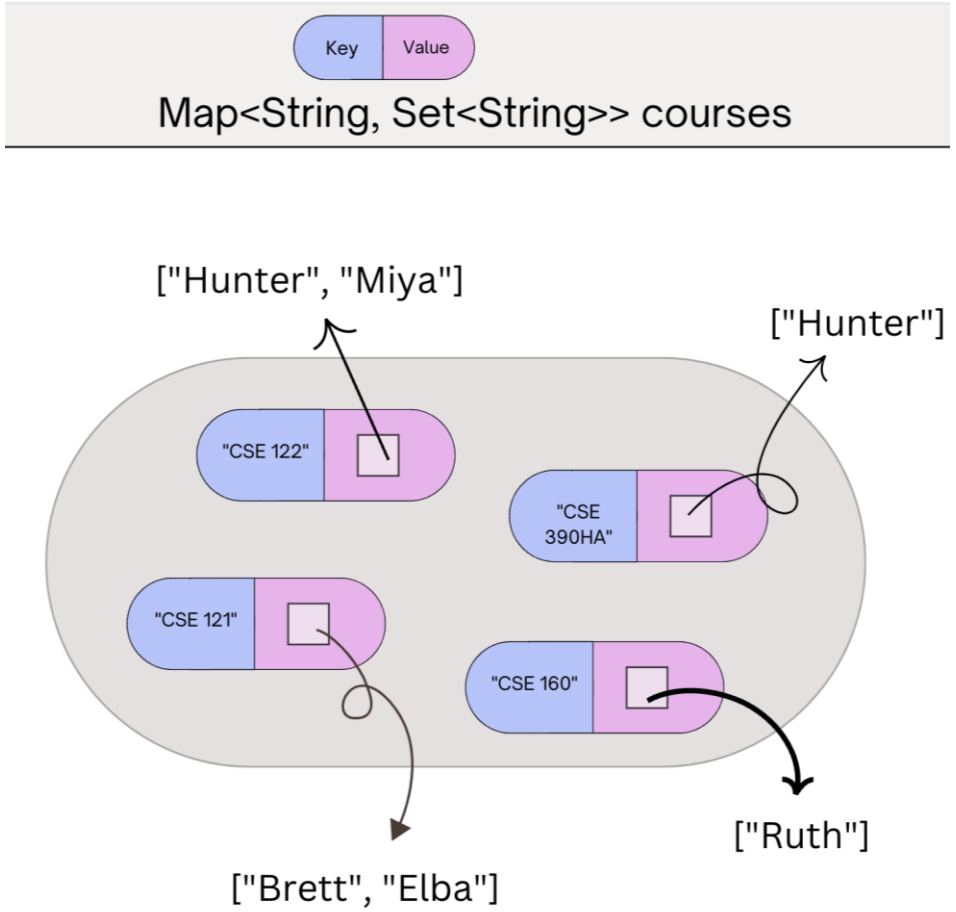
Nested Collections

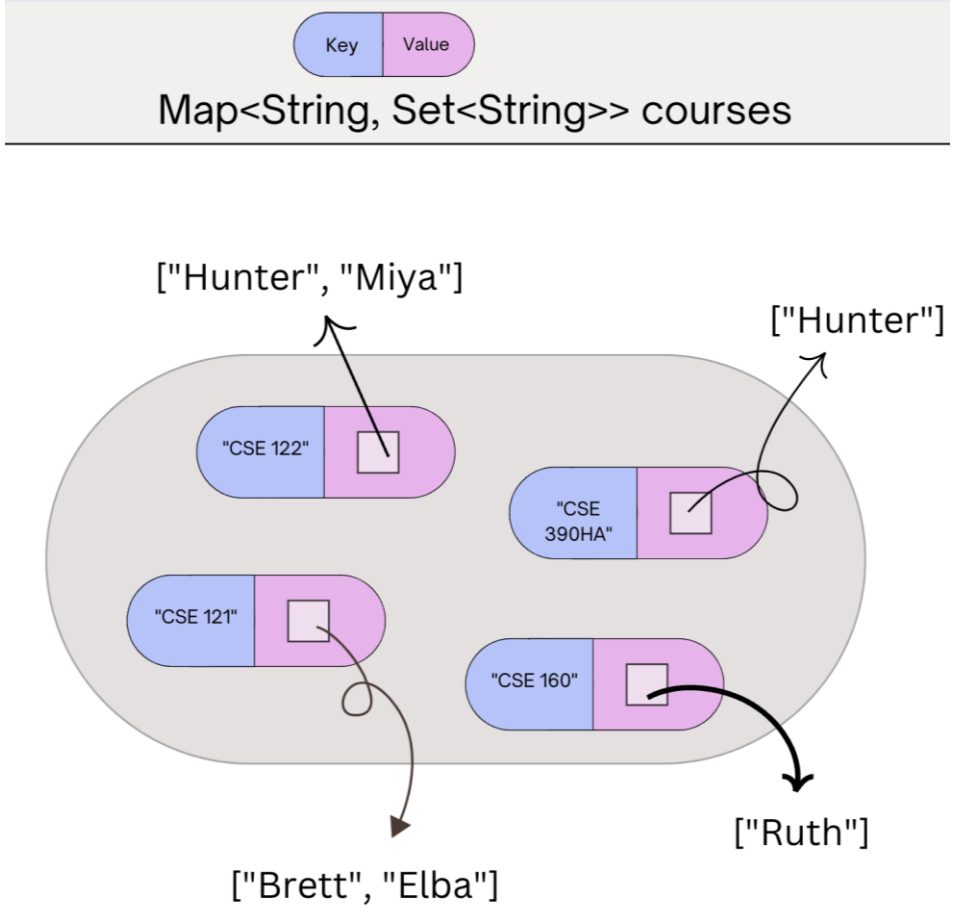
- The values inside a Map can be any type, including data structures
- Common examples:
  - Mapping: Section ➔ Set of students in that section
  - Mapping: Recipe ➔ Set of ingredients in that recipe
    - Or even Map<String, Map<String, Double>> for units!



Updating Nested Collections

The "value" inside the Map is a reference to the data structure!

- Think carefully about number of references to a particular object




```
courses.put("CSE 123", new HashSet<String>());
courses.get("CSE 123").add("Kasey");

Set<String> cse123 = courses.get("CSE 123");
cse123.add("Brett");
```

Practice : Think

sli.do #cse122

Suppose map had the following items. What would its items be after running this code?

```
map: {”KeyA"=[1, 2], ”KeyB"=[3], ”KeyC"=[4, 5, 6]}
```

```
Set<Integer> nums = map.get("KeyA");
nums.add(7);
map.put("KeyB", nums);
map.get("KeyA").add(8);
map.get("KeyB").add(9);
```

