

AP Computer Science Principles Course

Instructor Notes

UNIT NOTES: How Computers Work: Computer Architecture and Data Storage.

This unit will cover all of the topics in Computer Science Principles "big ideas" numbers 2 and 3; *Abstraction* and *Data and Information that* would not be covered in the units on *Programming* and *The Internet*. Many of the labs use free software. Here is the list of software in both Windows and Mac versions:

Windows

HxD Hex Editor https://mh-nexus.de/en/hxd/

Processing http://processing.org

7-zip http://www.7-zip.org/download.html

Audacity http://www.audacityteam.org/download/

MacIntosh

Hex Editor iHex (Note that I have been unable to get the File | Open Drive command to work for the Use a hex editor to retrieve deleted data lab)

Processing http://processing.org

 \underline{z} ip Macs have a built in compression, control click and choose compress

Audacity http://www.audacityteam.org/download/

ANSWERS TO PRACTICE QUIZ QUESTIONS

Slide 146: 1. HOW ALIVE — NASA's way of asking Watney how he has survived for nearly 100 Mars days at this point. 2. CROPS? — NASA's wondering how in the world Watney was able to grow food on a planet where that's supposed to be impossible. 3. BRING SJRNR OUT — NASA'S telling Watney to bring the Sojourner rover out near the Pathfinder to try and figure out an easier means of communication.

Slide 147: A (Hexadecimal 11 is 17 in decimal, Binary 00010011 is 19 decimal)

Slide 192: C. Either True or False

Slide 224: A.

Slide 226: A

Slide 234: 1. 25x50x24=30,000 bits. 30,000/8 = 3,750 bytes. 2. Lowering or Raising all the RGB values by the same amount will preserve the color while lightening or darkening the image. For example if you take a color like cyan (0,255,255) and multiply all the values by .7 you will end up with (0,178,178) which will be a darker shade of cyan.

NOTES ON PARTICULAR LABS

Virtual Desktop, Computer Assembly and Design your own PC labs: Computer hardware (other than logic gates) in not tested on the AP CSP test. However, many students take computer science to learn more about computers in general. Starting the course with a computer assembly can build excitement. Students are often surprised how easy it is to build a computer or replace a failed component. Understanding computer hardware is also important in the field of computer forensics which we will visit in subsequent labs. School districts often have large numbers of obsolete computers which would be ideal for learning how to take one apart. Instructors should consider contacting their district's IT department to see if any are available.

Movie: Digital Detectives (Documentary on computer forensics in the US dept. of defense): This movie sensationalizes computer forensics with a lot more blood and guns than necessary, so I would recommend that the instructor preview the 47 minute movie. There are many good nongratuitous scenes of disassembled computers and hard drives, and the classroom scenes where students are being trained in computer forensics are very applicable to the course.

Use a hex editor to retrieve deleted data: Small thumb drives work best for this lab (128Mb is ideal). This is a surprisingly easy lab and can generate a lot of student enthusiasm. To open an entire disk in HxD, Windows may require an administrator password. As a workaround, I've found that if I put a CD or DVD in the computers optical drive, it doesn't ask for administrator authorization to open an entire thumb drive. Any non-blank CD or DVD should work.

File Carving: Make sure your students start by downloading the pictures from the internet using the links in the assignment. Also, when editing the files, precision is paramount. Recommendation is to click on the beginning or ending of the region you want to delete and then shift clicking on the other end. Because we are deleting large amounts of data in this lab, it's easy to be just a little off if you are clicking and dragging.

