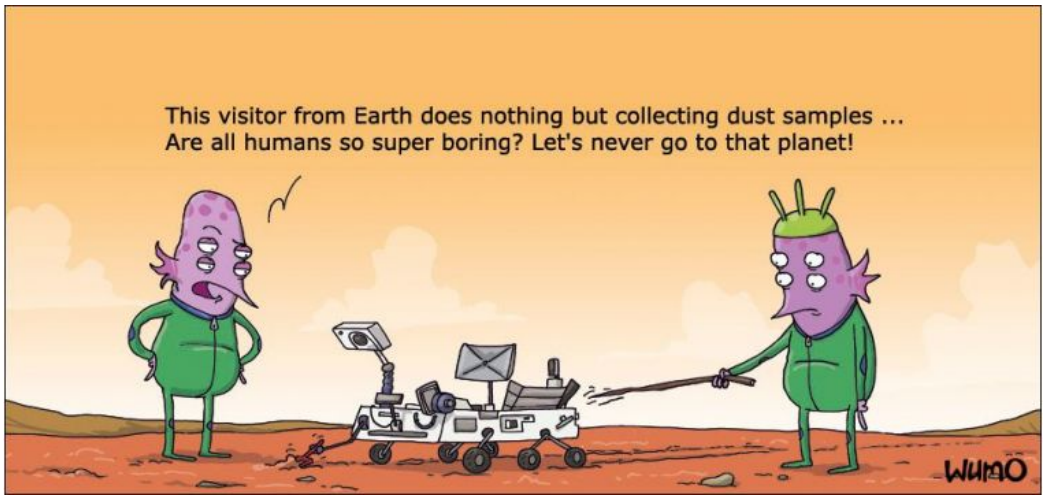
**CSCI 3202**

**Lecture 29**

**November 3, 2025**




Wumo by Wulff and Morgenthaler. https://wumo.com

**Announcements**

- HW 3 is graded and released
- Midterm is graded and released
- Project Intermediate Report due by Wednesday, 11/5 at 11:59 pm
- HW #7 is due on Friday, 11/7 by 11:59 pm

**Midterm**

- Scores listed are raw--no adjustment
- Average score is 82%

| Average Score | High Score | Low Score | Standard Deviation | Average Time |
|---|---|---|---|---|
| **82%** | 102% | 39% | 13.05 | 50:16 |




- You may resubmit Worked Out Problems (Q13-Q20) only from the midterm for regrading. The points you receive will replace your original score on the midterm. If you do not submit anything, there will be no change in your score. You have until Friday, November 17 to submit. No late submissions will be accepted
- Before calculating your final grade, I will add 5 points to your midterm exam score due to the length of the exam
- These points will only count towards your midterm score. They will not count as extra credit toward your course grade

**Quiz**

- Quiz #9 average is 82%
- On Question 1, allowed two correct answers
  - Describes how to choose an action for that state
  - Chooses an action for that state
- Review