A. `{"KeyA"=[1, 2], "KeyB"=[1, 2, 7], "KeyC"=[4, 5, 6]}`

B. `{"KeyA"=[1, 2, 8], "KeyB"=[1, 2, 7, 9], "KeyC"=[4, 5, 6]}`

C. `{"KeyA"=[1, 2, 7, 8], "KeyB"=[1, 2, 7, 9], "KeyC"=[4, 5, 6]}`

D. `{"KeyA"=[1, 2, 7, 8, 9], "KeyB"=[1, 2, 7, 8, 9], "KeyC"=[4, 5, 6]}`

Practice : Pair

sli.do #cse122

Suppose map had the following items. What would its items be after running this code?

```
map: {"KeyA"=[1, 2], "KeyB"=[3], "KeyC"=[4, 5, 6]}
```

```
Set<Integer> nums = map.get("KeyA");
nums.add(7);
map.put("KeyB", nums);
map.get("KeyA").add(8);
map.get("KeyB").add(9);
```

nums →

A: [1, 2, 7, 8, 9]

B: nums

C: [4, 5, 6]

A. `{"KeyA"=[1, 2], "KeyB"=[1, 2, 7], "KeyC"=[4, 5, 6]}`

B. `{"KeyA"=[1, 2, 8], "KeyB"=[1, 2, 7, 9], "KeyC"=[4, 5, 6]}`

C. `{"KeyA"=[1, 2, 7, 8], "KeyB"=[1, 2, 7, 9], "KeyC"=[4, 5, 6]}`

D. `{"KeyA"=[1, 2, 7, 8, 9], "KeyB"=[1, 2, 7, 8, 9], "KeyC"=[4, 5, 6]}`

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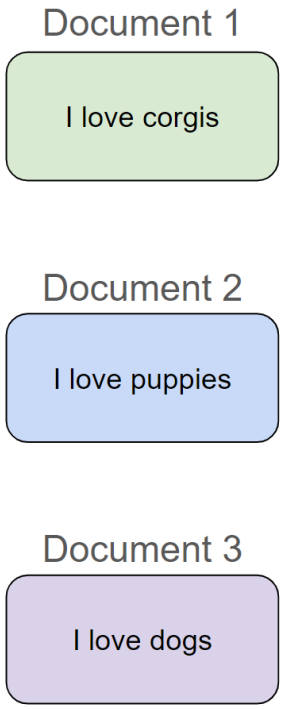
Background: Search Engines

