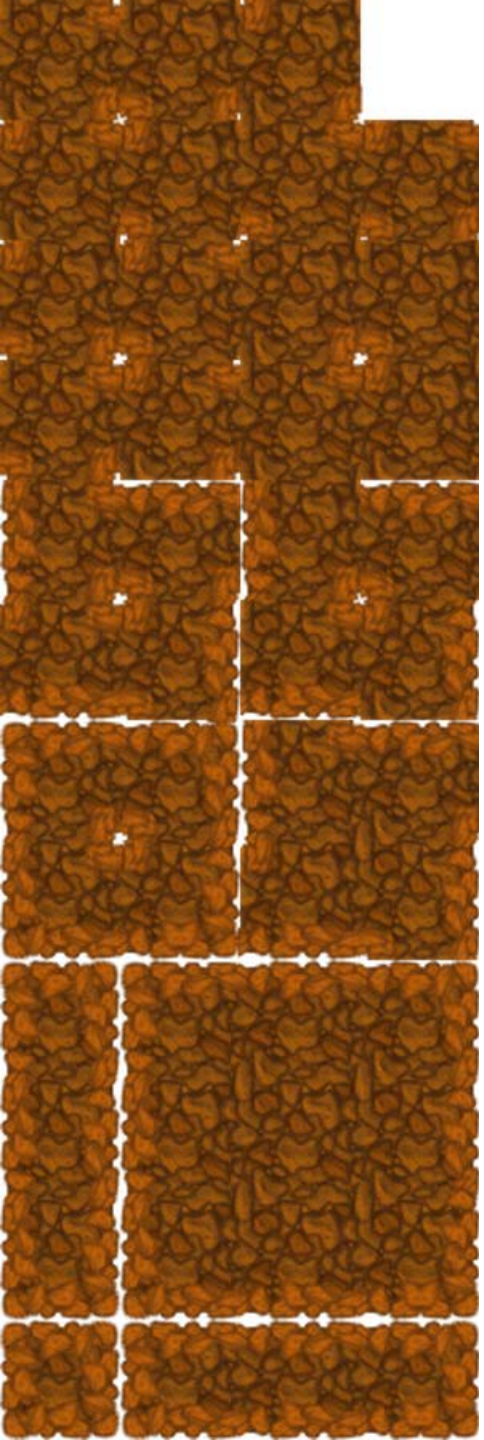


CS/INFO 4154:
Analytics-driven Game Design

Lecture 8:

