Design Patterns (2)

CSE 403

Object pool pattern

- Problem:
  - Expensive to create objects (allocation, initializaton)
  - Expensive to destroy objects (cleanup, GC)
  - Few objects are in use at any one time
- Examples: connections, threads, memory, fonts
- Solution: re-use objects
  - Obtain objects from the pool
    - Re-initialize some fields
    - What if the pool is empty?
      - Err
      - Create and add to the pool
      - Wait for resources to become available
  - Return them to the pool when done (empty some fields)

Null object pattern

- Problem: null pointer errors
- myMap.get(key).doSomething()
- Solutions:
  - Suffer a crash at run time
  - Test return value before use
  - Statically prove correctness
  - Make doSomething work on null values
  - Return a special value for which doSomething is a no-op (null object pattern)

Memento pattern

- Representation of previous state
- Permits undo or redo
- Examples:
  - seed in a pseudo-random number generator
  - state in a FSM
- Issues:
  - efficient representation
  - undoability of undo
  - how does your DVCS handle this?

The World Wide Web: Stateful connections or not?

Word processor data structures

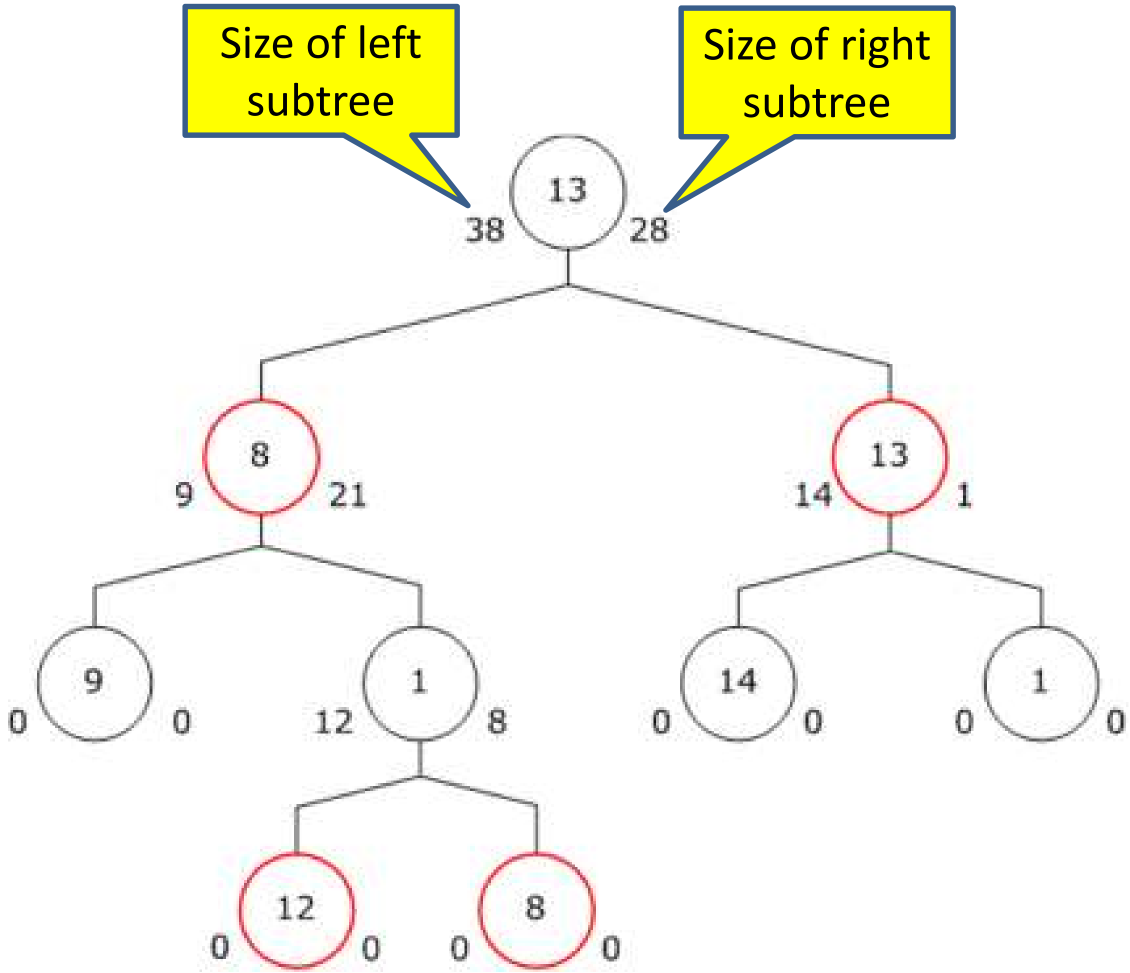
- Represent the text and formatting of the document
- Goals:
  - fast lookup (char at a location)
  - fast insertion/deletion
  - supports multi-level undo
  - scales to large documents

Linked list of pieces

- Linked list of text fragments

- User operations:
  - insert
  - delete
  - move to new location
  - search
- Additional data structure operations:
  - split, merge
- How to support undo?