	Lab and/or Activity	PowerPoint slides	Enduring Understanding	Learning Objective	Computational Thinking Practice	Essential Knowledge
1-2	Virtual Desktop Lab and Answer key	1 - 39	2.3 Models and simulations use abstraction to generate new understanding and knowledge	2.3.1 Use models and simulations to represent phenomena 2.3.2 Use models and simulations to formulate, refine and test hypothesis	P3 Abstracting P2 Creating computational artifacts P1 Connecting computing P4 Analyzing problems and artifacts P5 Communicating	2.3.1A 2.3.1B 2.3.1C 2.3.1D 2.3.2A 2.3.2B 2.3.2C 2.3.2D 2.3.2E 2.3.2F 2.3.2G 2.3.2H
3-5	Computer Assembly Lab	40-63	2.2 Multiple levels of abstraction are used to write programs or to create other computational artifacts	2.2.3 Identify multiple levels of abstractions that are used when writing programs	P6 collaborating	2.2.3E 2.2.3G 2.2.3H 2.2.3I
6	Design your own PC	65 - 96	2.3 Models and simulations use abstraction to generate new understanding and knowledge	2.3.1 Use models and simulations to represent phenomena 2.3.2 Use models and simulations to formulate, refine and test hypothesis	P3 Abstracting P2 Creating computational artifacts P1 Connecting computing P4 Analyzing problems and artifacts	2.3.1A 2.3.1B 2.3.1C 2.3.1D 2.3.2A 2.3.2B 2.3.2C 2.3.2D 2.3.2E 2.3.2F 2.3.2F 2.3.2G 2.3.2H

7	Binary Game	97-115	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data	2.1.1 Describe the variety of abstractions used to represent data	P3 Abstracting	2.1.1A 2.1.1B 2.1.1C 2.1.1D 2.1.1E 2.1.1G
8	Bits, Bytes and File Sizes (code.org)	116 - 122	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data 3.3 There are trade offs when representing information as digital data	2.1.1 Describe the variety of abstractions used to represent data 3.3.1 Analyze how data representation, storage, security and transmission of data involve computational manipulation of information	P4 Analyzing problems and artifacts	2.1.1A 2.1.1B 2.1.1C 2.1.1D 2.1.1E 3.3.1A 3.3.1G 3.3.1H
9	Encoding Hexadecimal Numbers (code.org)	123 - 141	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data	2.1.1 Describe the variety of abstractions used to represent data 2.1.2 Explain how binary sequences are used to represent digital data	P3 Abstracting P4 Analyzing problems and artifacts	2.1.1A 2.1.1B 2.1.1C 2.1.1D 2.1.1E 2.1.1F 2.1.1G
10	Hexadecimal in The Martian	142 - 147	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data	2.1.1 Describe the variety of abstractions used to represent data 2.1.2 Explain how binary sequences are used to represent digital data	P3 Abstracting P4 Analyzing problems and artifacts	2.1.1A 2.1.1B 2.1.1C 2.1.1D 2.1.1E 2.1.1F 2.1.1G 2.1.2D 2.1.2E 2.1.2F

11	Movie: Digital Detectives (Documentary on	148	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
	computer forensics in the US dept. of defense)		abstractions built	the variety of	P1 Connecting	2.1.1B
			upon binary	abstractions used	computing	2.1.1C
			sequences can be	to represent data	P4 Analyzing problems	2.1.1D
			used to represent	2.1.2 Explain how	and artifacts	2.1.1E
			all digital data	binary sequences	P6 Collaborating	2.1.1F
			3.2 Computing	are used to		2.1.2D
			facilitates	represent digital		2.1.2E
			exploration and	data		2.1.2F
			the discovery of	3.2.1 Extract		3.2.1A
			connections in	information from		3.2.1B
			information	data to discover		3.2.1C
			3.3 There are	and explain		3.2.1D
			tradeoffs when	connections or		3.2.1E
			representing	trends		3.2.2A
			information as	3.2.2 Determine		3.2.2B
			digital data	how large data		3.2.2C
				sets impact the		3.2.2D
				use of		3.2.2G
				computational		3.3.1A
				processes to		3.3.1G
				discover		3.3.1H
				information and		
				knowledge		
				3.3.1 Analyze		
				how data		
				representation,		
				storage, security		
				and transmission		
				of data involve		
				computational		
				manipulation of		
				information		
		1				