Procedural Content Generation

The Dream

AI

Play games automatically

Procedural Content Generation

Design games automatically

Programming and Design

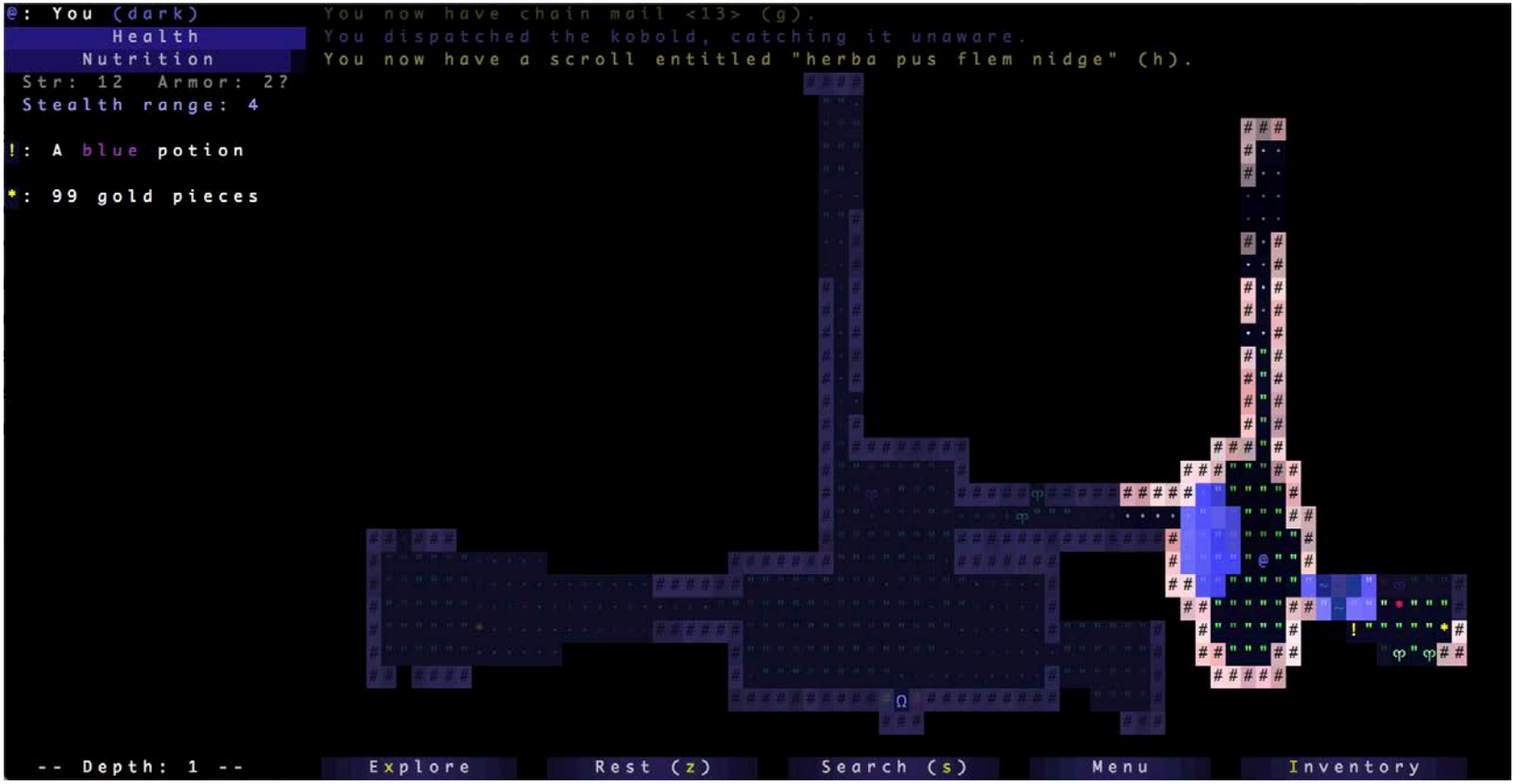
Source: Mojang

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: 2?
Stealth range: 4
!: A blue potion
*: 99 gold pieces
You now have chain mail <13> (g).
You dispatched the kobold, catching it unaware.
You now have a scroll entitled "herba pus flem nidge" (h).
-- Depth: 1 --
Explore
Rest (z)
Search (s)
Menu
Inventory

