

Introduction

SECOND EDITION

Peeking into Computer Science

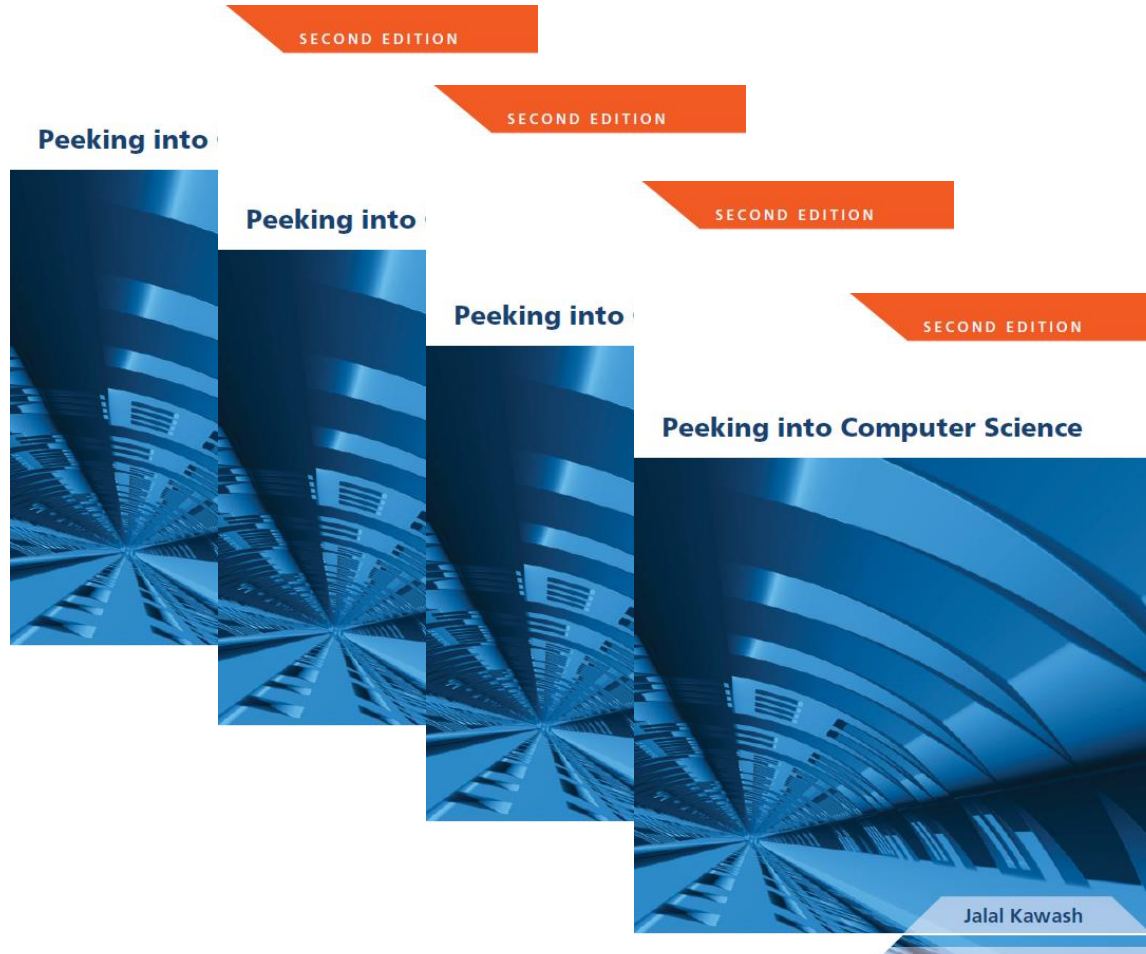


Peeking into Computer Science

- Mandatory: Chapter 1
- Optional: None



Reading Assignment



Problems & Solutions

Computer Science perspective

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

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

- 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

- 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

- 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

- Browsers and crawlers are specialized programs
- General-purpose programs can be used to solve variety of problems
- Example: Microsoft Excel program



General-Purpose Programs

- Grid 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

- 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
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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

