CS 100

Tuesday

6 October 2015

Today's Agenda

0. Announcements
1. Calendar
2. Professor Ruigang Yang, UK Computer Science
3. Teem Geek Chapter 2
4. *The Magic of Computer Science*
   A. Algorithms and Structure
   B. Massive Parallelism (map reduce)

0. Announcements

- 13 October: Group Project Launch
  - Expect Group assignments and project details
- 20 October: Quiz 1
  - Begin to organize your notes for Quiz Study
- Office hours
  - Can check with Amy or Diane in CS department to see if a meeting and/or trip has curtailed office hours

1. Calendar

- HW3 (“numbers”) due tonight by midnight tonight

```
int main () {
  int SHIFT=10; // number of shifts to print in table

  // ASCII codes to "decode" (this was given in the assigned problem)
  char A[55] = {80, 94, 25, 58, 107, 94, 25, 80, 98, 101, 93, 92, 90,
                109, 108, 26};
  // Construct a string from the declared array of characters
  string message(A);

  // Print the table for each shift value, starting at zero
  for(int i =0;  i < SHIFT;  i++) {
    printShifted(message, -i);
    cout << endl;
  }
  return 0;
}
```

```
// Shifts each ASCII character in string by "shift"
void printShifted (string s, int shift) {
  // print shifted values as characters, fixed field width so that
  // it lines up
  for (int i=0; i < (s.length()); i++)
    cout << setw(3) << (char)(s[i]-shift);
  cout << endl;

  // print shifted values as ASCII equivalents
  for (int i=0; i < (s.length()); i++)
    cout << setw(3) << s[i]-shift;
  cout << endl;
}
```

2. Professor Yang

- PhD UNC Chapel Hill
- Full Professor at UK

Teem Geek

- Clickers

The Magic of Computer Science (Part 2)

Any sufficiently advanced technology is indistinguishable from magic

- Arthur C. Clarke

There is no magic.

- Ken Calvert

Review: Powers of 2

$2^0 = 1$	$2^4 = 16$	$2^8 = 255$	$2^{12} = 4096$
$2^1 = 2$	$2^5 = 32$	$2^9 = 512$	$2^{13} = 8192$
$2^2 = 4$	$2^6 = 64$	$2^{10} = 1024$	$2^{14} = 16384$
$2^3 = 8$	$2^7 = 128$	$2^{11} = 2048$	$2^{15} = 32768$

Recap

- The power of computing comes from the ability to manipulate digital information
- Analog-to-Digital conversion translates natural phenomena (e.g., waveforms) into digital representation
  - Music (MP3), voice telephony
  - Images (JPEG, HDTV)
- Once information is encoded digitally, it can be:
  - Stored on any digital medium
  - Manipulated by any computer
  - Duplicated perfectly at very low cost

Algorithms

Exploit structure of a problem / ordering

Very common problem:

Order a set of information

Resumes

- Last Name, First Name
- Lots of other info…

- Problem – return resumes to owners (after ingesting information, of course)

Ordering is Crucial for Queries

- Queries (or "data mining")
  - Find information in the set of data to answer questions
  - Information can be composite:
    - How many people are from Jessamine county?
  - Or individual
    - What is Jamie Lewis' age?
- Queries are *hard* without structure / ordering

Algorithm for Ordering

- Multiple stages
  - "sort" smallest stack
  - Reduce number of stacks via merge

Ordering a.k.a. Sorting

- Sort
  - Sort a single group of papers any way you want. Make sure at the end your group of papers is in alphabetical order by last name.
  - At the end of this phase we should have a bunch of stacks of papers, each of which is alphabetized.

Total Ordering: Can Merge to Reduce Number of Stacks

- Merger task: merge two stacks together, keeping them in alphabetical order
- Now find another merger and negotiate again (one of you drops out, the other continues to the next round as a merger)
- Double down!

Alternate Plan: Shards

- How about creating shards based on first letter of last name?
- 26 shards
- Now order each shard

- Any relationship to binary numbers?

- There is no magic.

