Intro to Game Design
The Weird, Weird World of Randomness

Fall 2015
Mondays & Wednesdays 9:30 AM-12:15 PM

Instructor: Naomi Clark
nmc5@nyu.edu / naomi@halfrobot.com

Teaching Assistant: Angela Lee
al4317@nyu.edu
Why do we use randomness?

Chaos.

Unpredictable systems.

Forces beyond human control (or understanding?)

Source of uncertainty, which makes games work.
I’ll flip a coin twice.
You bet on how many heads will come up.

One head?  Two heads?  Zero heads?
I’ll flip a coin twice.
You bet on how many heads will come up.

Which is the best bet? Which is the best bet? Which is the best bet?

One head?
Two heads?
Zero heads?

Can you make money at this game? Can you make money at this game? Can you make money at this game?
Probabilities: Chart it out

Flip One  |  Flip Two

- Heads
- Tails
Probabilities: Chart it out

Flip One

50% Heads
50% Tails

Flip Two
Probabilities: Chart it out

<table>
<thead>
<tr>
<th>Flip One</th>
<th>Flip Two</th>
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<tr>
<td>25% Heads</td>
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Probabilities: Chart it out

Flip One

- 25% Heads
- 25% Heads
- 25% Tails
- 25% Tails

Flip Two

- Heads
- Tails
- Heads
- Tails
Dependent and Independent Probability

Bob & Ken: Oh man, we were late because one of the tires on the city bus blew out!

Bob & Ken are separated, and the principal asks each of them which tire blew.

If they’re lying, what’s the chance they don’t get caught in the lie?
**Dependent and Independent Probability**

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Bob & Ken are separated, and the principal asks each of them which tire blew.

If they’re lying, what’s the chance they don’t get caught in the lie?

**Bob Says**
- Front Left
- Front Right
- Back Left
- Back Right

**Ken Says**
- Front Left
- Front Right
- Back Left
- Back Right
Bob & Ken: Oh man, we were late because one of the tires on the city bus blew out!

Bob & Ken are separated, and the principal asks each of them which tire blew.

Bob Says

Front Left
Front Right
Back Left
Back Right

Ken Says

Front Left
Front Right
Back Left
Back Right

If they’re lying, what’s the chance they don’t get caught in the lie?

16 possible combos?
Dependent and Independent Probability

**Bob & Ken:** Oh man, we were late because one of the tires on the city bus blew out!

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16 possible combos?
Dependent and Independent Probability

Bob & Ken: Oh man, we were late because one of the tires on the city bus blew out!

Bob & Ken are separated, and the principal asks each of them which tire blew.

“Doubles” – if both possibility sets are identical the chance is independent of the first probability, since it’s just a chance to MATCH
How about “higher roll wins” dueling?
How about “higher roll wins” dueling?
How about “higher roll wins” dueling?
How about “higher roll wins” dueling?

\[ \times = \frac{15}{30} \]

50%

\[ = \frac{6}{36} \text{ or } 16.667\% \]
Squoddron: May the Best Die Win
Squoddron: Design your own asymmetrical dice
Squoddron: Custom dice & asymmetrical odds!

Must add up to 21, just like a regular die.

Can leave faces blank (counts as “0”)

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Must add up to 21, just like a regular die.

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10 11
Squodron: Custom dice & asymmetrical odds!

Must add up to 21, just like a regular die.

Can leave faces blank (counts as “0”)

Secretly write your numbers on a blank die

Then duel!

Then mark wins & losses on chart
Squoddron: Custom dice & asymmetrical odds!

Whose die is better?

Now map it out on the chart.
Squoddron: Dice vs. Dice... is there a best die?

\[ x = \frac{16}{31} \]

52%

\[ x = \frac{15}{31} \]

48%
Squoddron: Dice vs. Dice... there's always a weakness?

$$\times = \frac{12}{30}$$

40%

$$\times = \frac{18}{30}$$

60%
Squoddron: Custom dice & asymmetrical odds!

Losing player:

Secretly write your numbers on a blank die

Redesign your die to try and beat your opponent!

Then duel!