**Project**

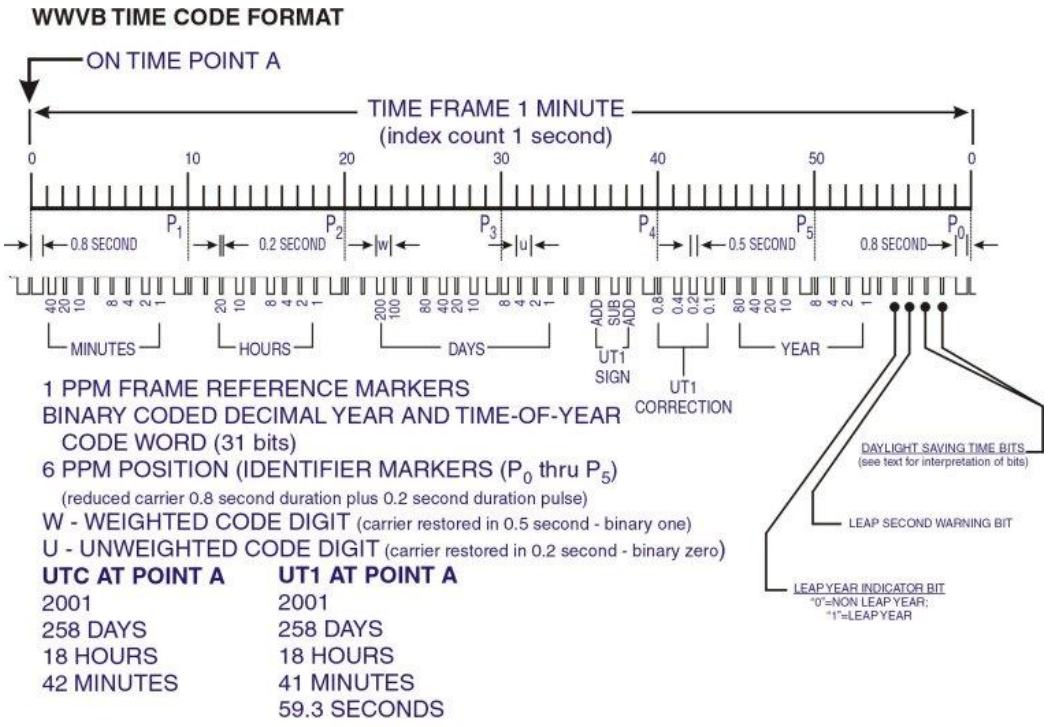
- Intermediate report for project due Wednesday, November 5, 2025
- Turn in a Jupyter notebook or Zip file
  - Include your code
  - Write a paragraph describing your results so far
- For Mancala:
  - Game completely implemented, all rules
  - Random player implemented and working
  - Play random vs. random player for 100 games and report statistics for each random player separately (Player 1 vs. Player 2)
    - Games won, %

        - Games lost, %
        - Games tied, %
    - For both players
        - Average number of turns per game (count the total number of times either player drops stones into a pit). Note this is the number of turns, not the number of stones or pits.
    - Answer question: Is there a first move advantage? If so, how much?
    - Game should run without error for 100 games
    - Turn in code and answer questions in Canvas
- For "Choose Your Own"
    - Show me functional code for your game or agent
    - How do you know it is running correctly?
    - What do you have left to complete?
    - Turn in code and answer questions in Canvas
- Will post an assignment in Canvas where you can answer questions and turn in your code
- CSCI 3202 Course Project 2025.pdf

**Hidden Markov Models**

- Previously, our Markov Models all had known states
- What happens if we don't which state the system is operating in, but need to determine the most likely state?
- We can use a Hidden Markov Model to determine
- Many models rely on a Bayesian Model with a prior distribution to determine the most likely state
    - This is similar to a Bayesian Network where we are solving for the result diagnostically (against the arrows)
- Example:
    - National Bureau of Standards has a radio signal that continuously broadcasts a stream of data that gives the time every minute to the continental US and parts of Alaska
    - Details at: https://www.nist.gov/pml/time-and-frequency-division/time-distribution/radio-station-wwvb
    - The goal is to provide an inexpensive time signal to the entire US for use by industry, farmers and individuals
    - There are transmitters in Fort Collins and Hawaii
        - The transmitter in Fort Collins operates at 60 kHz with 70,000 watts of power

- The signal is transmitted continuously in time code:




- The time code sends 1 of 3 states per second, https://en.wikipedia.org/wiki/WWVB

> The WWVB 60 kHz carrier, which has a normal ERP of 70 kW, is reduced in power at the start of each UTC second by 17 dB (to 1.4 kW ERP). It is restored to full power some time during the second. The duration of the reduced power encodes one of three symbols:
>
> * If power is reduced for one-fifth of a second (0.2 s), this is a data bit with value zero.
> * If power is reduced for one-half of a second (0.5 s), this is a data bit with value one.
> * If power is reduced for four-fifths of a second (0.8 s), this is a special non-data "mark", used for framing.

- You have in inexpensive radio and antenna that receives the WWVB signal
- How can you decode the signal and provide the right time to a device?
  - The signal fades during the day
  - You need to synchronize your decoder to the start of the time signal
  - There are bursts of noise that obscure the signal at unpredictable times of the day or night

    - You want to make certain that you have received the signal correctly before giving the time to your device (say a center-pivot irrigation pump)
- How do you decode this signal?
    - Want to determine which state is most likely given the signal (evidence) we have received
    - Use a Hidden Markov Model
- Hidden Markov Models.pdf

**Upcoming**

- More Hidden Markov Models