Outline

- Reaction Papers
- Probability and Information Theory
- Cybernetics
  - Feedback loops
- Homework #2
Admin

- 1\textsuperscript{st} Reaction paper due Monday
Reaction Papers

- Game syllabus
  - Grand Theft Auto 3, Grand Theft Auto: Vice City, Grand Theft Auto: San Andreas, or Bully
  - Half-Life or Half-Life 2
  - Katamari Damacy or We Love Katamari
  - Age of Mythology, Civilization IV, Lord of the Rings: Battle for Middle Earth (I or II), Total War(any) or WarCraft III
  - Guitar Hero, Guitar Hero II, or Dance Dance Revolution (any)
  - Gears of War, Dead Rising, Rainbow Six: Vegas, or Ghost Recon: Advanced Warfighter (XBOX 360)

- Play one game a week
  - submit a one-page reaction paper

- Due dates: 1/22, 2/5, 2/14, 2/21, 2/28, 3/7

- Object
  - exercise game analysis skills
  - use the analytic schemas from the book
Uncertainty

- Many games are probabilistic
  - roll the dice
  - shuffle the cards
- Some games are not
  - Chess
  - Checkers
  - Dots and Boxes
Certainty vs uncertainty

- **Certainty**
  - the condition when the outcome of an action is known completely in advance.

- **Some games operate this way**
  - Chess
  - Dots and Boxes

- **But even then**
  - uncertainty about who will win
  - otherwise what is the point?
Probability

- Probability is the study of chance outcomes
  - originated in the study of games

- Basic idea
  - a random variable
  - a quantity whose value is unknown until it is "sampled"
  - the random variable has a distribution
    - for each possible value
      - a probability that the value will occur
Single Die

- Random variable
  - # of spots on the side facing up
- Distribution
  - 1...6
  - each value 1/6 of the time
- Same event, different random variable
  - odd or even # of dots
Two dice

- Random variable
  - sum of the two die values

- Distribution
  - 2, 12 = 1/36
  - 3, 11 = 1/18
  - 4, 10, = 1/12
  - 5, 9 = 1/9
  - 6, 8 = 5/36
  - 7 = 1/6

- Non-uniform
  - not the same as picking a random # between 2-12
  - dice games use this fact
Role of Chance

- Chance can enter into the game in various ways
- Chance generation of resources
  - dealing cards for a game of Bridge
  - rolling dice for a turn in Backgammon
- Chance of success of an action
  - an attack on an RPG opponent may have a probability of succeeding
- Chance degree of success
  - the attack may do a variable degree of damage
Role of Chance 2

- Chance changes the players' choices
  - player must consider what is likely to happen
    - rather than knowing what will happen
- Chance allows the designer more latitude
  - the game can be made harder or easier by adjusting probabilities
- Chance preserves outcome uncertainty
  - with reduced strategic input
  - example: Thunderstorm
Psychology

- People are lousy probabilistic reasoners
- We overvalue low probability events of high risk or reward
  - Example: Otherwise rational people buy lottery tickets
- We assume success is more likely after repeated failure
  - Example: "Gotta keep betting. I'm due."
- Impacts for game design
Information Theory

- There is a relationship between uncertainty and information
  - Information can reduce our uncertainty
- Example
  - The cards dealt to a player in "Gin Rummy" are private knowledge
  - But as players pick up certain discarded cards from the pile
  - It becomes possible to infer what they are holding
Classical Information Theory
- Shannon

Information as a quantity
- how information can a given communication channel convey?
  - compare radio vs telegraph, for example
- must abstract away from the meaning of the information
  - only the signifier is communicated
  - the signified is up to the receiver

Information is measured in bits
- how many choices the receiver must choose from in interpreting the message
Noise

- Noise interrupts a communication channel
  - by changing bits in the original message
  - increases the probability that the wrong message will be received

Redundancy
- standard solution for noise
  - more bits than required, or
  - multi-channel
Example

- Legend of Zelda: Minish Cap
- Monsters are not all vulnerable to the same types of weapons
  - 10 different weapons
  - (we'll ignore combinations of weapons)
- Encounter a new monster
  - which weapon to use?
  - 4 bits of unknown information
- We could try every weapon
  - but we could get killed
Example, cont'd

- Messages
  - the monster iconography contains messages
    - rocks and metal won't be damaged by the sword
    - flying things are vulnerable to the "Gust Jar"
    - etc.
  - the game design varies the pictorial representations of monsters
    - knowing that these messages are being conveyed
  - learning to interpret these messages
    - is part of the task of the player
    - once mastered, these conventions make the player more capable

- Often sound and appearance combine
  - a redundant channel for the information
Information Flow

- People exchange information with a game system
  - to figure out options and outcomes
- But a game system can use information flow internally as well
  - Norbert Weiner developed *cybernetics* to explain this type of system
- Cybernetics is an attempt to unify the study of engineered and natural systems
Cybernetics is about control
- How is the behavior of a system controlled?

