INTRODUCTION TO COMPUTING
TOPIC 1: WHAT IS COMPUTING?

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1. Definitions

Modern computers receive, store, process, and transmit information. Information, to a computer, consists of a sequence of zeros and ones.

Electrical current transmitted on a wire is typically referred to as either

- analog: continuously varying;
- digital: either on or off.

In digital transmission, with on being 1 and off being 0, we see a sequence of zeros or ones. So, computers understand digital information.

How does the computer interpret the zeros and ones? Why is this called "digital"?

To understand this more fully, first we investigate the meaning of "to compute".

According to my dictionary, we have these definitions:

- Compute: to determine by reckoning; to calculate
- Calculate: to reckon or determine by reasoning
- Reckon: to count

So by definition, a computer counts and uses reasoning (that is, logic). Counting and reasoning combine to produce arithmetic (adding, multiplying, etc.) The word "calculate" comes from *calculus*, a pebble used in counting. This in turn comes from *calx*, or limestone.

2. Counting

There is archeological evidence that man began counting as far back as 50,000 years ago.

The jaw bone of a wolf has been discovered which is 20,000 years old, and has 25 notches slashed in groups of five. So, this bone is evidence that man used "technology" to aid in counting at least that long ago.

However, this evidence indicates that actually, an earlier counting technology had been developed: that man counted on his five fingers per hand earlier than this.

Many undeveloped tribes have been discovered that use the word "hand" to mean five. A "man" may mean ten or twenty, depending on the tribe. One tribe used the word "mattress" to mean forty.

Now when we count to ten on two hands, the number represented is simply the number of fingers held up. Which fingers, on which hand, is irrelevant to the number indicated.

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However, consider counting to thirty on two hands by letting the fingers on the left hand each have a value of five. When the right hand reaches five fingers up, lower them and raise an additional finger on the left hand. This is counting in *base five*.

The ancient Mayans had a method of counting uses rocks and sticks. Each rock was worth one and each stick was worth five. Then, one could trade five rocks for a stick. This later became how they wrote numbers. After four sticks, however, the Mayans got tired. What could they do? They used position to indicate powers of twenty. Under this scheme, each position represented a power of twenty, and a shell was used as a place holder (that is, a shell is zero).

Actually, we can count from 0 to 31 on one hand. Why 31? Because it is $2^5 - 1$. Here's how. Evaluate each finger on your right hand as follows:

- right thumb = 1
- right index finger = 2
- right middle finger = 4
- right ring finger = 8
- right pinky = 16

Then count according to this chart:

0	no fingers	16	pinky
1	thumb	17	pinky + thumb
2	index	18	pinky + index
3	index + thumb	19	pinky + index + thumb
4	middle	20	pinky + middle
5	middle + thumb	21	pinky + middle + thumb
6	middle + index	22	pinky + middle + index
7	middle + index + thumb	23	pinky + middle + index + thumb
8	ring	24	pinky + ring
9	ring + thumb	25	pinky + ring + thumb
10	ring + index	26	pinky + ring + index
11	ring + index + thumb	27	pinky + ring + index + thumb
12	ring + middle	28	pinky + ring + middle
13	ring + middle + thumb	29	pinky + ring + middle + thumb
14	ring + middle + index	30	pinky + ring + middle + index
15	ring + middle + index + thumb	31	all fingers

This is counting using a positional base two scheme. Positional, because the position of the finger which is up or down matters. Base two, because each finger has two possible values (up or down).

Suppose we evaluate each finger on our left hand as follows:

- left thumb = 32
- left index finger = 64
- left middle finger = 128
- left ring finger = 256
- left pinky = 512

Then we could count to $2^{10} - 1 = 1023$. If we additionally used our toes, we could count to $2^{20} - 1 = 1048575$.

3. Digital Information

Computers use only zeros and ones to count, reason, and store information.

We have seen how two count using positioned zeros and ones, and we will explore this more later in our study of bases.

Information is received, stored, and transmitted as a sequence of zeros and ones. The program must interpret how to view a given sequence of zeros and ones; this is done through the concept of *data types*. Having gotten used to binary numbers through studying bases, we will then explore how computer store different types of information in binary codes.

Zeros and ones are also used as the logical values of *false* and *true*. Logical operators such as AND and OR combine inputs of zeros and ones to create an output. We will study the *truth tables* which define the logical operators, and then briefly look at the circuitry which implements these operators through what are known as *gates*. This will give some idea of how a computer reasons.

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