Introduction
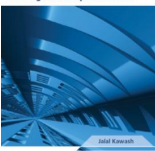
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- Mandatory: Chapter 1
- Optional: None

Reading Assignment

1

Problems & Solutions
Computer Science perspective

3

At the end of this section, you will be able to:

1. Define a (computational) problem
2. Understand the terms *algorithm* and *program*
3. Start working with Microsoft Excel Spreadsheets

Objectives

- Studying computers and utilizing them to solve problems

- **Computational** problems are solved by computers

- Computer scientists use methodological thinking when approaching problems

Computer Science

- Any problem has *input* and *output*
  ◦ Examples: laundry, cooking, building

- The problem specifies *what* needs to be done
- It specifies the relationship between *input* and *output*
- The problem is not concerned with *how*

Problems

- Searching the Web is a computational problem
- **Input:** A collection of keywords
- **Output:** A ranked list of Web documents that are relevant to the input keywords

computational+problem	Search

About 8,670,000 results (0.32 seconds)   Advanced search

Computational problem - Wikipedia, the free encyclopedia ☆
In theoretical computer science, a **computational problem** is a mathematical object
representing a collection of questions that computers might want to solve. **...**
en.wikipedia.org/wiki/**Computational_problem** - Cached - Similar

Category:**Computational problems** - Wikipedia, the free encyclopedia ☆
This category lists **computational problems**, formal problems in theoretical computer
science which are studied in computational complexity theory. **...**
en.wikipedia.org/wiki/Category:**Computational_problems** - Cached - Similar
⊞ Show more results from en.wikipedia.org

Example: Searching the Web

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- Collects and records information about Web documents in a *database*
- *Web crawlers* or *spiders* collect information
- You can use a search engine through a *Web browser*

- All are **programs**

Solution: Search Engine

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- Solutions to computational problems are represented as programs
- Program = sequence of computer *instructions*
- Written in a *programming language*

- **Algorithm** = A program that is not written in a programming language
- *It is the specification of a program*

Programs

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- to-visit = a non-empty list of initial URLs to be visited
- For each URL in to-visit:
  ◦ Open that URL document d
  ◦ Record information about d in the database
  ◦ Scan d for hyperlinks
  ◦ For each hyperlink in d:
    · Add the hyperlink to to-visit

Web Crawler Algorithm

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- Browsers and crawlers are specialized programs

- General-purpose programs can be used to solve variety of problems

- Example: Microsoft Excel program

General-Purpose Programs

- Gird of cells
- Cell = intersection of a column and row
- Columns are referenced by letters
- Rows are referenced by numbers
- Example cell: B1 contains **124**

	A	B	C	D	E	F
1	Invoice Number	124				
2	Date	18/04/2010				
3	Customer	Saleh Dice				
4	US-CAD Rate	1.15				
5						
6	Serial Number	Item Description	Individual Price	Quantity	Total Price	Total CAD Price
7		1 Kindle Wireless Reading Device	$ 256.00	2	$ 512.00	CAD 588.80
8		2 Avatar (Two-Disc Blu-ray/DVD Combo)	$ 24.99	3	$ 74.97	CAD 86.22
9		3 Wines of Central & Southern Italy	$ 8.98	2	$ 17.96	CAD 20.65
10						
11	Invoice Total				$ 604.93	CAD 695.67

Spreadsheets

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Slide 13

- Allow us to perform calculations
- Formulas start with **=**
  - ◦ = is an instruction to perform calculations

=C7*D7

	A	B	C	D	E	F
1	Invoice Number	124				
2	Date	18/04/2010				
3	Customer	Saleh Dice				
4	US-CAD Rate	1.15				
5						
6	Serial Number	Item Description	Individual Price	Quantity	Total Price	Total CAD Price
7	1	Kindle Wireless Reading Device	$ 256.00	2	$ 512.00	CAD 588.80
8	2	Avatar (Two-Disc Blu-ray/DVD Combo)	$ 24.99	3	$ 74.97	CAD 86.22
9	3	Wines of Central & Southern Italy	$ 8.98	2	$ 17.96	CAD 20.65
10						
11	Invoice Total				$ 604.93	CAD 695.67

Formulas

Slide 14

- Allow us to perform group calculations
- Some example functions: sum, average, minimum, and maximum

=SUM(E7:E9)

	A	B	C	D	E	F
1	Invoice Number	124				
2	Date	18/04/2010				
3	Customer	Saleh Dice				
4	US-CAD Rate	1.15				
5						
6	Serial Number	Item Description	Individual Price	Quantity	Total Price	Total CAD Price
7	1	Kindle Wireless Reading Device	$ 256.00	2	$ 512.00	CAD 588.80
8	2	Avatar (Two-Disc Blu-ray/DVD Combo)	$ 24.99	3	$ 74.97	CAD 86.22
9	3	Wines of Central & Southern Italy	$ 8.98	2	$ 17.96	CAD 20.65
10						
11	Invoice Total				$ 604.93	CAD 695.67