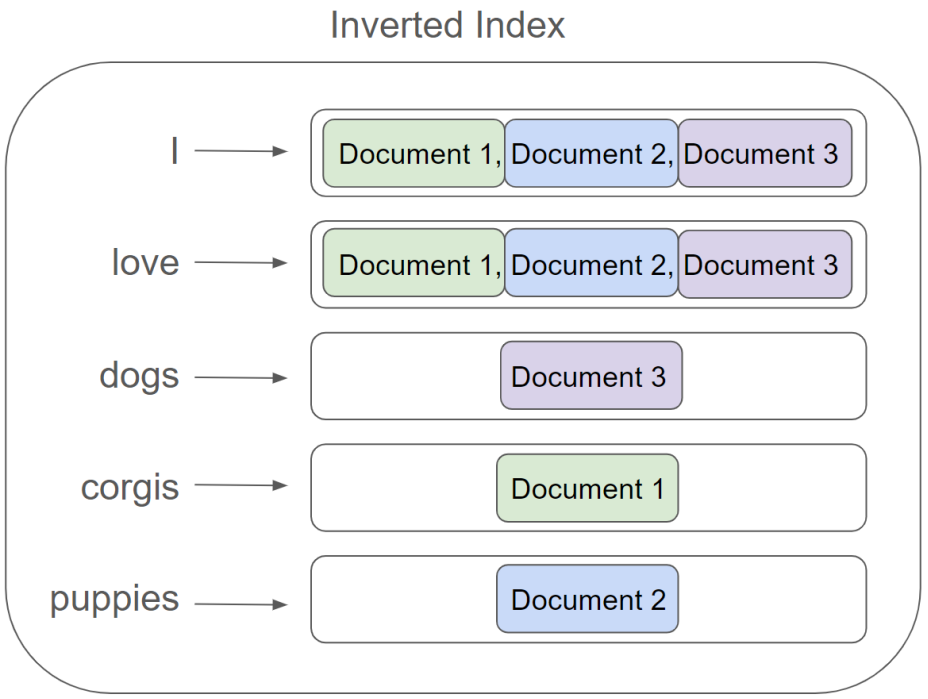
- A **search engine** receives a **query** and returns a set of relevant **documents.** Examples: Google.com, Mac Finder, more.
  - Queries often can have more
- A search engine involves two main components
  - An **index** to efficiently find the set of documents for a query
    - Will focus on "single word queries" for today's example
  - A **ranking algorithm** to order the documents from most to least relevant
    - Not the focus of this example

- Goal: Precompute a data structure that helps find the relevant documents for a given query

Inverted Index

- An **inverted index** is a Mapping from possible query words to the set of documents that contain that word
  - Answers the question: "What documents contain the word 'corgis'?"





Ranking Results

- There is no one right way to define which documents are “most relevant” There are approximations, but make decisions about what relevance means
- Idea 1: Documents that have more hits of the query should come first
  - Pro: Simple
  - Con: Favors longer documents (query: “the dogs” will favor long documents with lots of “the”s)
- Idea 2: Weight query terms based on their “uniqueness”. Often use some sort of score for “Term Frequency – Inverse Document Frequency (TF-IDF)
  - Pro: Doesn’t put much weight on common words like “the”
  - Cons: Complex, many choices in how to compute that yield pretty different rankings
- Idea 3: Much more! Most companies keep their ranking algorithms very very secret ☺

