# Math Camp

Module #0 Introduction

# Why are we here?

Who are we?

What is economics?

What is math?

# Why is there math in economics?

There's not.

Definition. A *theory* is a set of assumptions together with the necessary implications.

Two approaches to forming theories

1. Construct a narrative to explain behavior witnessed in data

- Pro: language allows for nuance and therefore realistic modeling assumptions
- Con: language is imprecise so assumptions and their implications can be unclear

## About math in economics (continued)

2. Use math to lay out precise assumptions and deduce necessary implications

- Pro: meaning of assumptions and what implications follow cannot be debated; debate is limited to appropriateness of assumptions

- Con: tractable assumptions are necessarily restrictive, limiting reach of theory

# About this course

Four important points

- New concepts in mathematics are completely mysterious until they are trivial
- Simply reading the lecture slides/text may not be enough to understand the concepts
- Your ability to apply course concepts only comes through self practice
- Don't skip the exercises

## Prereqs: Logic

Let $P$ and $Q$ be statements

- "A declarative sentence that is either true or false but not both"
- We can use logical operators to create new compound statements that are either true or false.

it's sunny blue pen

Logical Operators

- **Conjunction:** the conjunction of $P$ and $Q$ is the statement "$P$ *and* $Q$", denoted $P \wedge Q$. Is only true if **both** $P$ and $Q$ are true.
- **Disjunction**: the disjunction of $P$ and $Q$ is the statement "$P$ *or* $Q$", denoted $P \vee Q$, and is only true if **either** $P$ or $Q$ are true.

## Prereqs: Logic

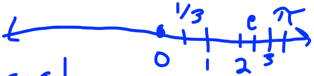
Logical Operators cont.

- **Negation**: the negation of a statement $P$ is the statement "*not* $P$", denoted $\neg P$, and is only true if $P$ is false, and is only false if $P$ is true. $\neg P$
  ↳ not sunny .

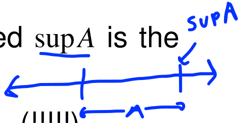
- **Conditional**: the conditional statement is the statement "*If* $P$ *then* $Q$, denoted $P \to Q$, means that Q must be true whenever P is true, and is only false when $P$ is true and $Q$ is false.

# Prereqs: Numbers

$\mathbb{R}$



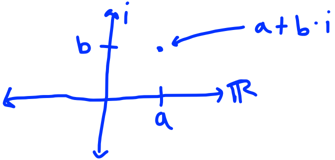

- What about $\mathbb{R}$?
  - $\mathbb{R}$ is the completion of the ~~rational~~ real numbers
  - Let $A \subset \mathbb{R}$. The *supremum* of $A$, denoted $\sup A$ is the least upper bound of $A$ (may be infinite).




  - If $A \subset \mathbb{R}$ is bounded above then $\sup A \in \mathbb{R}$. (!!!!!)

$$\left.\begin{array}{l} A=[b,c] \\ A=(b,c) \end{array}\right\} \sup A = c$$

- What about $\mathbb{C}$?
  - $\mathbb{C}$ is algerbraically closed: every non-constant polynomial has a root in $\mathbb{C}$
  - Every polynomial equation has a solution in $\mathbb{C}$




$$\sum_{j=0}^{n} a_j \cdot x^j = 0$$

$j=2$ $\quad a_0 + a_1 x + a_2 x^2$

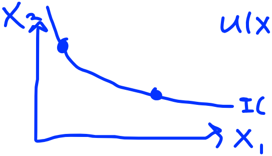
$j=107$

$\sim$

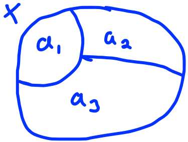
**Definition.** A *relation* on a set $X$ is a subset $R$ of $X \times X$

- if $(x,y) \in R$ then we write $x \sim y$
- $R$ is an equivalence relation if it has the following properties
  - reflexivity $x \sim x$
  - symmetry $x \sim y \Rightarrow y \sim x$
  - transitivity $x \sim y$ and $y \sim z$ implies $x \sim z$
- the collection of all elements related to a given element is called an equivalence class

$u(x_1, x_2) = \bar{u}$



# partition




**Definition.** A *partition* of a set $X$ is a collection of non-intersecting subsets whose union is $X$.

More formally, $\{X_\lambda\}_{\lambda\in\Lambda}$ is a partition of $X$ provided

- $X_\lambda \subset X$ for all $\lambda \in \Lambda$
- $X = \cup_{\lambda\in\Lambda} X_\lambda = X_1 \cup X_2 \cup \cdots \cup X_n$
- $\lambda_1 \neq \lambda_2 \Rightarrow X_{\lambda_1} \cap X_{\lambda_2} = \emptyset$

$\{a_1, a_2, a_3\}$

$\{a_\lambda\}_{\lambda\in\Lambda}$

$\Lambda = 1, 2, 3$