Spelunky

Diablo II

Source: www.dlcompare.com

Spore

Source: spore.wikia.com

Spore

Source: spore.wikia.com

Skyrim

- Random quests:
  - giver
  - location
  - challenges
  - redeemer

A* Mario


FPS: 24
Attempt: 1 of 1
AStarAgent
Selected Actions:
RIGHT
SPEED

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

Kate Compton

Source: spore.wikia.com

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

Minecraft

Source: Mojang

Management of Randomness

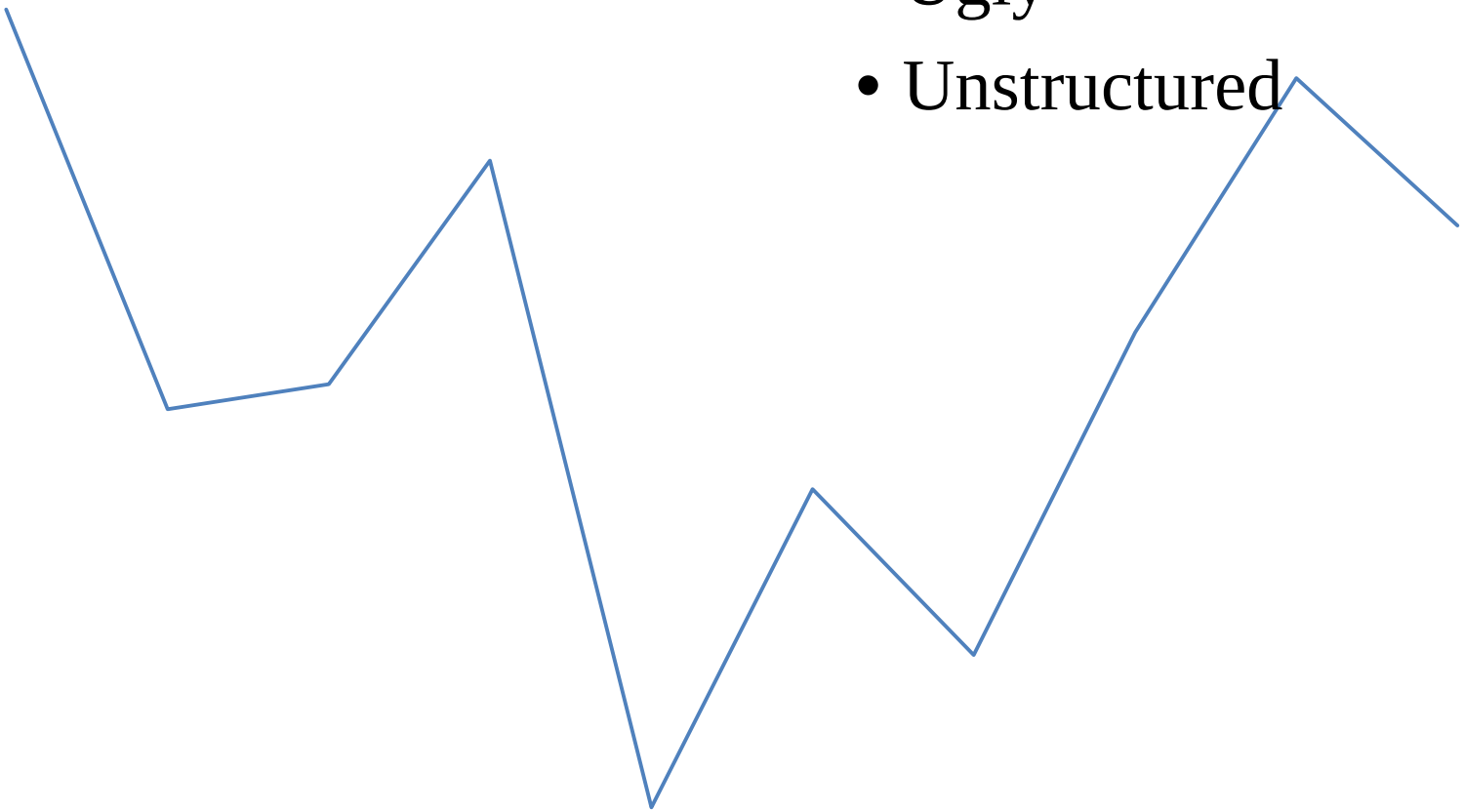
more random

Random numbers

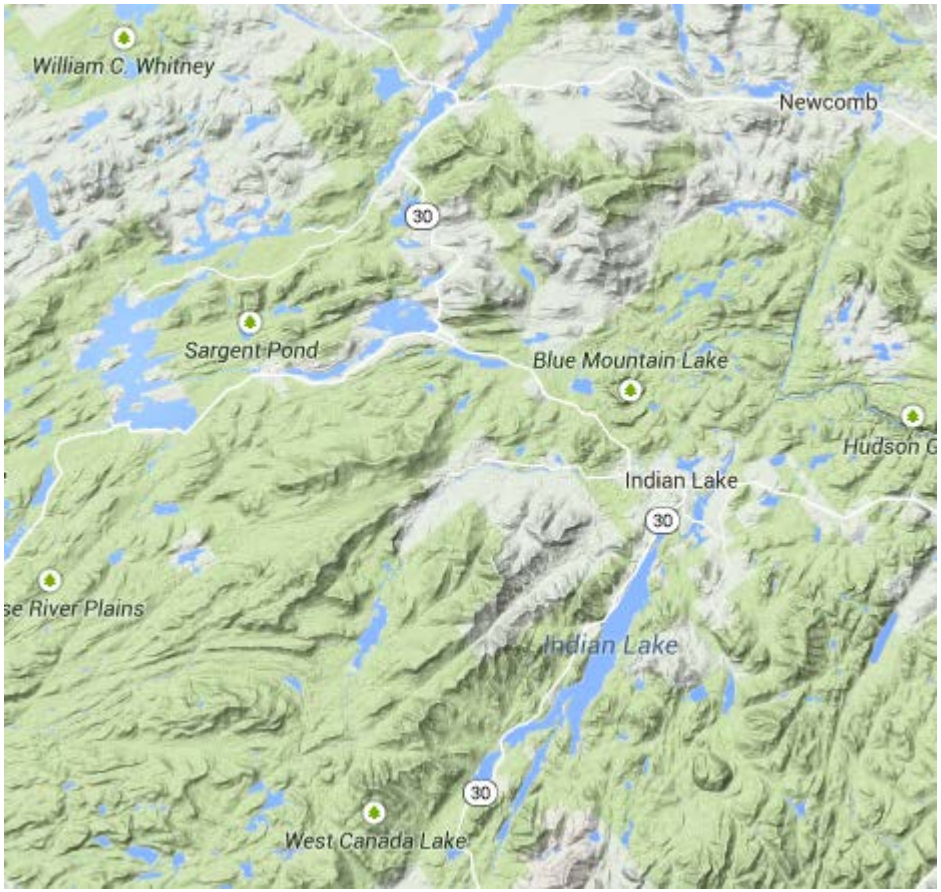
more structured

Random numbers

- Ugly
