February 14, 2024 Notes

Random Experiment

- The agent needs reason in an uncertain world
- Uncertainty can be due to
  - Noisy sensors (e.g., temperature, GPS, camera, etc.)
  - Imperfect data (e.g., low resolution image)
  - Missing data (e.g., lab tests)
  - Imperfect knowledge (e.g., medical diagnosis)
  - Exceptions (e.g., all birds fly except ostriches, penguins, birds with injured winds, dead birds, . . .)
  - Changing data (e.g., flu seasons, traffic conditions, etc.)
  - . . .
- The agent still must act (e.g., step on the breaks, diagnose a patient, order a lab test, . . .)

Random Experiment is a process by which we observing something uncertain.

An outcome is a result of a random experiment.

The set of all possible outcomes is called the sample space S (frequently labeled Ω).

Probability In AI: Selected Application

- Classification
  - Naïve Bayes, logistic regression, neural networks
  - Maximum likelihood estimation, Bayesian estimation, gradient optimization, back-propagation
- Decision making
  - Episodic decision making, Markov decision processes, multi-armed bandits
  - Value of information, Bellman equations, value iteration, policy iteration, UCB1, ϵ-greedy
- Reinforcement learning
  - Prediction, control, Monte-Carlo methods, temporal difference learning, Sarsa, Q-learning

Outcomes / Sample Space / Event

Outcome – A result of a random experiment

Sample space S – The set of all possible outcomes

Event – A subset of the sample space S

Events

Union and Intersection

If A and B are events, then

$$A \cap B$$

and

$$A \cup B$$

are also events.

$\cup$ union ("or")

$\cap$ intersection ("and")

Simple event – An event that cannot be decomposed

Complementary Event

The complement of any event A is the event A' ("not A"), i.e. the event that A does not occur.