3Y03 - Probability and Statistics for Engineering

RANDOMNESS — how to handle it

Experiments — anything that produces data

- e.g. • monitoring queues in student centre
  - population controls / census
  - earthquake sensing

We can **model** many situations

- e.g. • **mechanistic model** (theoretical principles)

  - **empirical model** (guess about relationship between factors based on observed data)

BUT however good the model, residual variation (noise) & chance play a role

e.g. electric noise, environment conditions, human error ...

STATISTICS : the science of collecting, describing, analysing (numerical) data & inferring (learning) information about the whole from a representative sample

PROBABILITY : the mathematics of random phenomena.

PROBABILITY THEORY

2-1   The "Language" of Probability.

Sample Spaces & Events

Sample Space = set of all possible outcomes of an "experiment"

  – denoted S
  – can be discrete ← can list outcomes (finite, or countably infinite)
     continuous ← contains an interval

Examples (i) Roll a regular 6-sided die

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

(discrete)

(ii) Amount of money in envelope
(possibly none) $S = \{x \mid x \geqslant 0\}$

If I tell you there are at most $50,

then $S = \{x \mid 0 \leqslant x \leqslant 50\}$

(both continuous)

(iii) Who's going to win the Superbowl?

$S = \{$ Saints, Chiefs, Rams, ... $\}$

← 8 teams
(discrete)

Who's going to win it next year?
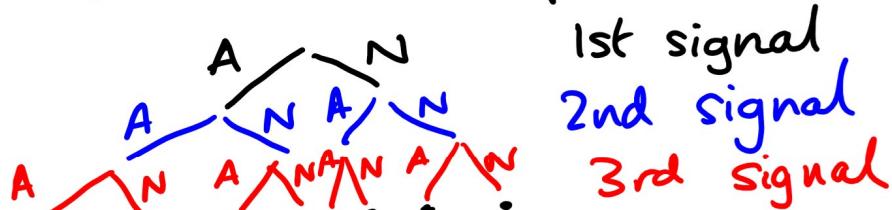
$S = \{$ 49ers, Bears, Bengals, ... $\}$

← 32 teams
(discrete)

(iv) Send 3 signals in succession in
a comms system. Record whether they
arrive (A) or not (N).

Set of possible outcomes represented by a tree:

$S = \{AAA, AAN, ANA, ..., NNN\}$ — 8 outcomes (discrete)