12	Use a hex editor to retrieve deleted data	149-156	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
			abstractions built	the variety of	P1 Connecting	2.1.1B
			upon binary	abstractions used	computing	2.1.1C
			sequences can be	to represent data	P4 Analyzing problems	2.1.1D
			used to represent	2.1.2 Explain how	and artifacts	2.1.1E
			all digital data	binary sequences		2.1.1F
			3.2 Computing	are used to		2.1.1G
			facilitates	represent digital		2.1.2D
			exploration and	data		2.1.2E
			the discovery of	3.2.1 Extract		2.1.2F
			connections in	information from		3.2.1A
			information	data to discover		3.2.1B
			3.3 There are	and explain		3.2.1C
			tradeoffs when	connections or		3.2.1D
			representing	trends		3.2.1E
			information as	3.2.2 Determine		3.2.1F
			digital data	how large data		3.2.2A
				sets impact the		3.2.2B
				use of		3.2.2C
				computational		3.2.2D
				processes to		3.2.2G
				discover		3.3.1A
				information and		3.3.1G
				knowledge		3.3.1H
				3.3.1 Analyze		
				how data		
				representation,		
				storage, security		
				and transmission		
				of data involve		
				computational		
				manipulation of		
				information		

13	Computer Forensics Lab and Key	157-170	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
			abstractions built	the variety of	P1 Connecting	2.1.1B
			upon binary	abstractions used	computing	2.1.1C
			sequences can be	to represent data	P4 Analyzing problems	2.1.1D
			used to represent	2.1.2 Explain how	and artifacts	2.1.1E
			all digital data	binary sequences		2.1.1F
			3.2 Computing	are used to		2.1.1G
			facilitates	represent digital		2.1.2D
			exploration and	data		2.1.2E
			the discovery of	3.2.1 Extract		2.1.2F
			connections in	information from		3.2.1A
			information	data to discover		3.2.1B
			3.3 There are	and explain		3.2.1C
			tradeoffs when	connections or		3.2.1D
			representing	trends		3.2.1E
			information as	3.2.2 Determine		3.2.1F
			digital data	how large data		3.2.2A
				sets impact the		3.2.2B
				use of		3.2.2C
				computational		3.2.2D
				processes to		3.2.2G
				discover		3.3.1A
				information and		3.3.1G
				knowledge		3.3.1H
				3.3.1 Analyze		
				how data		
				representation,		
				storage, security		
				and transmission		
				of data involve		
				computational		
				manipulation of		
				information		

14	Overflow Lab and Key	171-187	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data 3.3 There are tradeoffs when representing information as digital data 5.5 Programming uses mathematical and logical concepts	2.1.2 Explain how binary sequences are used to represent data 3.3.1 Analyze how data representation, storage, security and transmission of data involve computational manipulation of information 5.5.1 Employ appropriate mathematical and logical concepts to programming	P3 Abstracting P4 Analyzing problems and artifacts P5 Communicating	2.1.2A 2.1.2B 2.1.2C 2.1.2D 2.1.2F 3.3.1A 3.3.1G 5.5.1B
15	Logic Gates in Logic.ly and Key	188-194	2.2 Multiple levels of abstraction are used to write programs or to create other computational artifacts 5.5 Programming uses mathematical and logical concepts	2.2.3 Identify multiple levels of abstractions being used when writing programs 5.5.1 Employ appropriate mathematical and logical concepts in programming	P3 Abstracting P1 Connecting computing	2.2.3E 2.2.3F 5.5.1E 5.5.1F 5.5.1G

