Information 1

<u>Materials</u>

(per studernt):

   i)   14 crayons;
   ii)   set of 30 square counters
   iii)   1 sheet of yellow cardstock with 1" grid
   iv)   1 sheet of black cardstock or construction paper

<u>Reading</u>

Petzold, Pp. 69-76

<u>Handouts</u>

ASCII Code
Morse Code
7 segment worksheet
14-segment worksheet
7x5 grid worksheet
7-segment and 14-segment and 5 x 7 grid displays

<u>Resources:</u>

Hand gestures around the world:

https://www.worktheworld.com/infographics/around-world-42-hand-gestures
https://www.hotelcontractbeds.co.uk/blog/2015/03/around-the-world-in-18-gestures

Text displays https://www.csunplugged.org/en/topics/image-representation/unit-plan/colour-by-numbers/

1) What is information? A meaningful change or difference in the environment. Examples: a telephone ringer, a doorbell, an alarm clock, a basic traffic light (red or green), an alarm clock and a light switch, "ring bell for service", bicycle or car horn, "Walk/Don't Walk" each has two possible states, on or off, and contains the most basic unit of information: presence or absence of a signal. Each one can be represented by one binary digit, 0 or 1, or one bit of information.

<u>Group Activities</u>:

a) Identify other devices that contain only one bit of information.

b) Modify each one so it contains more than one bit.

<u>Class discussion:</u>

a) Under what circumstances could silence convey information?

b) What meaning is conveyed by common hand gestures? How does the answer vary with culture?

2) <u>Analog vs. digital</u>

<u>Class discussion:</u>

i) Look at your wristwatch or think about your clock at home or in your classroom. Is it analog or digital?

ii) How is an analog watch or clock different from a digital one?

Our senses are analog: they have a continuous range. Examples, brightness of light, loudness of sound, intensity of pressure or pain, some machines accept or provide info in analog form faucet, speaker, tuning dial vs push buttons on car radio, watches, stoves vs. microwaves, faucet, dimmer vs switch, thermometers, x-ray vs CAT scan, accelerator, steering wheel, brake pedal etc. More common today is digital information, which is carved up into a finite number of little buckets, each of which has a finite # of possibilities. We have already seen that computers use the binary system, which accepts only two possibilities, 0 and 1.

Class Activity: Scavenger hunt for info in analog and digital forms.

3) Guessing Game: Since computer info is handled using binary numbers, a convenient way of measuring information is to say how many binary digits or bits are needed to include all the possibilities. For example, when we represented a birthdate in binary, we needed five bits, because the range of birthdates is from 1-31. We could ask the same question about other forms of information, such as letters, number symbols, punctuation, emojis, control functions, etc.

Group Activity: The Game of "How Many Questions":

a) Students work in groups of three: i) the Secret Keeper, ii) the Questioner and iii) the Recorder.

b) The secret keeper in each group picks a number from 1 to 100, writes it down, but doesn't tell the others what the number is.

c) The questioner asks the secret keeper series of YES/NO questions until he or she determines the secret number. The goal of the game is to find out the number using the least number of questions.

d) The recorder writes down each of the questions, plus the secret keeper's answer.

e) Once each group has played the game, the groups share the number of questions needed by each questioner, and the strategies used to ask them.

Next, the instructor plays the game against the class. The class selects a secret number from 1 to 100 and writes it down. The instructor asks:

a) Is the number even? If the answer is YES, her or she writes a 0 on the board; otherwise, a 1.

b) The instructor tells the class to divide the number by 2 if the number was even; if it was odd, subtract 1 and then divide by 2. Is the result even? If so, the instructor writes a 0 under the first 0 or 1; if it is odd, he or she writes a 1.

c) Then the instructor and the class repeat b) until the class informs him or her that the result is 1, at which point the process stops.

d) The instructor then informs the class of the secret number by writing the binary number from left to right, starting at the bottom, and translating it into decimal.

Example: Suppose the secret number is 75.

Question #	Calculation	Decision	Result
1	Is 75 EVEN or ODD?	75 is ODD	1
2	$75 - 1 = 74$. $74 \mid 2 = 37$.	37 is ODD	1
3	$37 - 1 = 36$. $36 \mid 2 = 18$.	18 is EVEN	0
4	18 is already EVEN so don't subtract 1. $18 \mid 2 = 9$	9 is ODD	1
5	$9 - 1 = 8$. $8 \mid 2 = 4$	4 is EVEN	0
6	4 is already EVEN so don't subtract 1. $4 \mid 2 = 2$	2 is EVEN	0
7	2 is already EVEN so don't subtract 1. $2 \mid 2 = 1$	1 is ODD	1

The instructor then writes the number in the right column out in binary, reading from the bottom up: 1001011. In decimal, this number is $1 + 2 + 8 + 64 = 75$, the secret number! The method used by the instructor is another way to translate a number from decimal to binary.

