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# CSC 510

Foundations of Artificial Intelligence

Course Description

This graduate course provides students with an understanding of principles associated with Artificial Intelligence (AI).

Students will determine how to utilize structures to represent graphs associated in data exploration. Students will gain an understanding of how to efficiently apply knowledge representation and techniques associated with AI reasoning. Topics that students will explore include techniques efficiently applying game theory, integer programming, continuous optimization, and probability analysis.

Reference for graphs in Python: all algorithms and data structures implemented in Python, a reference:
**https://github.com/TheAlgorithms/Python/blob/master/DIRECTORY.md**

- Game theory:
    - **Game theory** is the study of mathematical models of strategic interactions among rational decision-makers.
    - The primary use of game theory is to describe and model how human populations behave.
    - Game theory is a way to mathematically describe strategic reasoning — of competitors in a market, or drivers on a highway or predators in a habitat.
    - In game theory, a “game” is any mathematical model that correlates different player strategies with different outcomes.

    - Especially in the case of packets on the internet, the system is incredibly dynamic, with new or different users and current events constantly impacting the traffic patterns. For many years, game theorists were focused on stability: finding and understanding the Nash equilibrium, where every user is content with their decision or strategy, given everyone else's decision.
- Integer programming:
    - Linear programming in Python is pretty easy (think training a model). Here is a **how to with steps in Python**: https://realpython.com/linear-programming-python/#what-is-linear-programming
    - An **integer programming** problem is a mathematical optimization or feasibility program in which some or all of the variables are restricted to be integers.
    - Integer programming is NP-complete.
    - In many settings the term refers to **integer linear programming** (ILP), in which the objective function and the constraints (other than the integer constraints) are linear.
    - **Linear programming** (**LP**, also called **linear optimization**) is a method to achieve the best outcome (such as maximum profit or lowest cost) in a mathematical model whose requirements are represented by linear relationships.
- NP-complete problem:
    - Any of a class of computational problems for which no efficient solution algorithm has been found. Many significant computer-science problems belong to this class—e.g., the traveling salesman problem, satisfiability problems, and graph-covering problems.
- Continuous optimization:
    - Continuous optimization means **finding the minimum or maximum value of a function of one or many real variables, subject to constraints**. The constraints usually take the form of equations or inequalities.
    - The variables used in the objective function are required to be continuous variables—that is, to be chosen from a set of real values between which there

are no gaps.

        - In mathematical optimization and decision theory, a **loss function** or **cost function** (sometimes also called an error function) is a function that maps an event or values of one or more variables onto a real number intuitively representing some "cost" associated with the event.
        - An optimization problem seeks to minimize a loss function.
        - An **objective function** is either a loss function or its opposite (in specific domains, variously called a reward function, a profit function, a utility function, a fitness function, etc.), in which case it is to be maximized.

- Probability analysis:
    - A technique used by risk managers for forecasting future events, such as accidental and business losses.
    - This process involves a review of historical loss data to calculate a probability distribution that can be used to predict future losses.
    - The probability analyst views past losses as a range of outcomes of what might be expected for the future and assumes that the environment will remain fairly stable.
    - This technique is particularly effective for companies that have a large amount of data on past losses and that have experienced stable operations.

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