Then mark wins & losses on chart
Squoddron: Tile Version
Squoddron: Tiles are similar to dice in some ways
Squoddron: Tiles are similar to dice in some ways.
Squoddron: ...but not in others! Use once and it’s out of the chart

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<td>x</td>
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\[ x = \frac{9}{21} \text{  43\%} \]

\[ x = \frac{12}{21} \text{  57\%} \]
Using Randomness

On its own: the main thing driving a game

As a seasoning: the flavor of uncertainty

As one of many ingredients (luck + skill + politics...)
Using Randomness

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As a seasoning: the flavor of uncertainty
As one of many ingredients (luck + skill + politics...)
In a base: prepare beforehand
Using Randomness

On its own: the main thing driving a game

As a seasoning: the flavor of uncertainty

As one of many ingredients (luck + skill + politics...)

In a base: prepare beforehand
Perception of Probability

Sid Meier
Civilization series
Perception of Probability

50 / 50 odds

= “Even Match”
Perception of Probability

? / ? odds

= actually felt like “Even Match” ?
Perception of Probability

70 / 30 odds

= actually felt like “Even Match”
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

VS.
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

VS.

OUTER SPACE

ORBIT

ATMOSPHERE

EARTH !!!
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Two new Invaders are drawn from the deck each turn.
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

If they’re not stopped, at the end of the turn they move one step closer...
Perception of Probability: Invaders

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Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers must kill all Invaders to win

If *one* reaches the surface of the Earth, all hope is lost! (Invaders win)
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Two troopers to start
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Earthgov commits one new trooper for each Invader on the board.
Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers can deploy vs. any Invader in any zone to defend
Alien Invaders vs Earth Defense Force Rocket Troopers!

Invaders try to kill each Trooper one at a time
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Invaders try to kill each Trooper one at a time

% chance to kill Trooper: ???

ATTACK
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers attack one Invader together

% chance to kill *any* one Invader: +20% per Trooper
Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers attack one Invader together

% chance to kill any one Invader: +20% per Trooper
(now 60% chance to kill Queen)
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers attack one Invader together

% chance to kill *any* one Invader: +20% per Trooper

(now 80% chance to kill Queen)
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

Troopers attack one Invader together

% chance to kill any one Invader: +20% per Trooper
(5 Troopers = 100% chance, autokill)
Perception of Probability: Invaders

**Alien Invaders vs Earth Defense Force Rocket Troopers!**

**SETUP**

*Earth* player (EDF Xenobiologist) takes 2 Troopers.

*Invader* player (Genome Hivearch) secretly sets Invader success percentages.

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<table>
<thead>
<tr>
<th>Hatchling</th>
<th>Sentinel</th>
<th>Queen</th>
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<td>____%</td>
<td>&lt; ____%</td>
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hatchling must be less than sentinel, which must be less than queen
percentages can be from 5-90 and must add up to 100%
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

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![Hatchling](image1.png) ![Sentinel](image2.png) ![Queen](image3.png)

- Hatchling: 30%
- Sentinel: 32%
- Queen: 38%

hatchling must be less than sentinel, which must be less than queen percentages can be from 5-90 and must add up to 100%
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

SETUP

*Earth* player (EDF Xenobiologist) takes 2 Troopers.

*Invader* player does this behind the screen, shuffles deck, draws two Invaders.

- **Hatchling**
  - 5%

- **Sentinel**
  - 25%

- **Queen**
  - 70%

hatchling must be less than sentinel, which must be less than queen

percentages can be from 5-90 and must add up to 100%
Perception of Probability: Invaders

Alien Invaders vs Earth Defense Force Rocket Troopers!

**Strategy:** try to guess the threat of each Invader to allocate Troopers properly.

**Strategy:** allocate your 100% points for maximum terror & confusion

**At the End:** Lessons of War? Earth player tries to guess approximate percentages of each type of Invader
**Invader:** roll behind the screen

Percentile Dice generate a number from 1-100: identify the “tens dice” and the “ones dice.”

