CS/INFO 4154: Analytics-driven Game Design

Lecture 8: Procedural Content Generation
The Dream

AI

Play games automatically

Procedural Content Generation

Design games automatically
Programming and Design

Source: Mojang
Today you will learn

- Two bread-and-butter techniques
  - Perlin Noise
  - Grammars
    - Standard
    - Graph
    - Shape
- How Minecraft’s terrain generation works*

*to the extent that has been discussed publicly
Rogue

@: You (dark)

Health
Nutrition
Str: 12 Armor: 27
Stealth range: 4

!: A blue potion

*: 99 gold pieces
Spelunky
Diablo II

Source: www.dlcompare.com
Skyrim

- Random quests:
  - giver
  - location
  - challenges
  - redeemer
A* Mario
Infinite Mario
Minecraft

Source: Mojang
Clicker Heroes
Why?

- Creating content is a bottleneck
- Create designs that you wouldn’t have thought of
- Replayability
Challenges

• Quality
  • Good?
  • Fun?
  • Beatable?
  • Interesting?
  • As good as human-designed content?

• Consistency - is it *always* acceptable?

• Speed
Challenges

“You’ve just taken a really hard problem and made it harder”

Kate Compton

Source: spore.wikia.com
Minecraft

Source: Mojang
Management of Randomness

more random

Random numbers

more structured
Random numbers

- Ugly
- Unstructured
Actual surface of the earth

Source: Google maps
Management of Randomness

more random

Random numbers
Perlin Noise

more structured
Perlin Noise
Source: Giliam de Carpentier
How can this work in Minecraft?

Source: Mojang
Idea: Do this on a grid
Management of Randomnessness

- more random
- Random numbers
- Perlin Noise
- Grammars
- more structured
Grammars

\[ S \rightarrow a \]
Grammars

\[ S \rightarrow a \mid b \]
Grammars

\[ S \rightarrow Sb | a \]

\[ S \]
\[ Sb \]
\[ Sbb \]
\[ abb \]

\[ S \rightarrow Sb \]
\[ S \rightarrow Sb \]
\[ S \rightarrow Sa \]
Grammars

S → Sb | a
Grammars

\[ S \rightarrow aSc \]
\[ S \rightarrow b \]

abc
aabbcc
aaabcccc
Grammars

S → X | Y
X → XX | ab
Y → YY | bc

ab
ababab
bcbc
bcbcbcbcbc

NOT: ababbc
Zelda: Twilight Princess

Source: ZorZelda Youtube
Missions
Create Game World ➔ Interesting Decisions?
Create Game World

Choose Decisions
Graph Grammars
Shape Grammar
Shape Grammar
Shape Grammar
Example: The Triplicates
Management of Randomnessness

more random

Random numbers
Perlin Noise
Grammars
Constraint satisfaction

more structured
Maze
Constraints

- must have an entrance
- must have an exit
- must have a path to get to the exit
- cells have four walls
- walls can be open or closed
- exterior walls (except entrance/exit) must be closed
- can get from cell to adjacent cell if wall is open
Source: Gillian Smith, *Launchpad*
Management of Randomnessness

more random

Random numbers
Perlin Noise
Grammars
Constraint satisfaction

more structured
Summary

• Procedural content generation
  • enhances design power
  • enables some games (Minecraft)
  • combines programming and design

• Key techniques
  • Perlin Noise
  • Grammars
Alpha Prototype

- Thursday!
- Three playable levels
This may go badly
Alpha Postmortem 10/6

- 6-8 minute presentation
- Pick *two central* design questions.
- For each question, state:
  - The design question
  - Why is this question important?
  - Why were you unsure about the answer?
  - What methods did you use? (Q&A, survey, think-aloud)
  - What results did you obtain?
  - What will you change about the game?
- You *must* use a survey
will be LIKE THIS, not necessarily these questions

1. What are the two design questions? ____________
2. What methods did the team use for the first question? ______________________________
3. What were the results? _____________________

1. Are you convinced?    YES           SORT OF           NO

4. What will the team change? _________________

1. Are you convinced this will work?    

   YES           SORT OF           NO
Traditional playtesting methods

- Direct observation
- Think-alouds
- Q&A
- Surveys
Direct Observation
Think-alouds

I don’t know what to do

I keep catching on fire and dying

Why are you making me do this
Questions and Answers

What happened when you went through the portal?

I can freeze water now
## Survey

How stressful were each of the following?  
(1 = not much, 5 = a lot)

<table>
<thead>
<tr>
<th>Activity</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciding where to go</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Jumping on platforms</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Defeating enemies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Solving puzzles</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Using the controls</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
More specific survey

How useful was each ability?
(1 = not much, 5 = a lot)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Flash Freezing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Flash Heating</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Team meetings 10/7 and 10/8
Revised Plan 10/8
Group Activity

- Pick playtesting questions
  - What methods will you use?
  - Who will be responsible for each method / question?
- Make a survey