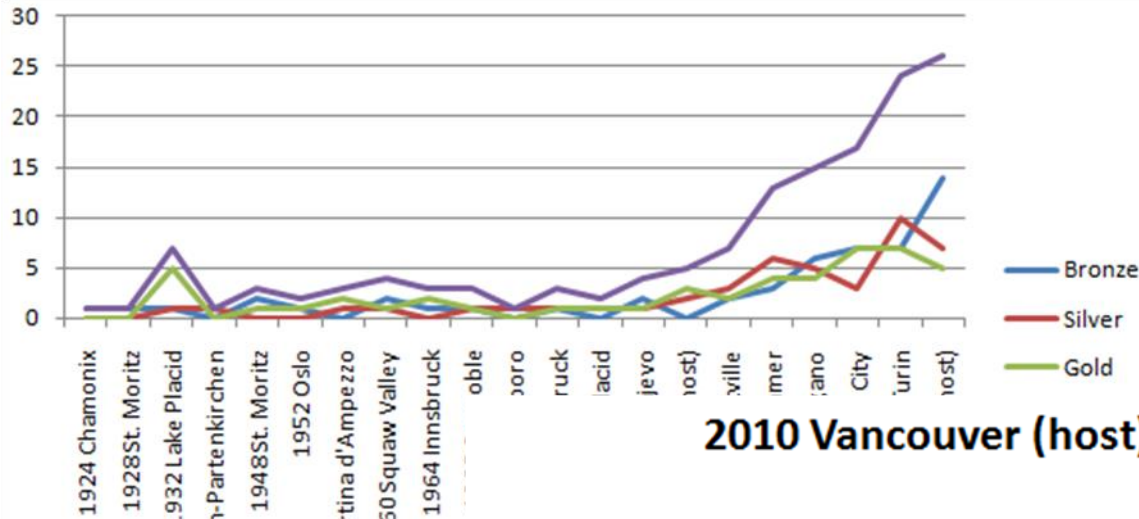
- Allow us to perform group calculations
- Some example functions: sum, average, minimum, and maximum

=SUM(E7:E9)

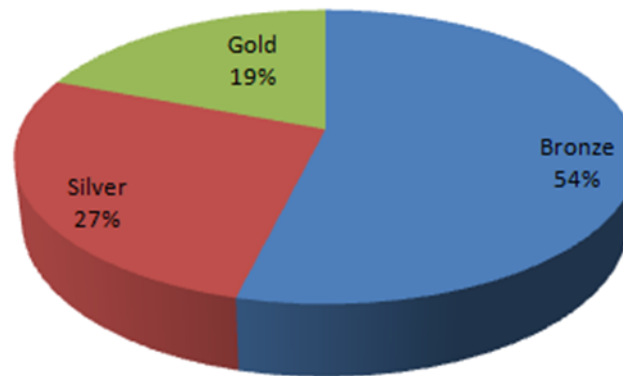
	A	B	C	D	E	F
1	Invoice Number		124			
2	Date		18/04/2010			
3	Customer	Saleh Dice				
4	US-CAD Rate		1.15			
5						
6	Serial Number	Item Description	Individual Price	Quantity	Total Price	Total CAD Price
7	1	Kindle Wireless Reading Device	\$ 256.00	2	\$ 512.00	CAD 588.80
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9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

