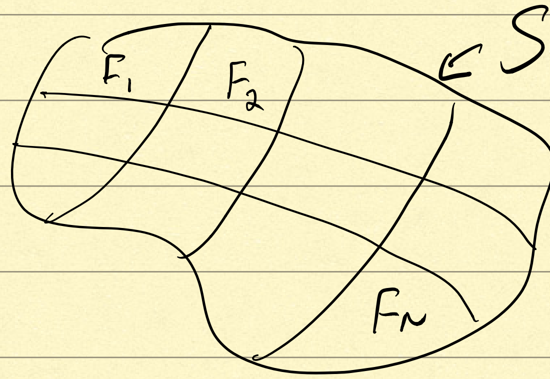
SUPPOSE A SAMPLE SPACE S CAN BE SPLIT INTO SUBSETS $F_1, F_2, \ldots F_N$ ← "PARTITION"

SUCH THAT



$\bigcup F_i = S$

$F_i \cap F_j$ = EMPTY ←

$$\mathbb{P}(e) = \mathbb{P}(e \cap F_1) + \mathbb{P}(e \cap F_2) + \ldots + \mathbb{P}(e \cap F_N)$$
$$= \mathbb{P}(e|F_1)\mathbb{P}(F_1) + \mathbb{P}(e|F_2)\mathbb{P}(F_2) + \ldots + \mathbb{P}(e|F_N)\mathbb{P}(F_N)$$

LAW OF TOTAL PROBABILITY

X - RANDOM VARIABLE

S - STATE SPACE

S - DISCRETE $(\{1, 2, 3\})$

CONTINUOUS $([0, \infty))$

COLLECTION OF RANDOM VARIABLES

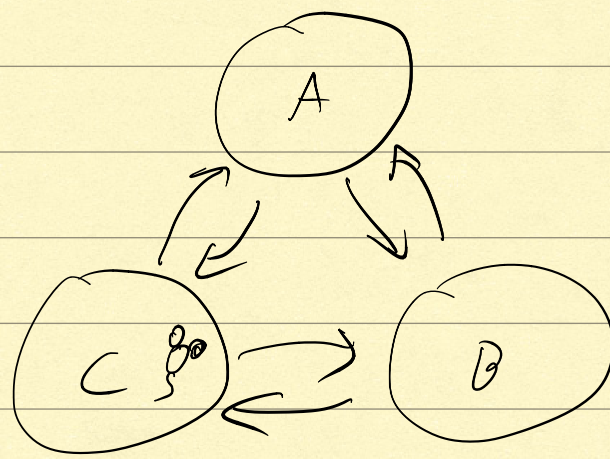
X_t ← INDEX

t IS IN A SET

- IF t IS FROM A DISCRETE SET $\{1, 2, 3, 4 \dots\}$ THEN X_t IS A DISCRETE-TIME STOCHASTIC PROCESS
- IF t IS FROM A CONTINUOUS SET $[0, \infty)$ THEN X_t IS A CONTINUOUS-TIME STOCHASTIC PROCESS

MARKOV CHAINS

MOUSE CAN TRAVEL BETWEEN 3 ROOMS EACH MINUTE



ASSUMPTION

$$\mathbb{P}(X_t = i \mid X_{t-1} = j, X_{t-2} = k \dots)$$

$$= \mathbb{P}(X_t = i \mid X_{t-1} = j)$$

$$M = \begin{bmatrix} p_{AA} & \cdots & p_{AC} \\ \vdots & \ddots & \\ \vdots & & p_{CC} \end{bmatrix}$$

TRANSITION MATRIX

$$p_{ij} = \mathbb{P}(X_t = i \mid X_{t-1} = j)$$

$p_{i \leftarrow j}$

THEN

$$\begin{bmatrix} p_A(t+1) \\ p_B(t+1) \\ p_C(t+1) \end{bmatrix} = M \cdot \begin{bmatrix} p_A(t) \\ p_B(t) \\ p_C(t) \end{bmatrix}, \quad \begin{bmatrix} p_A(0) \\ p_B(0) \\ p_C(0) \end{bmatrix}$$

$$\begin{aligned} p_A(t+1) = {} & \mathbb{P}(X_t = A \mid X_{t-1} = A)\, p_A(t) + \\ & \mathbb{P}(X_t = A \mid X_{t-1} = B)\, p_B(t) + \\ & \mathbb{P}(X_t = A \mid X_{t-1} = C)\, p_C(t) \end{aligned}$$

BASEPAIRS

$\circ \to \circ \to \circ \to \circ$

DNA

X_t = BASEPAIR AT LOCATION t

$$X_t \in S = \{A, C, T, G\}$$

PS2

$$
\begin{array}{c c}
\begin{array}{cccccc} S & E1 & E2 & E3 & I & END \end{array} & \\
\begin{bmatrix}
0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 \\
0 & & 0 & 0 & & \\
0 & & 0 & 0 & & 0 \\
0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix} & \begin{array}{c} S \\ E1 \\ E2 \\ E3 \\ I \\ END \end{array}
\end{array}
$$

?

$$p_{i \to j} = \mathbb{P}(X_{t+1} = j \mid X_t = i)$$

$$M = \begin{bmatrix} p_{1\to 1} & & p_{n \to 1} \\ & & \\ & & \\ p_{1 \to n} & & p_{n \to n} \end{bmatrix}$$