- Unstructured



Actual surface of the earth



Source: Google maps

Management of Randomness

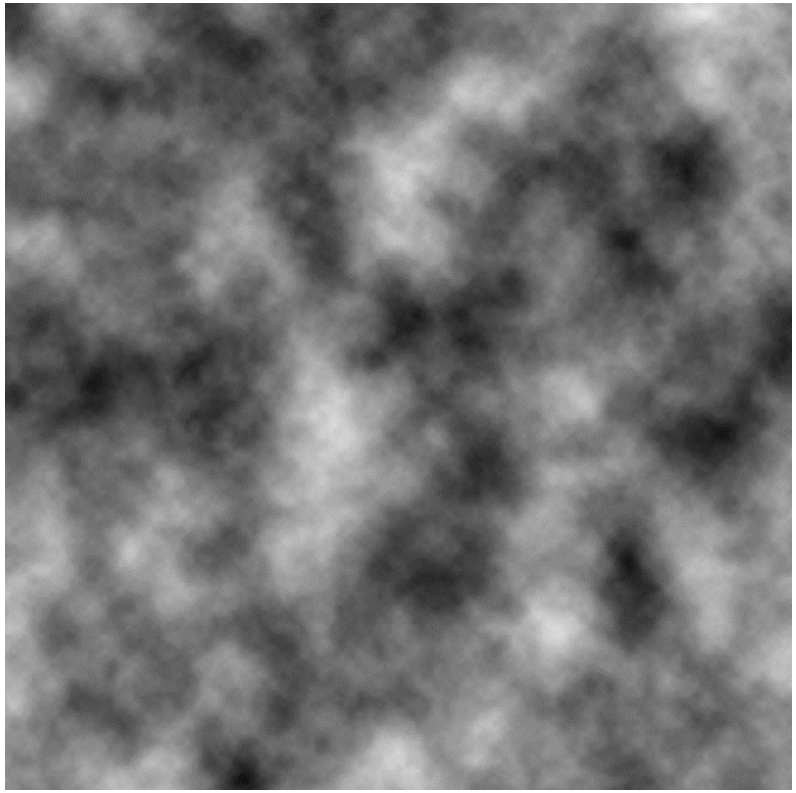
more random

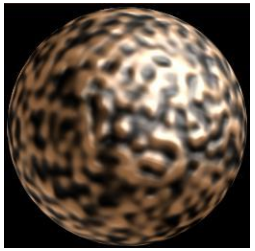
Random numbers

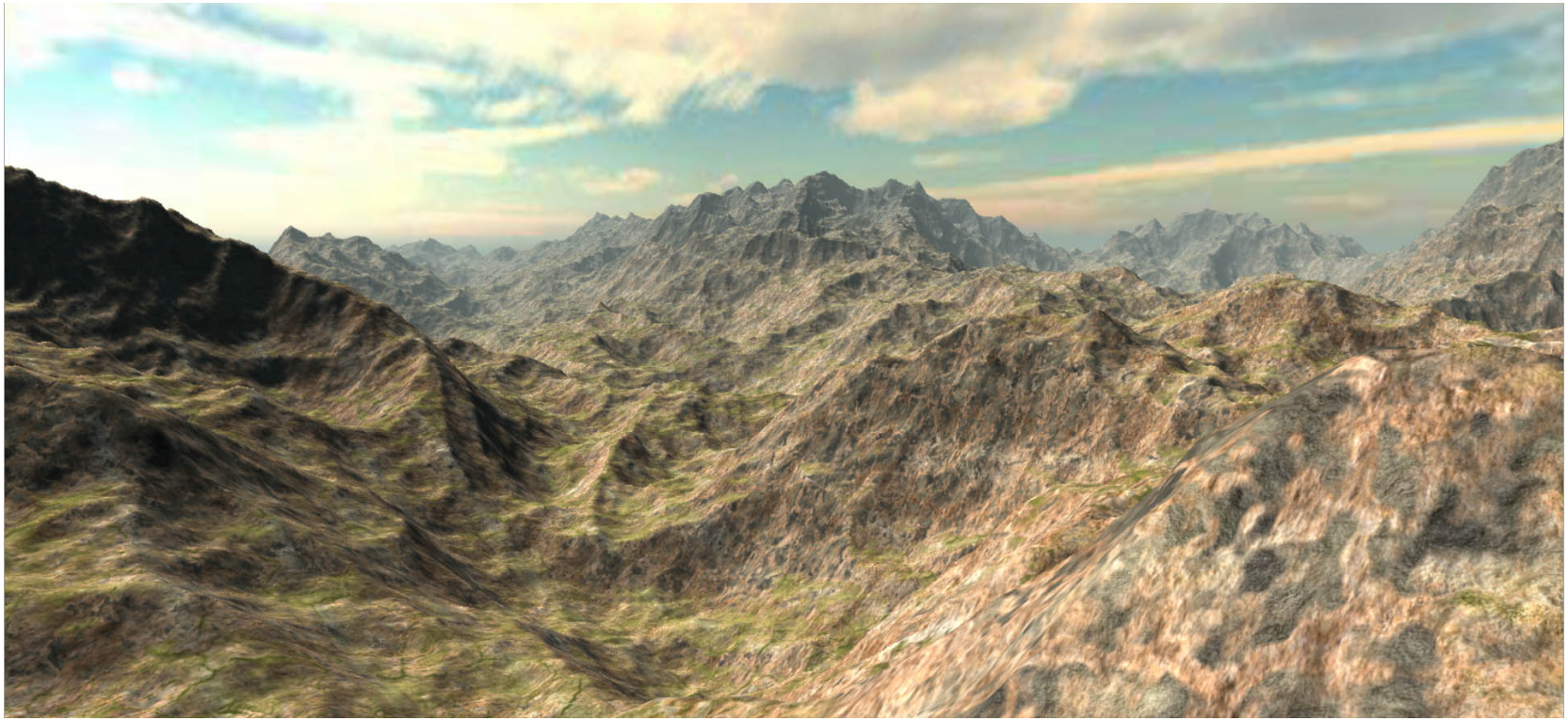
Perlin Noise

more structured

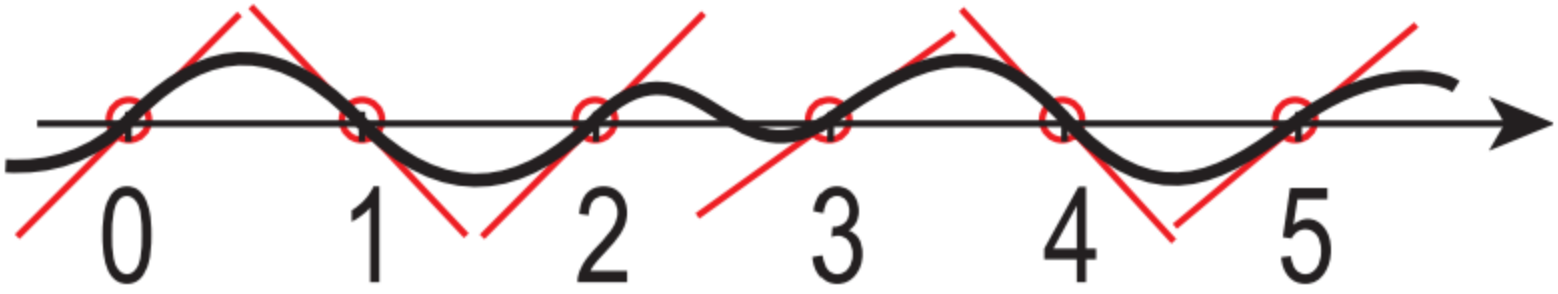