Functions

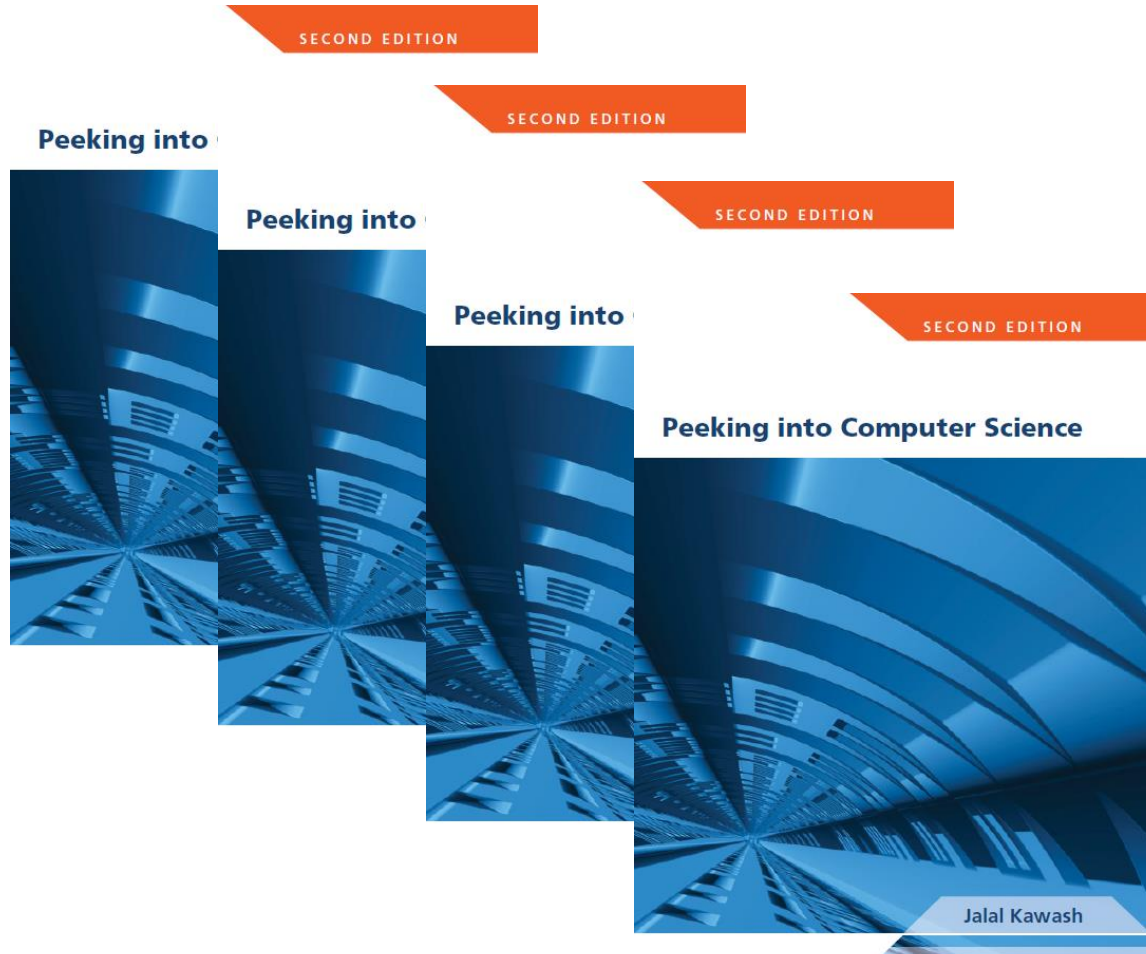
- A picture is worth thousand words!



	A	B	C	D	E
1	Games	Bronze	Silver	Gold	Total
2	1924 Chamonix	1	0	0	1
		1	0	0	1
		1	1	5	7
	Garmisch-Partenkirchen	0	1	0	1
		2	0	1	3
		1	0	1	2
	Ampezzo	0	1	2	3
	Sey	2	1	1	4
		1	0	2	3
		1	1	1	3
		0	1	0	1
		1	1	1	3
		0	1	1	2
		2	1	1	4
		0	2	3	5
		2	3	2	7
		3	6	4	13
		6	5	4	15
		7	3	7	17
		7	10	7	24
		14	7	5	26
		52	45	48	145



