Math 180A

Lecture 1 | Monday March 29th

Introduction

- Probability is a fundamental part of modern mathematics, statistical physics, computer science, biology, economics...
- It is used to model large-scale networks, evolutionary phenomena, to study algorithms, random processes, ...

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- Galton Board

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- Spread of disease

Game of Life

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- Number Theory

Random Number Generator

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Outcomes, sample space

- Sample space is a set Ω
- Elements of Ω are called outcomes or sample points.
- They are the result/s of performing an experiment

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Events

- Events are subsets of Ω
- E.g. the sample space could be the set of outcomes from tossing a six-sided die

$$\Omega = \{1,2,3,4,5,6\}$$

An event could be that the outcome is odd

$$A = \{1,3,5\}$$

- We use braces $\{...\}$ to denote sets/events.

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Events

- E.g. the event that the sum of two dice is seven is the event

  $$\{(1,6),(2,5),(3,4),(4,3),(5,2),(6,1)\}$$

  in the sample space

  $$\Omega = \{(1,1),(1,2),(1,3),(1,4),\ldots,(5,6),(6,6)\}$$

- The set of all events in Ω is denoted $\mathcal{F}$.

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Events

- E.g. the event that we pick a vowel from the word MISSISSIPPI is $\{\mathsf{I}\}$ and the sample space is

$$\Omega = \{\mathsf{M},\mathsf{I},\mathsf{S},\mathsf{P}\}$$

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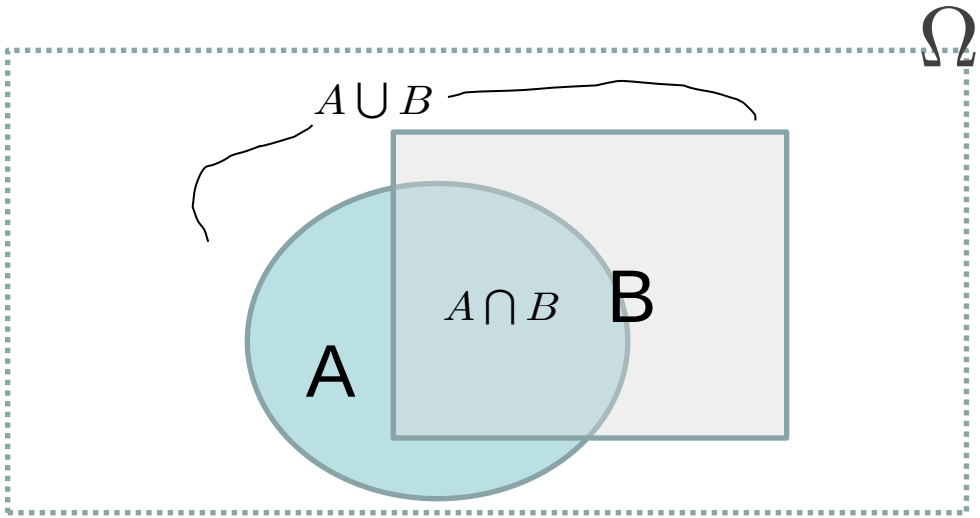
Set notation

Unions, intersections, empty set $\emptyset$

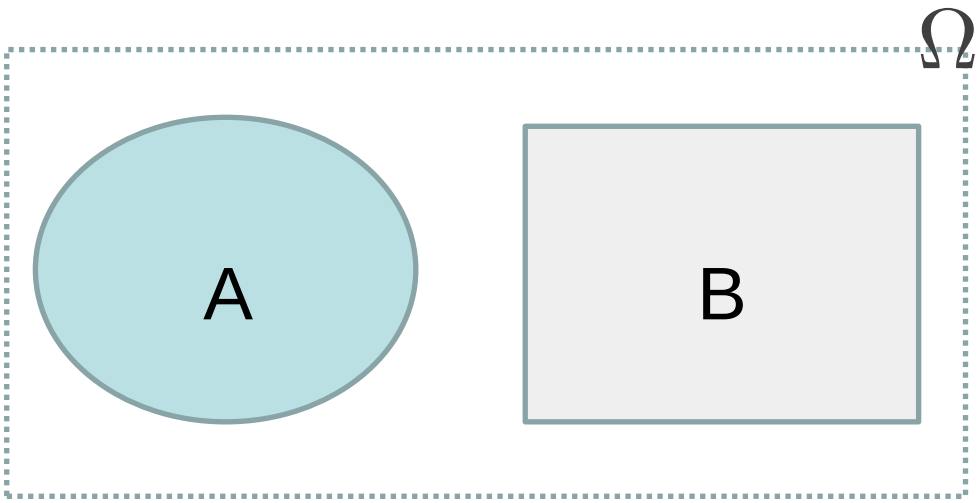
$$A \cup B = \{a \mid a \in A \text{ or } a \in B\}$$
$$A \cap B = \{a \mid a \in A \text{ and } a \in B\}$$



Intersection and union

Disjoint sets

- Disjoint sets : $A \bigcap B = \emptyset$
- Sets are pairwise disjoint if any two are disjoint (i.e all disjoint from each other)



Disjoint sets

Notation for multiple unions

- If we have sets $A_1, A_2, \ldots, A_n$ then their union is denoted

$$\bigcup_{i=1}^{n} A_i$$

- Sometimes we have a union of sets $A_i : i \in I$ and in that case we write

$$\bigcup_{i \in I} A_i$$