The maximum number of questions is 7, which is the minimum needed to guess any number between 1 and 100, unless the number is less than 63, when even fewer are needed. This number is almost guaranteed to be less than the number the Questioners used when they played the game at first.

4) <u>Measuring information</u>: Seven is the maximum number of questions, because each question divides the answers into nearly equal possibilities, so there is no wasted information. The fact that seven binary numbers are adequate to represent a number from 1 to 100 tells us the <u>amount</u> of <u>information</u> in a number that can be anything from 1 to 100. An unknown number from 1 to 100 is said to contain 7 bits of information. The reason is that 1111111 (seven 1's) in binary is 128 in decimal, slightly larger than 100, so any number from 1 to 100 can be expressed in 7 binary bits. The word <u>bit</u> is short for <u>b</u>inary dig<u>it</u>.

The number of bits is also a measure of the uncertainty involved. For example, if the unknown number could be between 1 and 1000, rather than 1 and 100, the uncertainty would be greater, and the amount of information would be 10 bits, rather than 7. The reason is that 1000 is slightly less than 1023, which is expressed in binary as 1111111111 (10 1's).

<u>Group Activity</u>: Re-form the same groups as in #3, but this time use the instructor's method.

5) <u>How much information?</u>

Develop a chart showing the number of possible combinations that can be encoded by 1, 2 or 3 bits of information. Look for a pattern in the results, and predict the number of possible combinations that can be represented by 4, 5 or 6 bits.

BREAK BETWEEN SESSIONs

6) <u>Information content of written English:</u> There are 26 letters in the language. If we add SPACE, plus five punctuation marks (which ones?) you get 32 possibilities, which can be represented by 5 binary digits or bits.

   <u>Group Activity</u>: Create a 5-bit binary code that represents all 26 letters, plus SPACE and 5 punctuation marks of your choice. The use this code to send a short secret message (a few words at most) within your group. Then give the same secret message to another group. Can a member of another group crack the code?

7) <u>Morse code</u>: Distribute the Morse Code handout. Morse code was developed for telegraphy in the 1840's. Today it has mostly been phased out, except among amateur radio enthusiasts, and for some seriously disabled people. It consists of dots (short bursts) and dashes (longer bursts).

   <u>Class Discussion</u>: How does the receiver know whether ••• represents "s" or "eee"?

   You might be wondering how letters, words and sentences are separated in Morse code. Since Morse code is sent by a telegraph key, a short pause – the length of a dash – indicates a space between letters, while a longer pause – three dashes – indicates a space between words. The end of a sentence is signaled by the word STOP, since there is no symbol for a period.

   <u>Class Activity</u>: What do you notice about this code? Is this a binary code? How is it different from the code you created in #4? What is the maximum number of bits it uses?

8) <u>Encoding letters, numbers and punctuation in binary</u>: Distribute the ASCI handout. The ASCII code is commonly used to encode text in binary. ASCII stands for American Standard Code for Information Interchange. The basic code uses 7 bits to represent all the letters, both lower- and upper-case, numbers, and simple arithmetic symbols, as well as some "control characters" such as "Start transmission", "End transmission", "Insert line", "Insert page" etc. How many different symbols does it have? What could these be used for in addition to letters, numbers, and control characters? -

   ASCII has codes for upper- & lower-case letters, numbers, plus the following punctuation and arithmetic symbols. Can you find all of these on your computer keyboard?

!	"	#	$	&	'	(	)	*	+	,	-
.	:	;	<	=	>	?	@	[	\	]	^
_	`	{	|	}	~						

   The ASCII code can be extended to 8 bits. How many more symbols does that add? The extra codes are used to represent characters that do not appear in English, such as ¿, à, ä, á, ñ, and ç. Demonstrate how to see these on the computer by opening MS Word, using a Insert > Symbol, and then displaying the symbol in Unicode, ASCII (hex) or ASCII (decimal).

9) <u>Displaying letters, numbers and more</u>: how to represent characters digitally.

   a) Seven-segment displays: Where do you find them? What letters or numbers can it represent? How many bits are required to display a number on a 7-segment display?

<u>Activity</u>: Represent all the numbers by laying out crayons in the 7-segment pattern. Record your results by darkening the appropriate rectangles a-g, of the seven-segment grid on the worksheet. Are there letters you can also represent? Are there some that you can't?

Seven-segment display (left) and 14-segment display (right)

b) The 14-segment display uses 14 bits to display a character. Use the crayons and the second worksheet to explore what letters and numbers it can display.

c) More possibilities are offered by the 5 x 7 matrix array, which uses 35 bits of data per character. Use the square counters and grid sheets to create as many letters, numbers and punctuation symbols as you can in a 5 x 7 array. Then use third worksheet to record your results.