Piece tree


Size of left subtree
Size of right subtree
13
38
28
8
9
21
13
14
1
9
0
0
1
12
8
14
0
0
1
0
0
12
0
0
8
0
0

Piece table

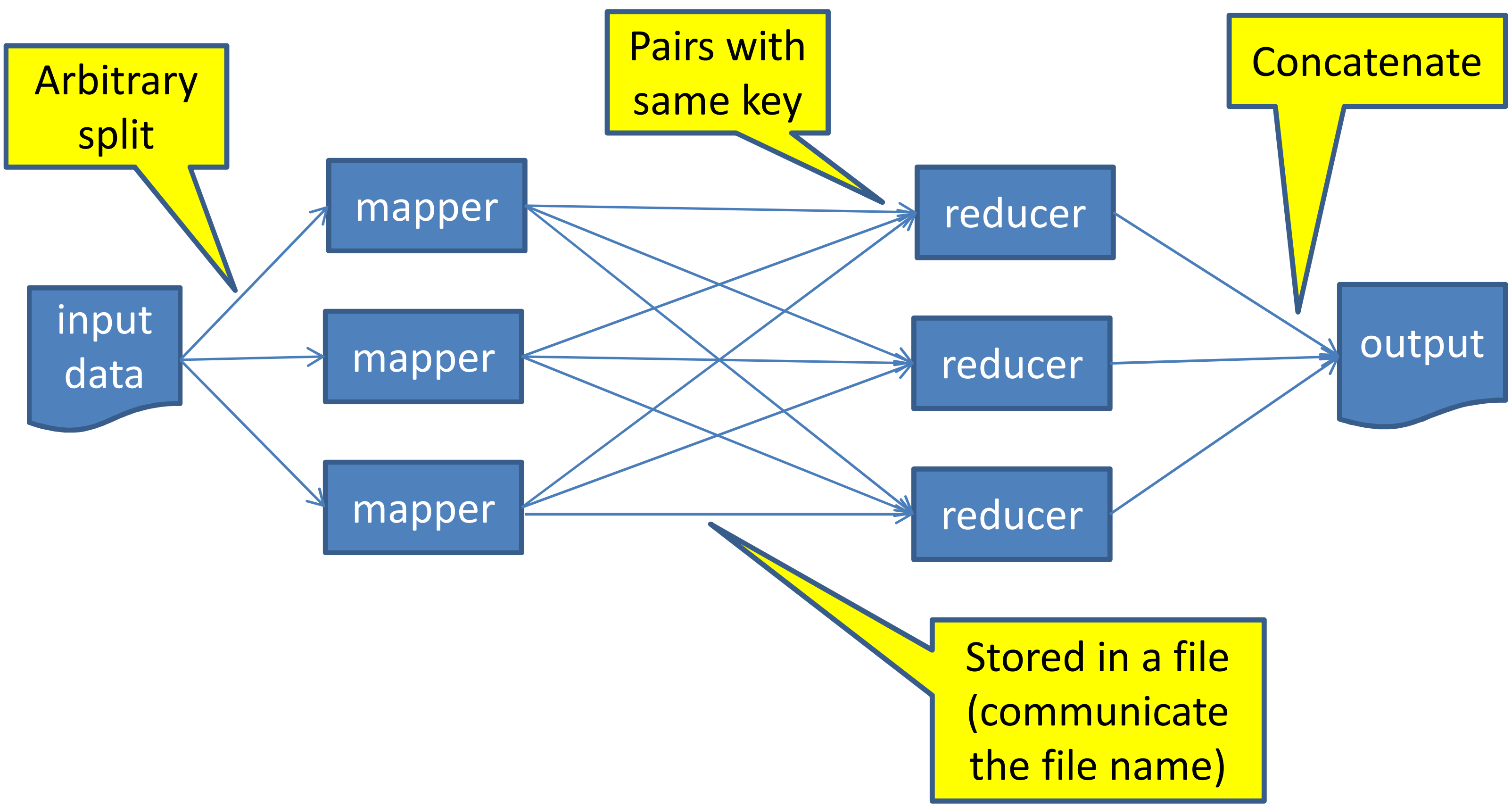
- List of pieces
  - Each piece is part of original file, or an addition
- Pieces are added at end of a buffer (fast)
- No mutation or copying of text data structures
- Originally used in the Bravo editor (Lampson & Simonyi)

MapReduce

- Goal: process large amounts of data
  - parallelism
  - fault recovery
  - simple programming model
- Previous approaches:
  - Databases (including parallel databases)
  - Ad hoc programs

MapReduce architecture

- map(k1, v1) -> list of <k2, v2>
- reduce(k2, list of v2) -> list of v3



Count each word in a corpus (a set of documents)

```
map(Document key, String text):
  for each word w in text:
    EmitIntermediate(w, "1")

reduce(String word, Iterator values):
  int result = 0
  for each v in values:
    result += toInt(v)
  Emit(new Pair(word, toString(result)))
```

Distributed grep

- Input: corpus (set of documents)
- Output: lines matching a given pattern
- map: emits a line if it matches the pattern
- reduce: identity function that just copies the supplied intermediate data to the output.

URL Access Frequency

- Input: logs of web page requests
- Output: for each webpage, number of accesses
- map: outputs <URL, 1>
- reduce: adds together all values for the same URL and emits a <URL, total count> pair

Reverse Web-Link Graph

- Input: Set of webpages
- Output: For each URL, webpages that link to it
- map: outputs <target, source> pairs for each link to a target URL found in a page named "source“
- reduce: concatenates the list of all source URLs associated with a given target URL and emits the pair: <target, list(source)>

Inverted index

- Input: corpus (set of documents)
- Output: For each word, a list of documents in which it appears
- map: parses each document, and emits a sequence of <word, document ID> pairs
- reduce: accepts all pairs for a given word, sorts the corresponding document IDs and emits a <word, list(document ID)> pair.
  - Optionally, keep track of word positions.

Anagram generator

- Input: list of words
- Output: list of all possible anagrams
- map: outputs <word with letters sorted, original word>
- reduce(sortedWord, Iterator realWords):
  for each realWord:
    output <realWord, realWords>