Control implies that there are parameters that should be maintained
- Example: temperature
  - human body
  - car engine

Control implies information
- Temperature messages
  - "too high"
  - "too low"
  - "OK"
Feedback Loops

- **Basic loop**
  - A cybernetic system needs a sensor that detects its state
  - The information detected by the sensor is then compared against the desired value
  - If the value is not correct, the system adjusts its state
  - the sensor detects this new state, etc.

- The system maintains stability by
  - feeding the information about its state back to the process producing the state
Two Types of Feedback Loops

- Negative Feedback Loop
  - "inhibition"
  - As the state changes, the loop acts to move it in the direction of its previous state
  - Example
    - thermostat
    - pendulum

- Positive Feedback Loop
  - "excitation"
  - As the state changes, the loop acts to move it in the direction that it is moving
  - Example
    - automobile turbocharger
    - home team advantage
Feedback Loops in Games

- From book

Diagram:
- Game state
- Scoring function
- Game mechanical bias
- Controller
Example 1

- game state
  - distribution of dice among players
- scoring function
  - number of unsuccessful challenges / bluffs
- controller
  - for each failure, lose a die
- bias
  - less information about game state
  - more likely to bid unsuccessfully
Effects?
Example 2

- game state
  - state of a fighting game
- scoring function
  - player's health
- controller
  - near-KO
- bias
  - increase chance of critical (high damage) hit on opponent
Effects?
Example 3

- **game state**
  - state of the chessboard

- **scoring function**
  - the number of pieces taken

- **controller**
  - for each piece taken

- **bias**
  - add that piece to the taker's side in any position

- Japanese Shogi has a rule like this
Effects?
Examples

- Mario Kart
Multiple Loops

- Games may have multiple feedback loops in operation
- Examples
  - Racing game
    - A player who falls behind may be better power-ups
    - AI racers may adjust their ability to keep pace with player
  - RPG
    - Killing monsters gives experience points for gaining levels
    - As a player gains levels, they gain better weapons and greater abilities
    - More success at killing monsters, etc.
    - But
      - Game is designed so advanced areas have tougher monsters
      - Levels get farther and farther apart
In General

- **Negative feedback loops**
  - increases system stability
  - makes the game last longer
  - magnifies late successes

- **Positive feedback loops**
  - destabilizes the system
  - makes the game shorter
  - magnifies early success

- **Positive feedback is usually essential**
  - propels a player to victory
  - otherwise, game can go on forever
  - one reason that three-player games are difficult to design
The Other Sense

- We also use the word "feedback" to mean:
  - praise vs criticism
  - "I got some negative feedback on the proposal, so I'm revising it."

- This is not the same:
  - psychological sense of feedback
    - information about the quality of something
      - good or bad
  - cybernetic sense of feedback
    - a dynamic established by a system's structure that pushes its state in one direction or another
    - in response to information
Game Design Issues

- Important
  - We are talking about the system internally
  - not the game + user system
- Know what feedback is going on in your system
  - analyze how game mechanisms combine to produce feedback
- Feedback may be undesirable
  - negative feedback may make a successful player feel punished
  - positive feedback may magnify ability differences between players
Example game

- **Crazy Eights**
  - deal 8 cards
  - turn up top card of stock
  - Each player
    - must follow suit or rank
    - or draw from pile
  - First one out of cards wins

- **Special cards**
  - 8 changes suit
  - A changes direction
  - 2 = draw 2
Play
Homework #2

- Crazy Eights rules +
  - Players with 4 or fewer cards
    - can use a King to change suit
    - and lay down a card at the same time

- Feedback effect?
Homework #2 cont'd

- Homework
  - restabilize the game
  - leave these rules as is
  - change the game to be more fair
    - countervailing negative feedback
    - but game can't go on forever

- Two stages
  - Rule Set #1 -> Playtest #1
  - Rule Set #2 -> Playtest #2

- Due 10/1
Monday

- Conflict
- Reaction paper #1
- Read: Chapter 20