Charts



Divide and Conquer

The power to solve

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

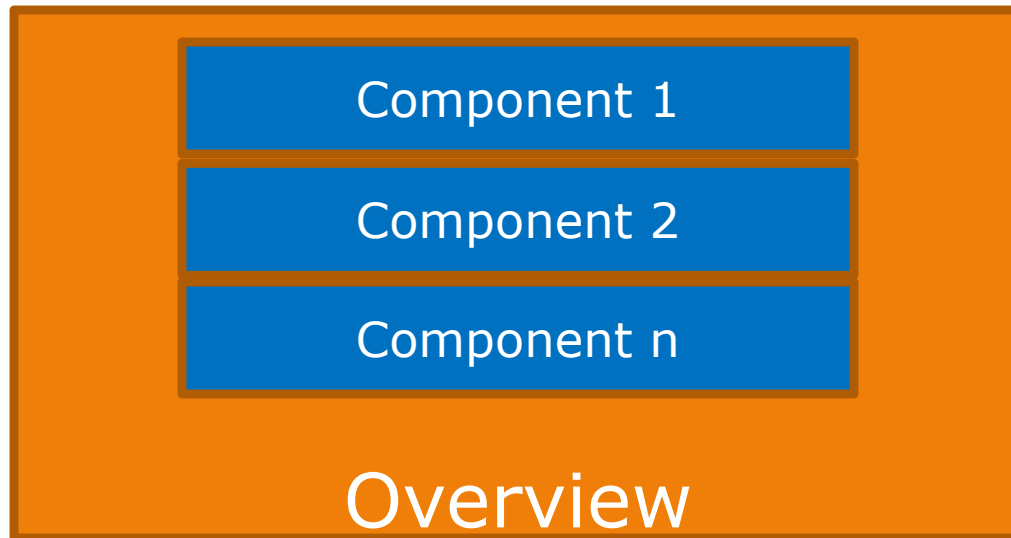


Objectives

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

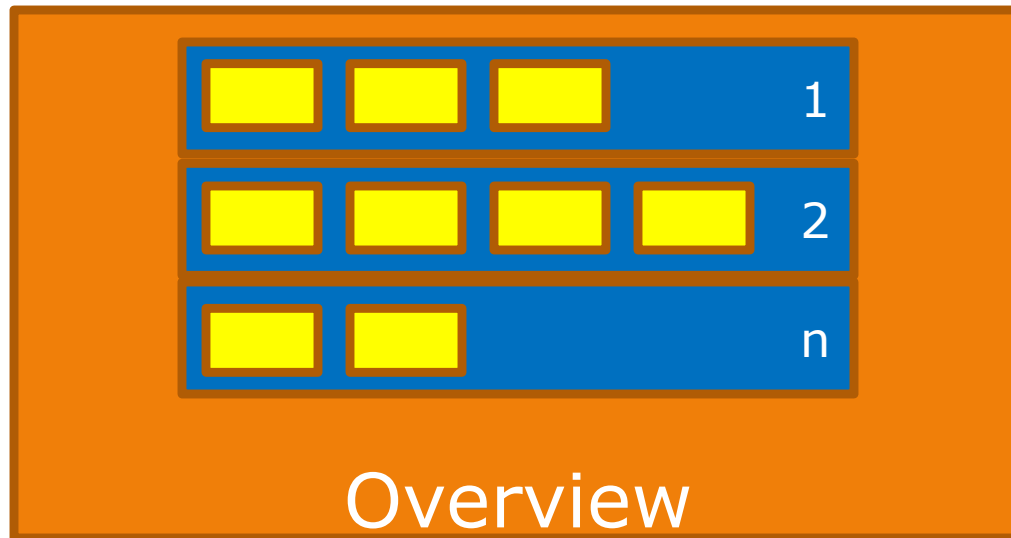
Divide & Conquer Approach

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



Divide & Conquer

- Repeat for the components, specify subcomponents

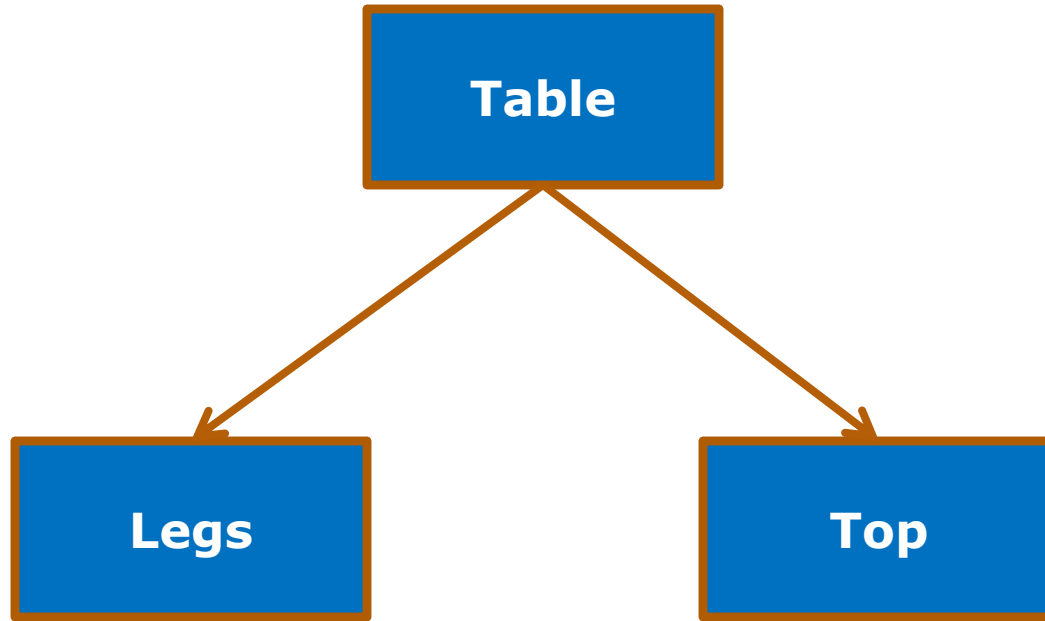


Divide & Conquer

- Making a table
- Easier:
 - Make the legs
 - Make the top
 - Combine them

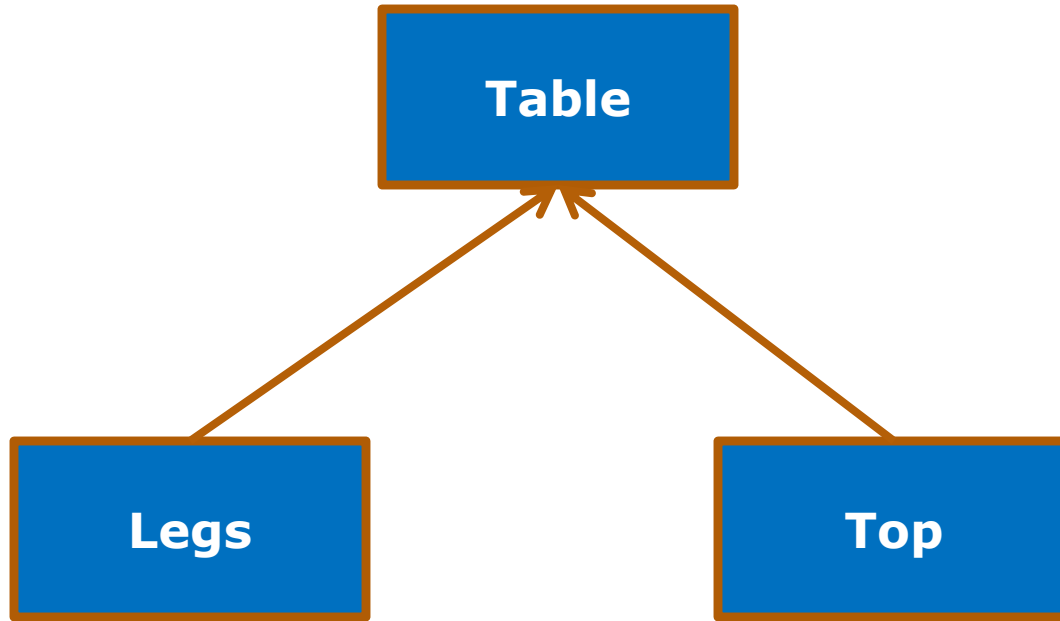


Divide and Conquer

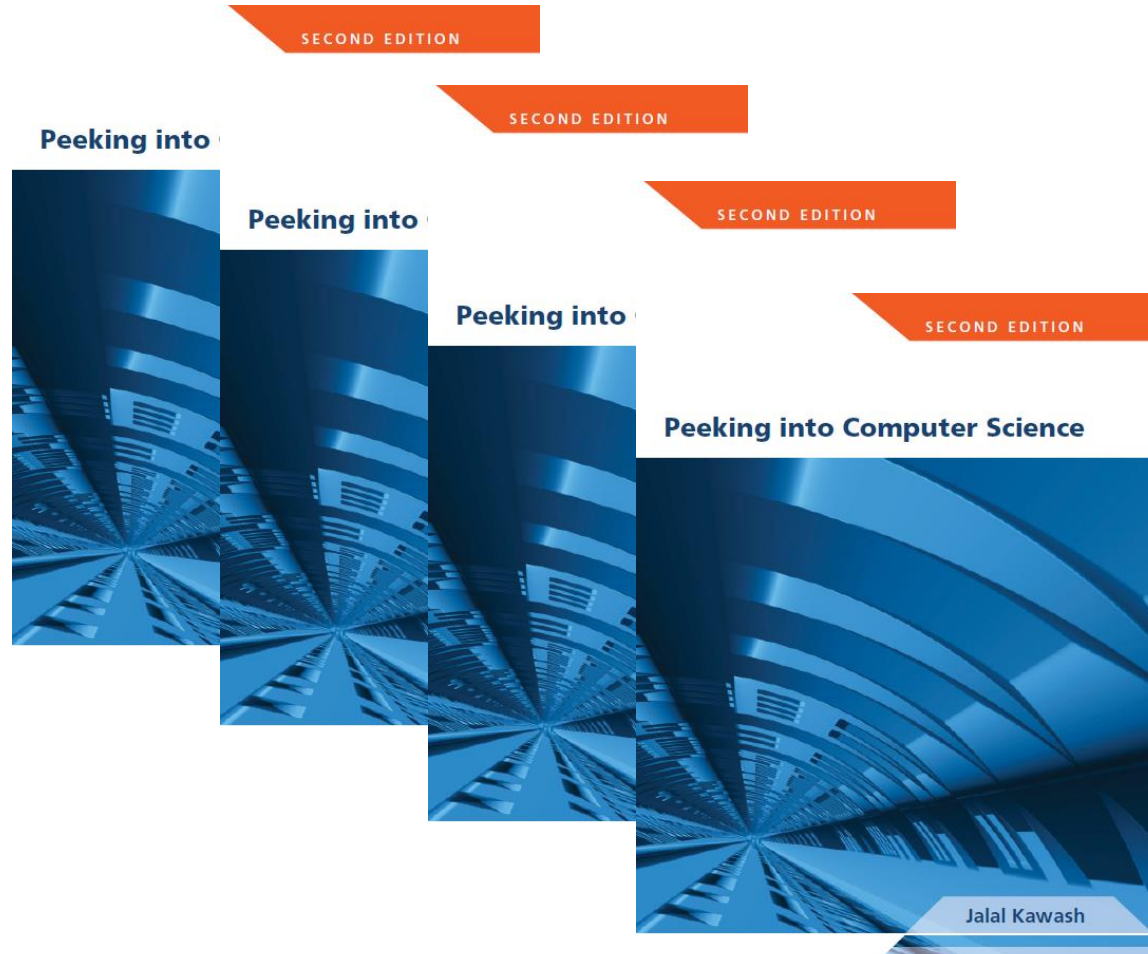


- Can go further down the tree if need be

Making a Table



Making a Table



Design Example

Spreadsheets

- 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

- 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

	A	B
1	State	Avg high tempare
2	Alabama	33
3	California	33.44
4	Connectic	29.33