Perlin Noise

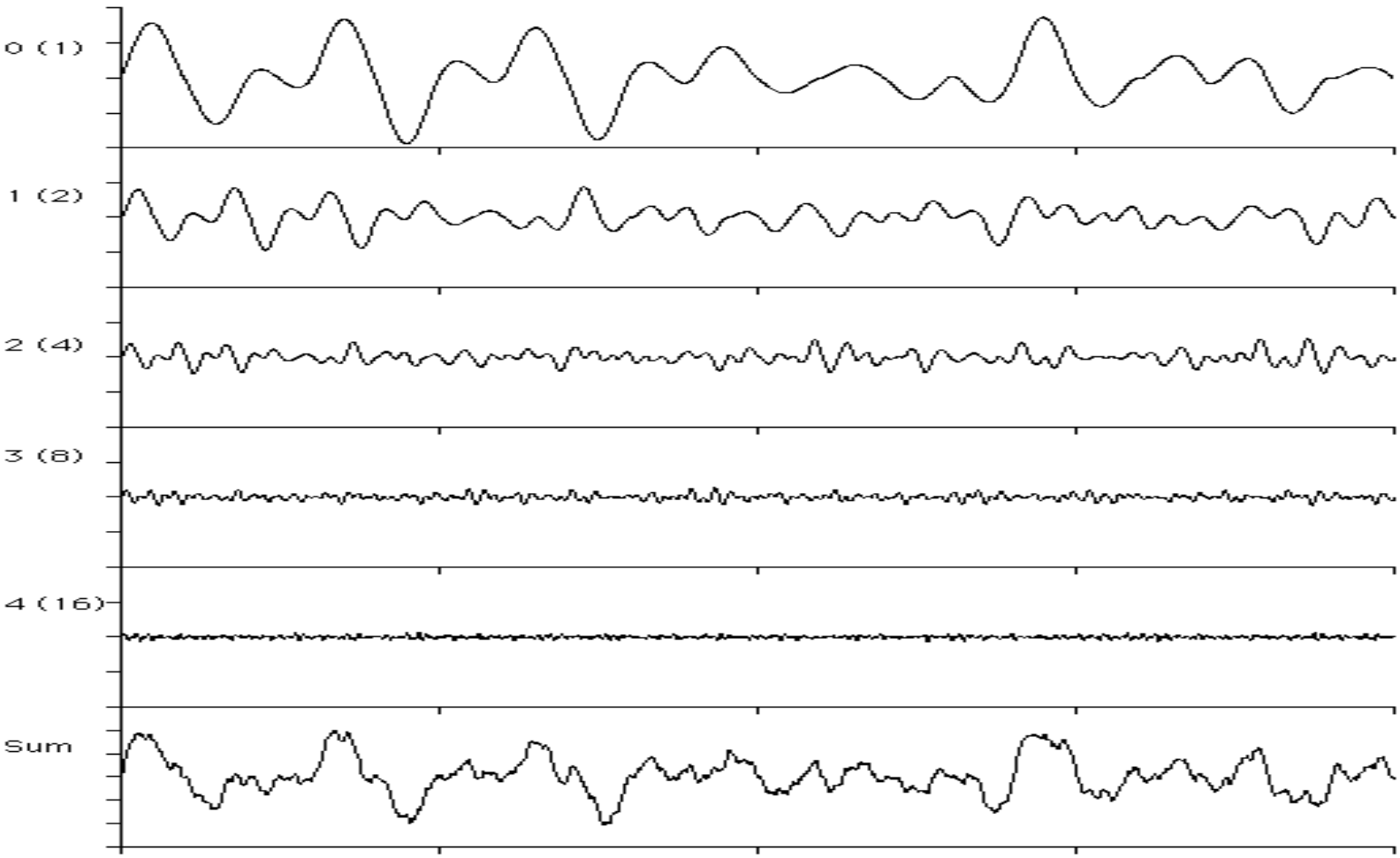






Source: Giliam de Carpentier

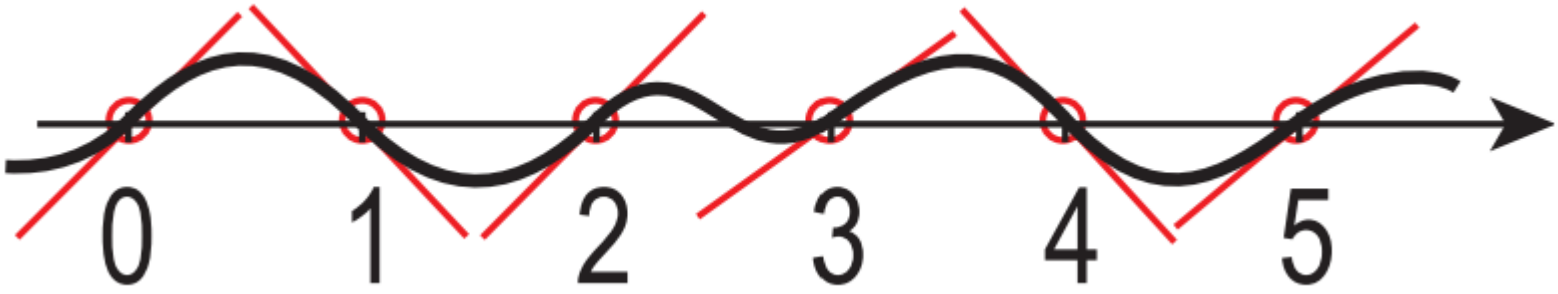

0
1
2
3
4
5

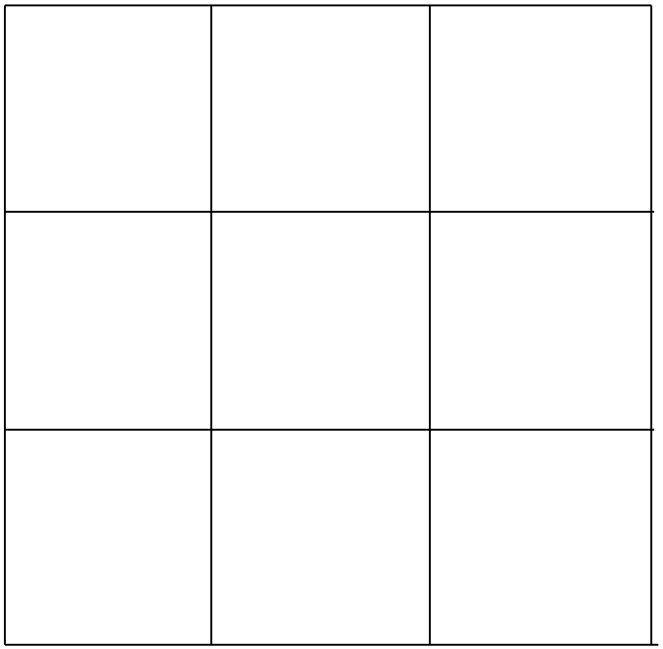

0 (1)
1 (2)
2 (4)
3 (8)
4 (16)
Sum

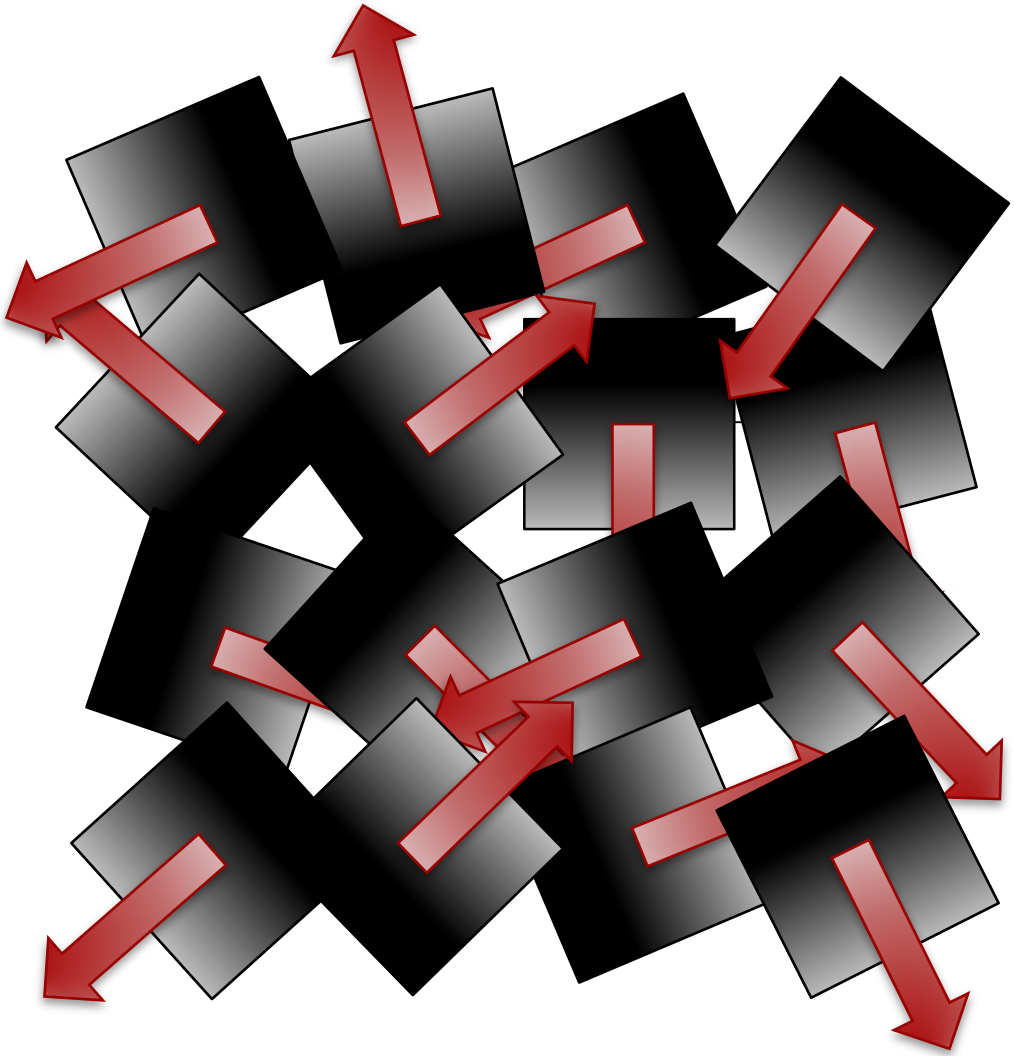
How can this work in Minecraft?