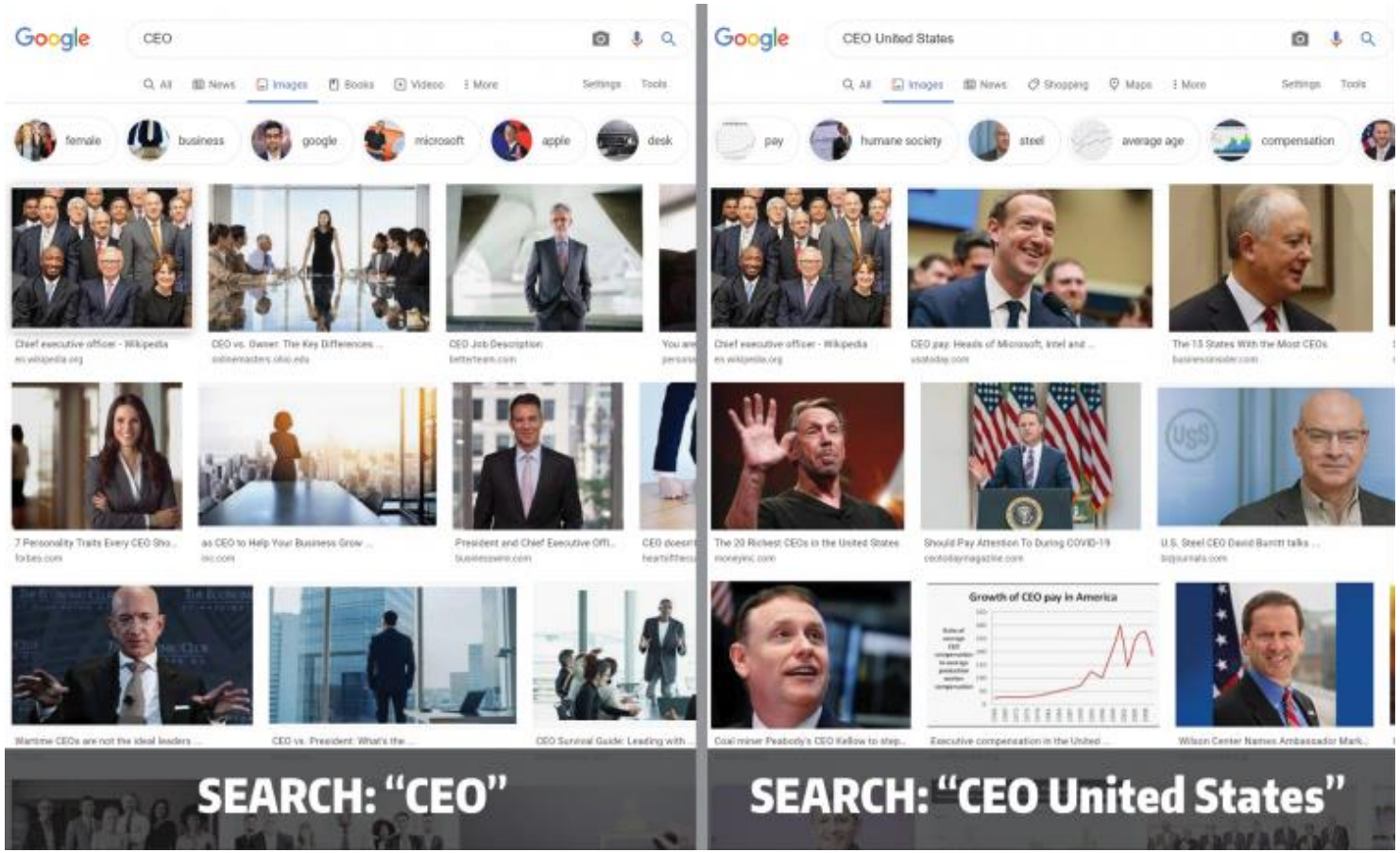
Data Bias

- Image results for searching the term “CEO” on Google (2015)
  - Notice anything about the results?

https://www.washington.edu/news/2015/04/09/whos-a-ceo-google-image-results-can-shift-gender-biases/

Data Bias

- Fix: Image results for searching “CEO” and “CEO United States” (2022)



https://www.washington.edu/news/2022/02/16/googles-ceo-image-search-gender-bias-hasnt-really-been-fixed

Data Bias

- Google's autocomplete recommendations used to actually look like this
  - Fix: Don't display autocomplete results for phrases like "why are [group] ____"

<u>Are these changes fixing the right thing?</u>

Btw, Miya says this is a great book that you should check out if you're interested ->