5	Georgia	33.44
6	Illinois	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

- 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	Illinois	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

- 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
<u>Alabama</u>	<u>Montgomery</u>
<u>Alaska</u>	<u>Juneau</u>
<u>Arizona</u>	<u>Phoenix</u>
<u>Arkansas</u>	<u>Little Rock</u>
<u>California</u>	<u>Sacramento</u>
<u>Colorado</u>	<u>Denver</u>
<u>Connecticut</u>	<u>Hartford</u>
<u>Delaware</u>	<u>Dover</u>
<u>...</u>	<u>...</u>

<http://www.usacitiesonline.com/>

http://maps.google.ca/?hl=en

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By car

Driving directions to Montgomery, AL, USA

☏ Suggested routes

I-65 S 2,124 km	20 hours 37 mins
I-81 S 2,128 km	20 hours 49 mins
I-75 S 2,141 km	20 hours 52 mins

Google Maps

Clipboard		Font		Alignment	
A1		fx		State	
	A	B	C	D	E
1	State	Avg high tempareture	HomicideRate	time to Ottawa	
2	Alabama	33	12	20.37	
3	California	33.44	8.8	41	
4	Connectic	29.33	3.9	7.12	
5	Georgia	33.44	8.7	18.26	
6	Illinois	30.6	9.8	15.19	
7	Kansas	33.8	6.1	21.7	
8	Louisiana	34	16.1	25	
9	Maine	26	1.8	17.13	
10	Maryland	30.6	10.9	9.13	
11	Minnesota	28.55	2.8	19.7	
12	Mississippi	33.6	14.2	22.27	
13	Nebraska	31.94	3.9	20.11	
14	New Ham	28.11	2.2	6.13	
15	New York	29.61	6.3	5.25	
16	South Dak	30.27	3	25	
17					

The Spreadsheet

- 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

Clipboard		Font		Alignment	
SUM		=B2*0.3+(100-C2)*0.5-D2*0.2			
	A	B	C	D	E
1	State	Avg high temperature	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	33.11	8.7	18.26	52.03

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

The Spreadsheet

	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	Illinois	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	Minnesota	28.55	2.8	19.7	53.225
12	Mississippi	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

The Solution