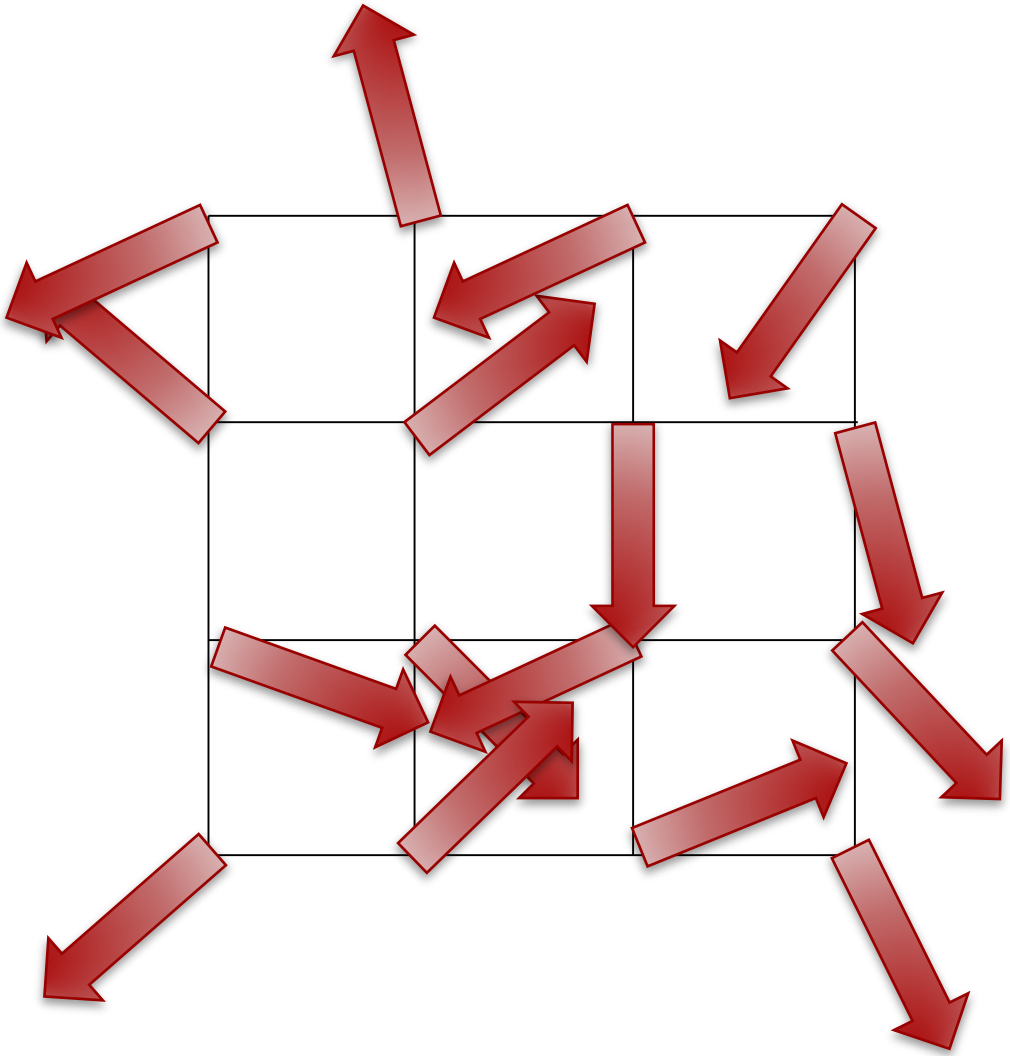
Source: Mojang

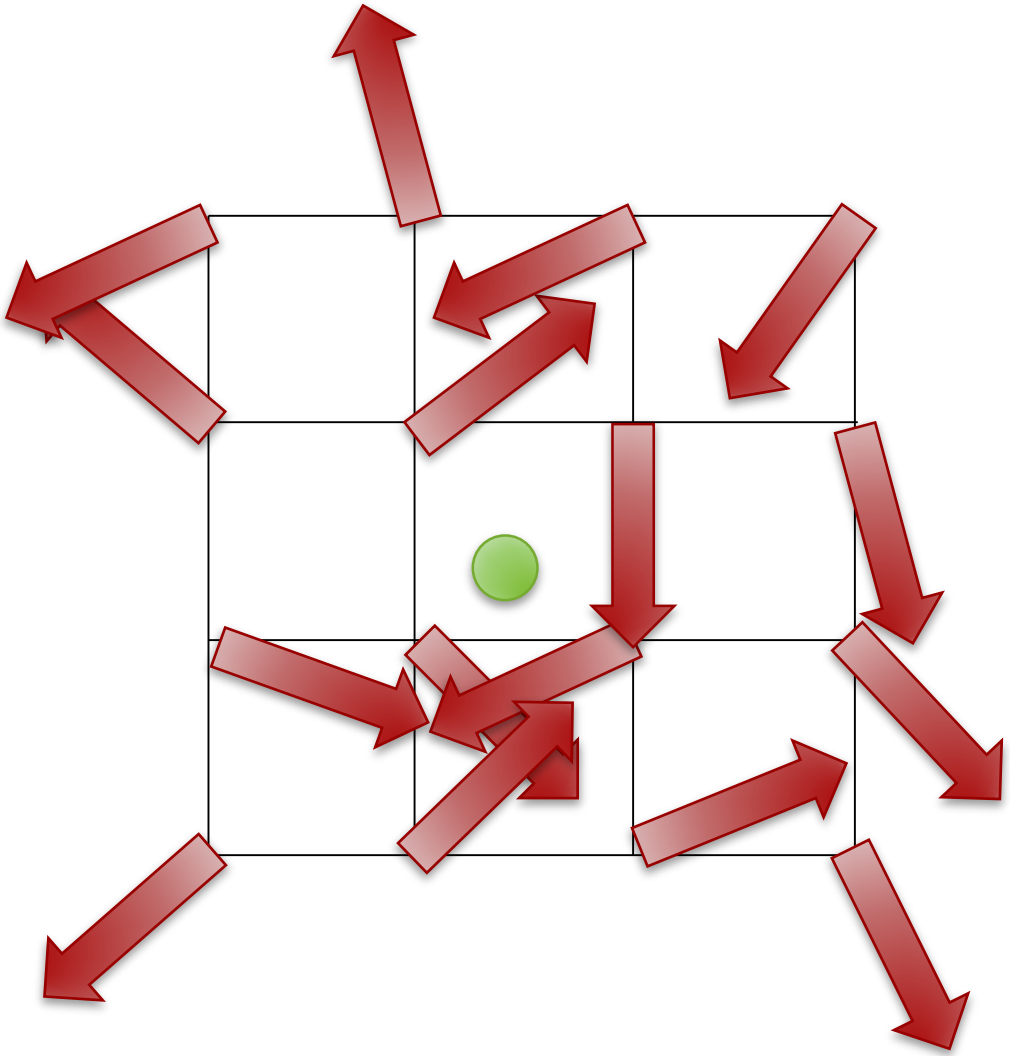
Idea: Do this on a grid

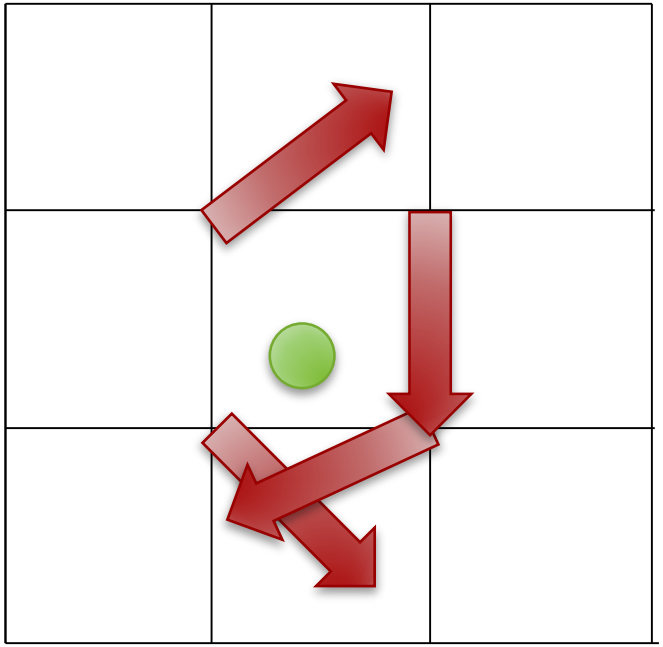


