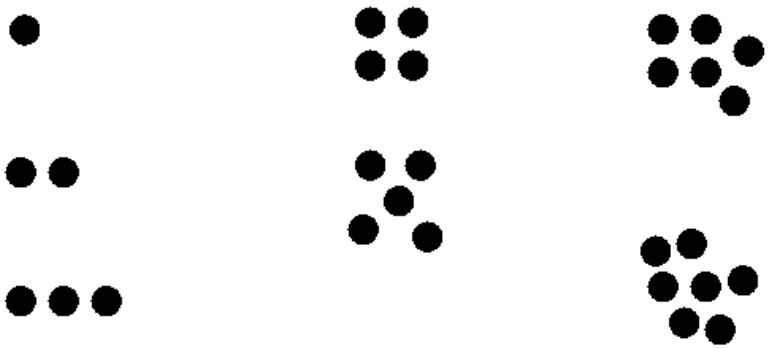
Numeric values

- Numeric **value** are something ***intrinsic***

  One would **ideally** represent "numeric values" in a **universal** manner, such as:



- This is obviously very clumsy (try larger values :-)
- So humanoids have invented many different **representations** for numerical values

  (This practice is obviously very important for their survival...)
- The **most popular** representation ***NOW*** (that was not always the case !) for numerical value is the **decimal number system**

  This system is based on the following ten funny looking symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9

  I am sure you are thoroughly familiar with this decimal number system, in fact, so familiar that you do not even think about **what** decimal numbers actually mean...
- There are **other** representations for numerical values invented by humanoids.

  A famous example is the number system invented by a class of humanoids that we call **Romans**

  Their number system goes like:

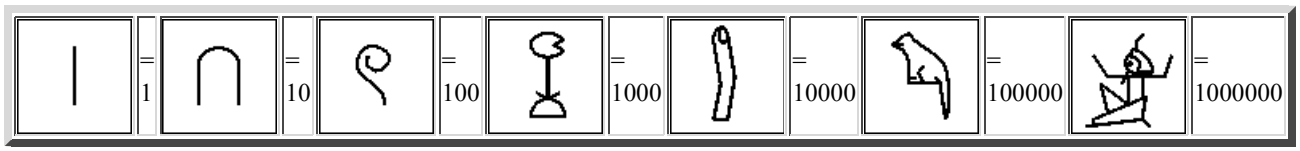
```
I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, ....
```

  Chinese numbers:

One	一	Seven	七	Thousand	千
Two	二	Eight	八	Ten Thousands	万
Three	三	Nine	九	Million	百万
Four	四	Ten	十	100 Millions	亿
Five	五	Hundred	百	Billion	十亿
Six	六				

BTW, notice there is **no symbol** for **ZERO**. Chinese character for **ZERO** is:

A not-so-famous system is the **Egyptian number system**:



There are many other humanoids who have invented their own representation systems for numerical values, among others: Greeks (they use the Greek alphabet), Chinese (I'll show you in class...), etc.

Here is a copy of a page from a book of my 6 yr old first grader (in 2003) that show a number of number systems used in the other cultures: click here

- It is important to know that:
  - A **value** **does *not* depends** on the **representation system** used:
    - If you see that there are 4 students in the classroom, no matter how you represent this number, there will be 4 students, no more and no less
  - As I mentioned above: a **value** is an ***intrinsic* property**....

- **Roman Arithmetic....**
  - **How can I use Roman numerals to do arithmetic problems?**

    - Let's start with an addition problem: 23 + 58.

      In Roman numerals, that's XXIII + LVIII.

      We'll begin by writing the two numbers next to each other: XXIII LVIII.

      Next, we rearrange the letters so that the numerals are in descending order: LXXVIIIIII.

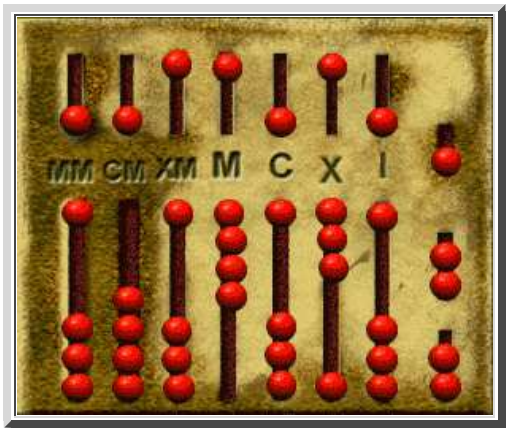
      Now we have six I's, so we'll rewrite them as VI: LXXVVI.

      The two Vs are the same as an X, so we simplify again and get LXXXI, or 81, as our final answer. (We can check this answer using Arabic numerals.)

  - More on this webpage: click here

  - **Complex arithmetic in Roman era:**

- When Romans wanted to do **complicated arithmetic problems**, they used a **special counting board** or an **abacus**:



An **abacus** represents ***values*** using a ***positional* representation**:

- The **right most** column has **weight = 1**
- The **second right most** column has **weight = 10**
- And so on.

Notice that this is an **encoding method** !!!

It is an **agreement** on ***how*** to **represent** a **value**

- **Positional representation system**
  - **Positional (value) representation:**
    - A ***position* representation system** uses the **same symbol** to represent ***different* values**
    - The **value** that is **represented** by a certain **symbol** depends on:
      - The **symbol itself**, **and**
      - The **position** in which that **symbox** is found !!!

  - **Example:**
    - The symbol **1** in the number **111** ***represents*** the **value * (= 1 dot)**.
    - The symbol **1** in the number **111** ***represents*** the **value ********** (= 10 dot)**.

In contrast:

- The symbol **V** will represent the value ***** (5)** not matter where you find it in a **Roman number** !!!

- **Advantage of *positional* representation**

- When humans started to use **positional system (based on 10)**, we can **teach children** to **add *any* two numbers** by:

  - **memorize** a simple **addition table**
  - **learn** a simple **carry/add rule**

- The **base 10 addition table**:

	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	10
2	3	4	5	6	7	8	9	10	11
3	4	5	6	7	8	9	10	11	12
4	5	6	7	8	9	10	11	12	13
5	6	7	8	9	10	11	12	13	14
6	7	8	9	10	11	12	13	14	15
7	8	9	10	11	12	13	14	15	16
8	9	10	11	12	13	14	15	16	17
9	10	11	12	13	14	15	16	17	18

- The **carry/addition rule**:

  - Add **digits** from **right to left**
  - When the **sum** of **two digits exceeds 9**, write down the the **right most digit** and **add the *carry*** to the **next position** of the **sum**

  After learning these **techniques**, the **positional systen** enable a **ordinary humans** to become a **human calculater** !!!

  (In contrast, a **Roman fellow** will need to use an **abacus** !!!)

- **Note:**

  - You have **memorized** these rules in **elementary school**
