

TO DO

- ✓. WELCOME!
- ✓. ME, YOU
- PREMISE
- SYLLABUS
- SCHEDULE ★
- PROBLEM SETS
- GITHUB
- AXIOMS OF PROBABILITY
- PS 1

MATH 227 C

STOCHASTIC

&

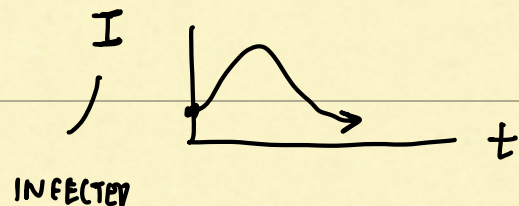
STATISTICAL

MODELING IN

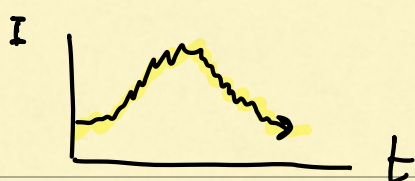
LIFE SCIENCES

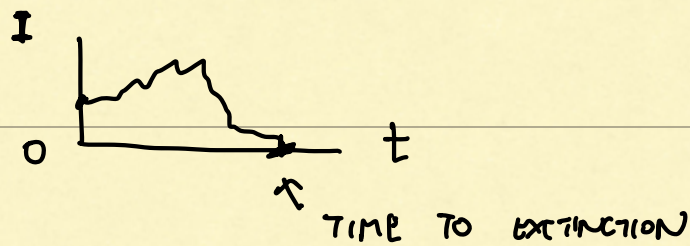
EX MODEL INFECTIOUS DISEASE

$$\frac{d}{dt} \begin{bmatrix} S \\ I \\ R \end{bmatrix} = f(S, I, R)$$

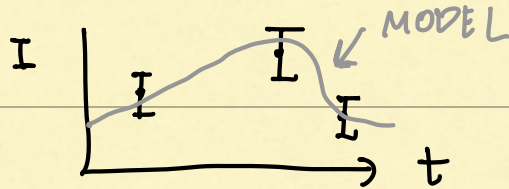


• NOISE?





• LEARNING / INFERENCE



AXIOMS OF PROBABILITY

X - RANDOM VARIABLE

$X \in$ STATE SPACE OR SAMPLE SPACE

EX FLIP A COIN $\{H, T\}$

ROLL A DIE $\{1, 2, 3, 4, 5, 6\}$

ELEMENTS AND SETS OF STATE SPACE ARE CALLED EVENTS.

EVENTS CAN BE COMBINED

$$e_1 \cup e_2$$

UNION
"OR"

$$e_1 \cap e_2$$

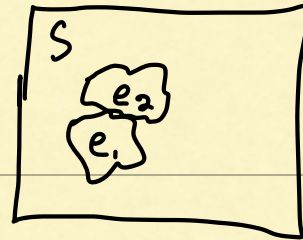
INTERSECT
"AND"

S - SAMPLE SPACE

$S \setminus e$ - COMPLEMENT
"NOT"

X HAS A PROBABILITY FUNCTION

$$P(e)$$



$$\bullet 0 \leq P(e)$$

$$\bullet P(S) = 1$$



• IF $e_1 \cap e_2 = \text{NOTHING}$ THEN

$$P(e_1 \cup e_2) = P(e_1) + P(e_2)$$

AS A CONSEQUENCE

$$\bullet P(e) \leq 1$$

$$\bullet P(\text{NOTHING}) = 0$$

EX

FAIR DIE



SAMPLE SPACE =

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

$$e_A = \{\text{EVEN}\} = \{2, 4, 6\} = \frac{3}{6} = \frac{1}{2}$$

$$e_B = \{< 3\} = \{1, 2\} = \frac{2}{6} = \frac{1}{3}$$

$$P(e_A \cup e_B) = P(\{1, 2, 4, 6\}) = \frac{4}{6}$$

$$P(e_A) + P(e_B) = \frac{1}{2} + \frac{1}{3} = \frac{5}{6}$$

CONDITIONAL PROBABILITY OF A GIVEN B

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$\text{EX } P(e_A | e_B) = \frac{P(e_A \cap e_B)}{P(e_B)} = \frac{\frac{1}{6}}{\frac{1}{3}} = \frac{1}{2}$$

TWO EVENTS ARE INDEPENDENT IF

$$P(A \cap B) = P(A) \cdot P(B)$$

$$\begin{aligned} \text{NOTE } P(A | B) &= \frac{P(A \cap B)}{P(B)} \\ &= \frac{P(A) \cdot \cancel{P(B)}}{\cancel{P(B)}} = P(A) \end{aligned}$$

$P_5 \perp A$:

E_6 - sum is 6

F_4 - FIRST die is 4

$$P(E_6) \stackrel{?}{=} \frac{5}{36}$$

$$P(F_4) = \frac{1}{6}$$

$$P(E_6 \cap F_4) \stackrel{?}{=} \frac{1}{36}$$

$$P(E_6 \cap F_4) \stackrel{?}{=} P(E_6) \cdot P(F_4)$$

$$\frac{1}{36}$$

$$\stackrel{?}{=}$$

$$\frac{1}{6} \cdot \frac{5}{36}$$

NOT INDEPENDENT