

0.1 | Types of Numbers

algebra:

algebra is doing stuff to things

- idea of a number changes – 500y ago they didn't know about negs

natural numbers are the most natural, apparently 0 not in natural, 0 in whole

\mathbb{Z} for integers, counting in german

rational numbers: a/b $a, b \in \mathbb{Z}$

real numbers: infinite all the way down way more real numbers than rational numbers

- Zero: important for groups – starting point on number lines. true neutral, **Additive Identity**
 - **Multiplicative Identity:** 1
 - identity lets it keep its identity? when the op doesn't change
- negs: so we can deal with negs? so we can undo addition

subtraction is a lie! add negs

subtraction on the natural numbers is not closed

closed: can make a number not in the set

0.2 | Groups

any set of mathematical elements under one operation such that there is an identity each element has an inverse

- they do not need to be **commutative**
 - $a+b = b+a$
- **associativity**
 - $(a+b)+c = a+(b+c)$
 - order doesn't matter
 - most things we are doing will be associative
 - nice number systems are almost always associative

can add dimensions, like complex adding more leads to quaternions or hamiltonians, then to octonions?

called the cayley dickson construction, or sdct

axioms:

- there exists an identity
- each element has an inverse
- it's closed
- associativity

0.3 | Matrices

- can be called an array
- 2d can use rows and columns as coords

operations: addition: only if same dimensions, loop through indices dot: cross: wrong! first row by first column with addition to make first entry, first row by second column for second entry loop through indices like addition

vectors: special case of matrix

column vec (1, 2)

row vec (1, 2)

cannot add diff dimensions

representations can draw up to 3, ish geometric is just arrow on graph to coords

adding vecs on the graph is just tip to tail, then first tip to last tail for resultant just like phys

```
(
  a1
  a2
  .
  .
  .
  an
)
```

is a vector of \mathbb{R}^n

matrix multiplication identity?

multiplication on group? multiplication on to column vectors