



ARTIFICIAL INTELLIGENCE & CYBER SECURITY

PROBABILISTIC REASONING

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OBJECTIVES

- Motivation
- Review the basics of probability theory
 - Events and Random Variables
 - Joint, Marginal and Conditional Probabilities
 - Product, Chain and Bayes Rules
 - Independence and Conditional Independence
- Examples
- Bayesian Networks

UNCERTAINTY AND LOGIC

- Does fit the way humans think and reason; we are the designers of intelligent agents.
- But it only concerns reasoning about properties which are true or false (1 or 0).
- In general we do not know if a statement is true or false, due to ignorance or intrinsic uncertainty

UNCERTAINTY

- Robocop is walking around in the city at night and there is car accident. A witness of the nighttime accident involving the car declares that the car was green.
- Do we have:
 - $wb \Rightarrow b$?
 - $wg \Rightarrow g$?
 - $b \Rightarrow wb$?
 - $g \Rightarrow wg$?
- Question: Is the car green or not?
 - Cannot be answered in a true/false way.
- But maybe we can compute the probability that the car is indeed blue

wb means "Witness declares car is blue".
b means "Car is actually blue".

MODELLING UNCERTAINTY WITH PROBABILITY THEORY

- Probability Theory
 - Allows modelling the likelihood of events
 - Likelihood is derived from the belief/knowledge of the agent
 - Empirical observations of such events
 - Allows us to update the likelihood of some events if we acquire further knowledge (observations)
 - Having observed that a witness stated that the car is blue, how can I update the probability that the car was indeed blue?