Rolling to Kill

- Percentile Dice: 1-100
  - Tens dice: 18
  - Ones dice: 3
  - Total: 18 + 3 = 21

- Percentile Dice: 1-100
  - Tens dice: 30
  - Ones dice: 100
  - Total: 30 + 100 = 130

Roll equal or less than the target number to kill
Perception of Probability: Invaders

**Turn Sequence**

1. **Invader refresh:** Invader draws 2 random Invaders & places both in Outer Space zone.
2. **Troopers drafted:** Earth gets 1 new troop for each Invader currently on the board.
3. **Redeploy troopers:** Earth deploys each trooper *anywhere* (in any zone). Place each trooper next to the Invader you want it to attack.
4. **Invaders attack:** Invader rolls *separately* to attack *each* trooper target attacking it. If roll is equal or less than that Invader creature’s strength, destroy that trooper (give back to Earth).
5. **Surviving troopers attack:** Earth rolls *once for each* Invader creature it can attack. Each trooper attacking the creature adds 20% to destroy the creature. Destroy creature if roll is low enough (discarded, does not go back to Invader player).
6. **Invade!** Surviving Invaders advance towards the Earth by 1 section of board, regardless of troop position.

**Winning:** If an Invader reaches the Earth zone, Invaders win. Earth must kill all Invaders to win.
Perception of Probability: Invaders

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More Probability Games
More Probability Games

1. Host reveals either goat
   - Player picks car (probability 1/3)
   - Switching loses.

2. Host must reveal Goat B
   - Player picks Goat A (probability 1/3)
   - Switching wins.

3. Host must reveal Goat A
   - Player picks Goat B (probability 1/3)
   - Switching wins.
Mrs. Jones: I have two children; the older child is a girl. What's the probability that both children are girls?
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Simple Multiplayer Dynamics: KINGDOM

- Groups of 4-5 people
- Shuffle the deck of little cards
- Deal a hand of three to each player
- Put ten tokens for each player together in a central pool
- Every turn: draw one card, then play one card (unless something you have lets you draw / play more)
- Take the action indicated on the sheet for that card
- Discard your card (unless a rule says to keep it)
- Game ends when the pool of tokens is empty
- Player with the most tokens wins
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MOD THIS GAME: Improve it!
Change at least two card rules
You may create new cards or get rid of some of them

What's up with this game?
Any noteworthy dynamics?

Is there a dominant strategy?
Feedback Loops

“Negative Feedback Loop”

• Keeps a system in balance
• Maintains stability
• If something gets too high, the feedback loops acts to pull it lower, and often vice versa
• Also called “catch-up” or “rubberbanding” in multiplayer games because it favors players that are further behind
• … but it has advantages in single-player as well!
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Feedback Loops

“Positive Feedback Loop”

- Makes small changes bigger
- Makes systems accelerate
- Also called “snowball” (as in, rolling downhill and getting bigger)
- Throws things out of equilibrium just as negative feedback loops maintain balance / equilibrium
- Someone starts to get ahead… they get more ahead
- Positive feedback loops can help bring a game to an end!
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FIGURE 4.2
A long game in which the player triumphs after an extended struggle against a powerful opponent.
Player Fortunes: How’re You Doing (in the game)

Game design can influence these shapes with feedback loops!

FIGURE 4.3
A short game with quick reversals of fortune

Time

Fortune

Player 1

Player 2
Feedback Loops: A Great Source of Complexity

1P Negative Feedback Loop

As the player starts to do better, the game pushes back

Basic economy example: the more you sell a particular resource, the less buyers are willing to pay for it. Stop selling, prices go back up.

Consequences for overspecializing. **Decision:** rely on multiple resources?
Feedback Loops: A Great Source of Complexity

2P Positive Feedback Loop

Arms race: who can make a positive feedback loop work better for them and accelerate faster?
In a direct-interaction game (where players can attack each other) the next step is for 1 to crush 2.
Now: Playtesting your Abstract Game

**Grid** and **Blocks**: explain & playtest each game

**Tokens** and **Cards**: explain & playtest each game
Now: Playtesting your Abstract Game

**Tiles** and **Cards**: explain & playtest each game

**Tokens** and **Blocks**: explain & playtest each game

**NOW**: swap games. You are now designing the game you just playtested. Still due next Wednesday!

**WHYYYYY?** Uncertainty is part of the design process too. Improve their game, make it your own.