16	Decode this Message and Text Compression	195-202	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
	(code.org)		abstractions built	the variety of	P1 Connecting	2.1.1C
			upon binary	abstractions used	computing	2.2.1A
			sequences can be	to represent data	. 0	2.2.1B
			used to represent	2.2.1 Develop an		2.3.2A
			all digital data	abstraction when		2.3.2C
			2.2 Multiple levels	writing a		2.3.2D
			of abstraction are	program or		2.3.2F
			used to write	creating other		3.1.1D
			programs or to	computational		3.1.1E
			create other	artifacts		3.1.3A
			computational	Use models and		3.1.3C
			artifacts	simulations to		3.1.3E
			3.1 People use	represent		3.3.1A
			computer	· ·		3.3.1G
			programs to	phenomena		4.2.3A
			process	2.3.2 Use models		4.2.3B
			information to	and simulations		4.2.3C
			gain insight and	to formulate,		1.2.50
			knowledge	refine and test		
			3.3 There are	hypothesis		
			tradeoffs when	3.1.1 Find		
			representing	patterns and test		
			information as	hypotheses		
			digital data	about digitally		
			solve many, but	information to		
			not all	gain insight and		
			computational	knowledge		
			problems	3.1.3 Explain the		
			problems	insight and		
				knowledge		
				gained from		
				digitally		
				processed data		
				by using		
				appropriate		
				visualizations,		
				notations, and		
				precise language		
				precise language		

	3.3.1 Analyze
	how data
	representation,
	storage, security
	and transmission
	of data involve
	computational
	manipulation of
	information
	4.2.2 Explain the
	difference
	between solvable
	and unsolvable
	problems in
	computer
	science
	4.2.3 Explain the
	existence of
	undecidable
	problems in
	computer
	science
1	

17	.zip Compression Lab and Key	201-206	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
			abstractions built	the variety of	P4 Analyzing problems	2.1.1C
			upon binary	abstractions used	and artifacts	2.1.1D
			sequences can be	to represent data		2.1.1E
			used to represent	2.2.3 Identify		2.1.1G
			all digital data	multiple levels of		2.2.3D
			2.2 Multiple levels	abstractions		2.2.3E
			of abstraction are	being used when		2.2.3K
			used to write	writing programs		3.1.1B
			programs or to	3.1.1 Find		3.1.1D
			create other	patterns and test		3.1.1E
			computational	hypotheses		3.2.1D
			artifacts	about digitally		3.2.1E
			3.1 People use	processed		3.3.1C
			computer	information to		3.3.1D
			programs to	gain insight and		3.3.1E
			process	knowledge		
			information to	3.2.1 Extract		
			gain insight and	information from		
			knowledge	data to discover		
			3.2 Computing	and explain		
			facilitates	connections or		
			exploration and	trends		
			the discovery of	3.3.1 Analyze		
			connections in	how data		
			information	representation,		
			3.3 There are	storage, security		
			tradeoffs when	and transmission		
			representing	of data involve		
			information as	computational		
			digital data	manipulation of		
				information		

18	File Carving Lab and Key	207-212	2.1 A variety of	2.1.2 Explain how	_	2.1.2D
			abstractions built	binary sequences	P4 Analyzing problems	2.1.2E
			upon binary	are used to	and artifacts	2.1.2F
			sequences can be	represent data	P1 Connecting	2.2.3D
			used to represent	2.2.3 Identify	computing	2.2.3E
			all digital data	multiple levels of		2.2.3K
			2.2 Multiple levels	abstractions		3.3.1C
			of abstraction are	being used when		3.3.1D
			used to write	writing programs		3.3.1E
			programs or to	3.3.1 Analyze		3.3.1F
			create other	how data		3.3.1G
			computational	representation,		
			artifacts	storage, security		
			3.3 There are	and transmission		
			tradeoffs when	of data involve		
			representing	computational		
			information as	manipulation of		
			digital data	information		

19	B&W Pixelation Widget (code.org)	213 - 218	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
			abstractions built	the variety of	P4 Analyzing problems	2.1.1B
			upon binary	abstractions used		2.1.1C
			sequences can be	to represent data	P1 Connecting	2.1.1D
			used to represent	2.1.2 Explain how	computing	2.1.1E
			all digital data	binary sequences		2.1.1F
			2.2 Multiple levels	are used to		2.1.1G
			of abstraction are	represent data		2.1.2D
			used to write	2.2.1 Develop an		2.2.3D
			programs or to	abstraction when		3.2.1G
			create other	writing a		3.2.1H
			computational	program or		3.2.11
			artifacts	creating other		3.3.1A
			3.2 Computing	computational		3.3.1C
			facilitates	artifacts		3.3.1D
			exploration and	2.2.3 Identify		
			the discovery of	multiple levels of		
			connections in	abstractions		
			information	being used when		
			3.3 There are	writing programs		
			tradeoffs when	3.2.1 Extract		
			representing	information from		
			information as	data to discover		
			digital data	and explain		
				connections or		
				trends		
				3.3.1 Analyze		
				how data		
				representation,		
				storage, security		
				and transmission		
				of data involve		
				computational		
				manipulation of		
				information		