Functions
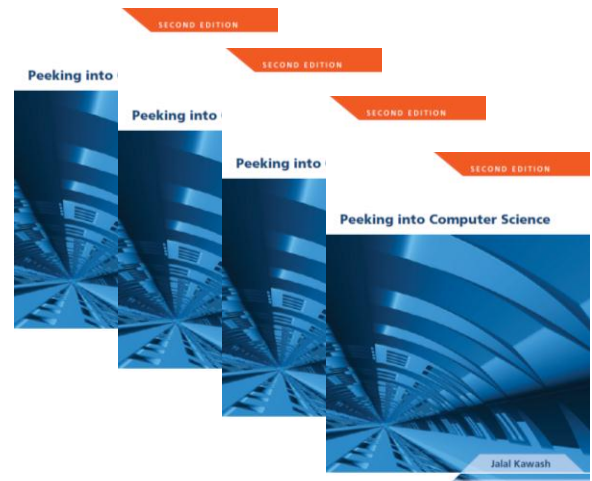
- A picture is worth thousand words!
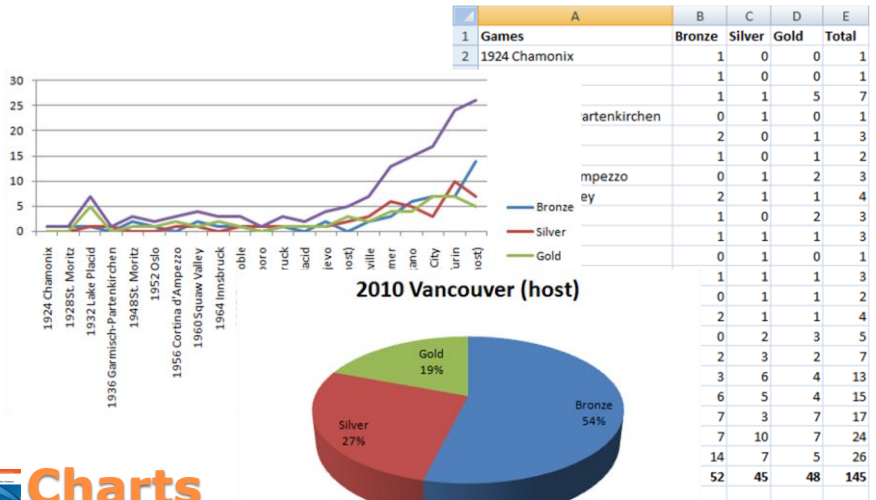
Charts

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Divide and Conquer
The power to solve

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At the end of this section, you will be able to:

1. Understand and use the Divide & Conquer technique
2. Apply Divide & Conquer to a spreadsheet example

Objectives

- Divide and Conquer:

- Divide the problem into smaller easier to solve problems
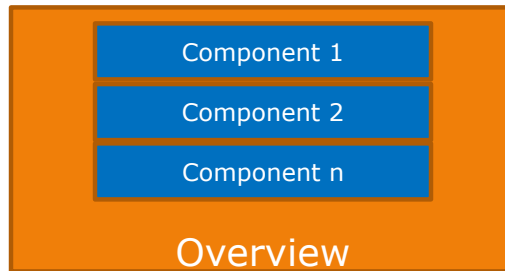- Solve the sub-problems
- Combine the sub-solutions

Divide & Conquer Approach

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- Start with an overview of the solution
  ◦ Specify the components

Component 1

Component 2

Component n

Overview

Divide & Conquer

- Repeat for the components, specify subcomponents

1

2

n

Overview
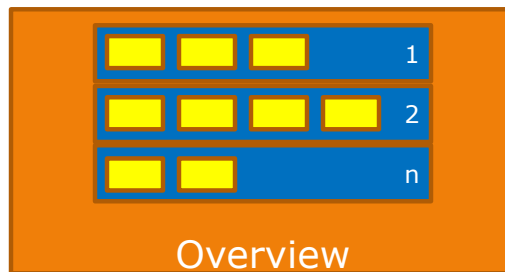
Divide & Conquer

- Making a table

- Easier:
  ◦ Make the legs
  ◦ Make the top
  ◦ Combine them

Divide and Conquer

```
                    Table
                  /        \
              Legs          Top
```
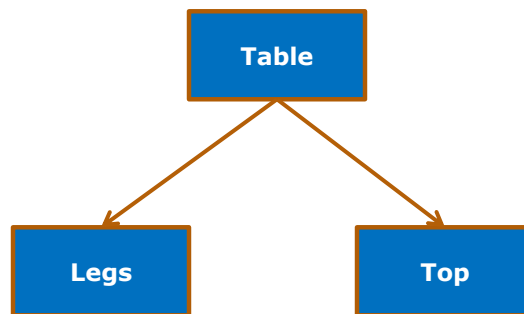
- Can go further down the tree if need be

