Numbers and Number Types

The Basic Computational Problem

How do I count this?

"Numbers, however, will account for the vast majority of suffering humanity."

Flann O'Brien
At Swim-two-birds

What are numbers?

- What we use to *count*.
  - Students registered on a course.
  - Correct answers on MCQ exam.
  - Points of a team at season end.
  - Converting Km to Miles

Types of numbers?

Number of

- Students: 1, 2, 3, 4, …
- Correct answers: 0, 1, 2, 3, 4
- Points: ….,-3, -2, -1, 0, 1, 2, 3, ...
- Km to M: M=(5/8)*Km

What are these?

N : 1, 2, 3, 4, … , (***Natural*** numbers)

W : 0, 1, 2, 3, 4,…, (***Whole*** numbers)

Z : ….,-3, -2, -1, 0,1,2,3, ... (***Integers***)

Q : ½, ¾, 2/3, 5/8 (***Rational***)

And that's all?

We know that:

$$\mathbb{N} \subseteq \mathbb{W} \subseteq \mathbb{Z} \subseteq \mathbb{Q}$$

and that, in "practice" all computers use "***only***" Rationals.

BUT

Are these *all* that arise in "*counting*" and "*measurement*"?

The Real Problem
"rationality" is not enough

Suppose we wish to lay out a square field with total area $2m^2$?

What length, L, should its side be?

"Obviously" – $L \times L = L^2 = 2$

But is $L \in \mathbb{Q}$?

Can't be in $\mathbb{Z}$: "too small" if 0 or 1, "too big" if larger.

So what about $L \in \mathrm{Q}$?

We need $p \in W$ and $q \in N$ with

$$\left(\frac{p}{q}\right)^2 = 2$$

There are no such p and q

But we *can* build squares with area $2m^2$? (textbook, p. 53)

Another Class of Number: *R*

These *irrational* numbers, such as $\sqrt{2}$, which cannot be described as ``fractions'' (p/q) belong to the set of

Real Numbers (*R*)

Modelled by data types such as **`float`**, **`double`**, etc. in HLLs.

For now, *R*, completes our survey of the number types we will need.