20	Metadata in .mp3 Files and Key	219-225	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data 2.2 Multiple levels of abstraction are used to write programs or to create other	2.1.1 Describe the variety of abstractions used to represent data 2.1.2 Explain how binary sequences are used to represent data 2.2.3 Identify multiple levels of abstractions	P3 Abstracting P4 Analyzing problems and artifacts	2.1.1A 2.1.1B 2.1.1C 2.1.1D 2.1.1E 2.1.1F 2.1.1G 2.1.2D 2.2.3D 3.2.1G 3.2.1H
			used to write	2.2.3 Identify		2.2.3D
				,		
			create other	abstractions		
			computational	being used when		3.2.11
			artifacts	writing programs		
			3.2 Computing	3.2.1 Extract		
			facilitates	information from		
			exploration and	data to discover		
			the discovery of	and explain		
			connections in	connections or		
			information	trends		

21	Encoding Color Images Lab (code.org)	226-232	2.1 A variety of	2.1.1 Describe	P3 Abstracting	2.1.1A
			abstractions built	the variety of	P4 Analyzing problems	2.1.1B
			upon binary	abstractions used		2.1.1C
			sequences can be	to represent data	P1 Connecting	2.1.1D
			used to represent	2.1.2 Explain how	computing	2.1.1E
			all digital data	binary sequences		2.1.1F
			2.2 Multiple levels	are used to		2.1.1G
			of abstraction are	represent data		2.1.2D
			used to write	2.2.1 Develop an		2.2.3D
			programs or to	abstraction when		3.2.1G
			create other	writing a		3.2.1H
			computational	program or		3.2.11
			artifacts	creating other		3.3.1A
			3.2 Computing	computational		3.3.1C
			facilitates	artifacts		3.3.1D
			exploration and	2.2.3 Identify		
			the discovery of	multiple levels of		
			connections in	abstractions		
			information	being used when		
			3.3 There are	writing programs		
			tradeoffs when	3.2.1 Extract		
			representing	information from		
			information as	data to discover		
			digital data	and explain		
				connections or		
				trends		
				3.3.1 Analyze		
				how data		
				representation,		
				storage, security		
				and transmission		
				of data involve		
				computational		
				manipulation of		
				information		

22	Personal Favicon Project (code.org)	233 - 234	2.2 Multiple levels of abstraction are used to write programs or to create other computational artifacts	2.2.1 Develop an abstraction when writing a program or creating other computational artifacts	P3 Abstracting P2 Creating computational artifacts P1 Connecting computing P5 Communicating	2.2.3A 2.2.1B
23	Lossy Text Compression and File Formats Lab (code.org)	235 - 238	2.1 A variety of abstractions built upon binary sequences can be used to represent all digital data 2.2 Multiple levels of abstraction are used to write programs or to create other computational artifacts 3.2 Computing facilitates exploration and the discovery of connections in information 3.3 There are tradeoffs when representing information as digital data	2.1.1 Describe the variety of abstractions used to represent data 2.2.3 Identify multiple levels of abstractions being used when writing programs 3.2.1 Extract information from data to discover and explain connections or trends 3.3.1 Analyze how data representation, storage, security and transmission of data involve computational manipulation of information	P3 Abstracting P4 Analyzing problems and artifacts P1 Connecting computing	2.1.1A 2.1.1C 2.1.1D 2.1.1E 2.1.1G 2.2.3D 2.2.3E 3.2.1E 3.3.1A 3.3.1C 3.3.1E 3.3.1G