Making a Table

Making a Table

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Design Example
Spreadsheets

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- I would like to move to a US state that:
  ◦ Has a warm climate
  ◦ Has a low crime rate
  ◦ Is close to Ottawa
- Dividing the problem:
  1. Collect the avg high temperature per state
  2. Collect homicide rates from US states
  3. Measure the time it takes to drive from each state to Ottawa

The Problem

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- www.netstate.com

- Avg high temperature is recorded in Fahrenheit

- Use Google calculator to convert to Celsius

- Record the data in a spreadsheet

1. Collecting avg high temperatures

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	A	B
1	State	Avg high temparet
2	Alabama	33
3	California	33.44
4	Connectic	29.33
5	Georgia	33.44
6	Ilinois	30.6
7	Kansas	33.8
8	Louisiana	34
9	Maine	26
10	Maryland	30.6
11	Minnesot	28.55
12	Mississipp	33.6
13	Nebraska	31.94
14	New Ham	28.11
15	New York	29.61
16	South Dak	30.27
17		

The spreadsheet

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- Find some source and record the rates in the spreadsheet.

- My source is: "graphic Discovery" by Howard Wainer.

2. Collecting Homicide Rates

	A	B	C
1	State	Avg high tempareture	HomicideRate
2	Alabama	33	12
3	California	33.44	8.8
4	Connectic	29.33	3.9
5	Georgia	33.44	8.7
6	Ilinois	30.6	9.8
7	Kansas	33.8	6.1
8	Louisiana	34	16.1
9	Maine	26	1.8
10	Maryland	30.6	10.9
11	Minnesot	28.55	2.8
12	Mississipp	33.6	14.2
13	Nebraska	31.94	3.9
14	New Ham	28.11	2.2
15	New York	29.61	6.3
16	South Dak	30.27	3
17			

The spreadsheet

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- This needs to be further divided into sub-problems:
  1. Find a point in the state
  2. Measure the distance from that point to Ottawa
- For 2, we can simply use Google maps
- For 1, the geographic center, the capital city, or something else?
- We choose the capital city

3. Time to Ottawa

USA STATES AND THEIR CAPITAL CITIES

Here is a list of all 50 states and their respective capital cities
With a link to our Key to the City page for that city and state

Search our site or the web

State	Capital City
Alabama	Montgomery
Alaska	Juneau
Arizona	Phoenix
Arkansas	Little Rock
California	Sacramento
Colorado	Denver
Connecticut	Hartford
Delaware	Dover

http://www.usacitiesonline.com/

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Google Maps

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16

The Spreadsheet

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- Since we have more than one factor, we need to weigh the factors based on preference
- One way is to use a *weighted average*
- My preferences are:
  ◦ Warmer: 30%
  ◦ Fewer homicide: 50%
  ◦ Closer to Ottawa: 20%

Combining Sub-Solutions

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The Spreadsheet

	A	B	C	D	E	F
					SUM	=B2*0.3 +(100 -C2)*0.5-D2*0.2
1	State	Avg high tempareture	HomicideRate	Time to Ottawa	Objective Value	
2	Alabama	33	12	20.37	*0.5-D2*0.2	
3	California	33.44	8.8	41	47.432	
4	Connectic	29.33	3.9	7.12	55.425	
5	Georgia	33.44	8.7	18.26	52.03	

$$=B2*0.3 +(100 -C2)*0.5-D2*0.2$$

The Solution

	A	B	C	D	E
1	State	Avg high tempareture	HomicideRate	Time to Ottawa	Objective Value
2	Alabama	33	12	20.37	49.826
3	California	33.44	8.8	41	47.432
4	Connectic	29.33	3.9	7.12	55.425
5	Georgia	33.44	8.7	18.26	52.03
6	Ilinois	30.6	9.8	15.19	51.242
7	Kansas	33.8	6.1	21.7	52.75
8	Louisiana	34	16.1	25	47.15
9	Maine	26	1.8	17.13	53.474
10	Maryland	30.6	10.9	9.13	51.904
11	Minnesot;	28.55	2.8	19.7	53.225
12	Mississipp	33.6	14.2	22.27	48.526
13	Nebraska	31.94	3.9	20.11	53.61
14	New Ham	28.11	2.2	6.13	56.107
15	New York	29.61	6.3	5.25	54.683
16	South Dak	30.27	3	25	52.581