Ordered Data: Can Answer Queries

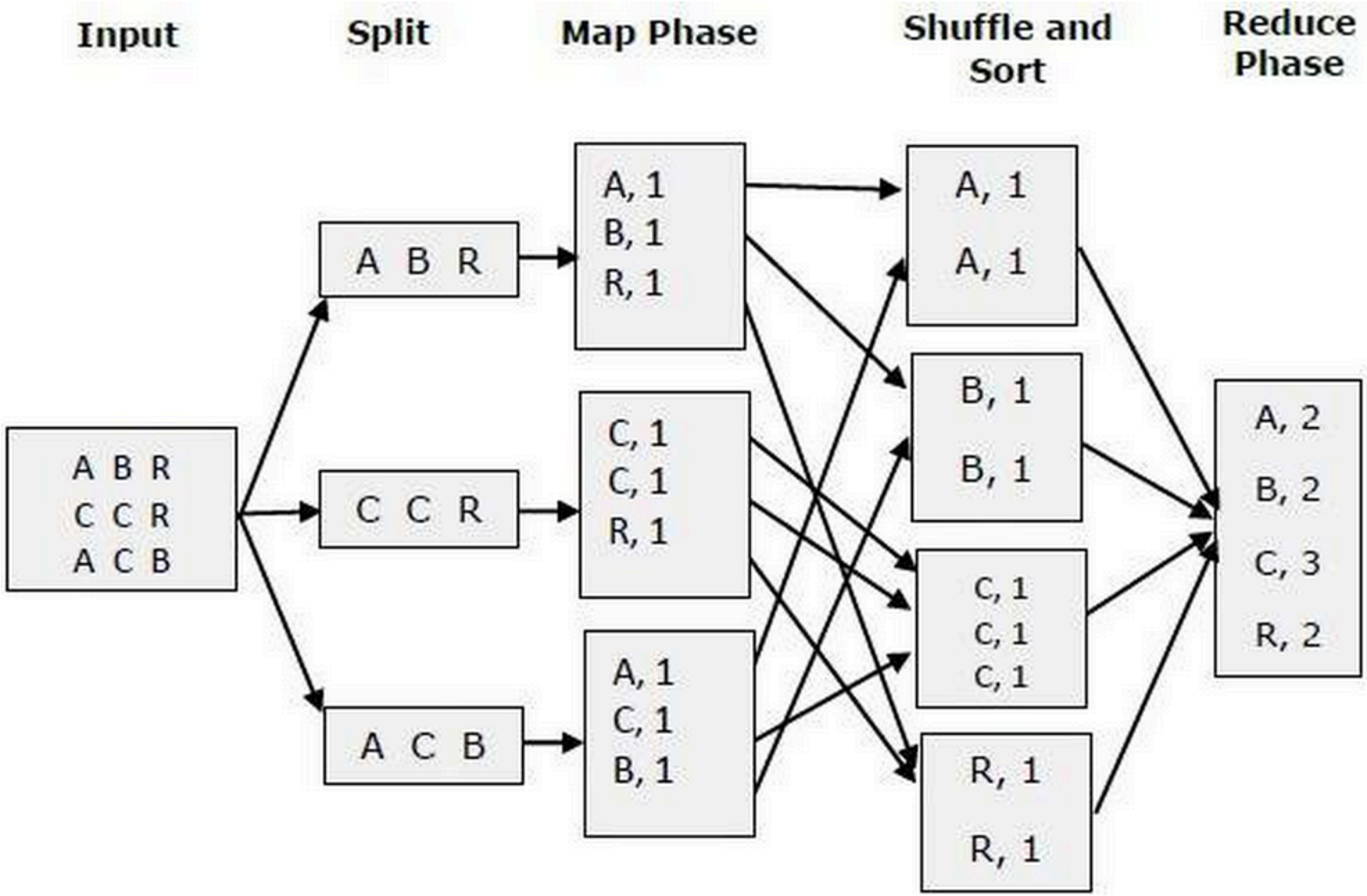
- Ordered / structured data very powerful
- But there is just one of *me* to rifle through the data source to answer questions….

- What about information like this?
  - What are the top Kentucky counties (by count) represented in this class?

Parallelism

- Structure of many problems allows the possibility to solve them in pieces, where the pieces happen simultaneously

(There is no magic)



http://www.tutorialspoint.com/map_reduce/map_reduce_quick_guide.htm

MapReduce

- Programming model for solving problems
  - In parallel
  - On a cluster
  - Low level abstractions (binary numbers)
  - Structure of information (algorithms)
  - Massively parallel / distributed solutions driven by data centers available on a global scale

TakeAways

- Numbers are an abstraction
  - At the lowest level, they are binary sequences
- Media is an abstraction
  - At the lowest level, digital media is a binary sequence
- Algorithms are abstractions
  - At the lowest level, they are sequences of operations on binary sequences
- Parallelism is an abstraction
  - At the lowest level, it is simultaneous, structured activity on binary sequences

Distributing Results

- Collect and show results