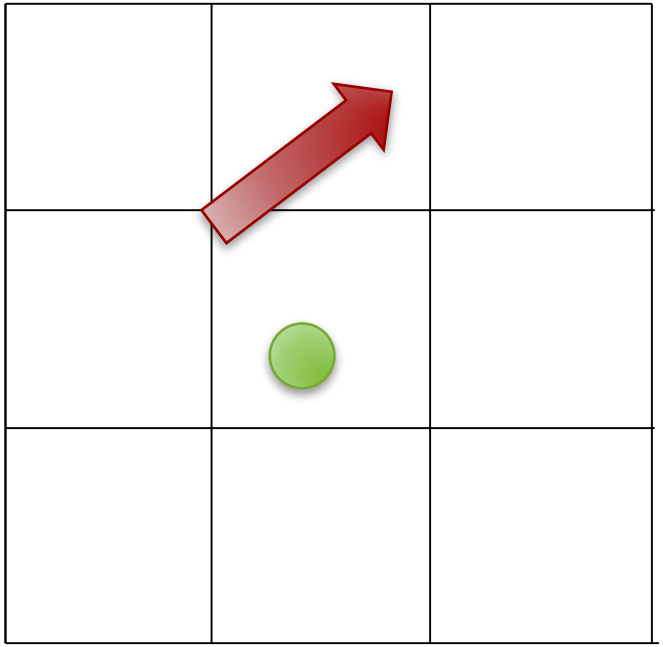


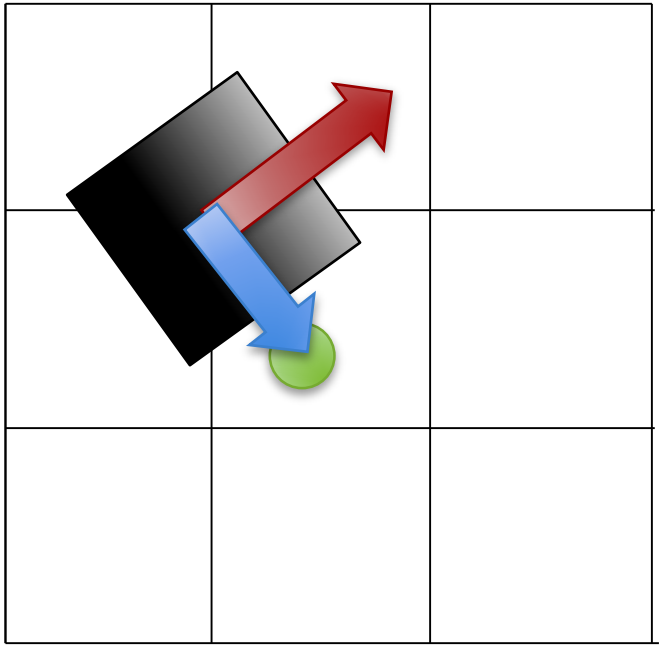


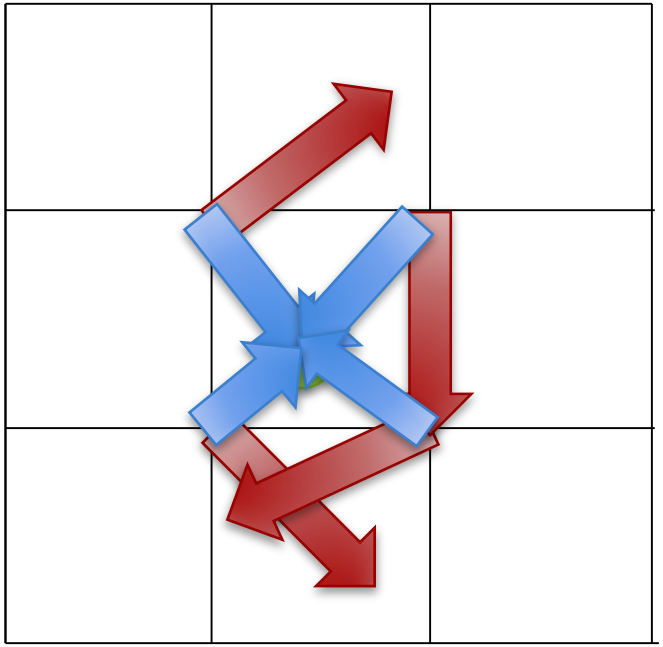


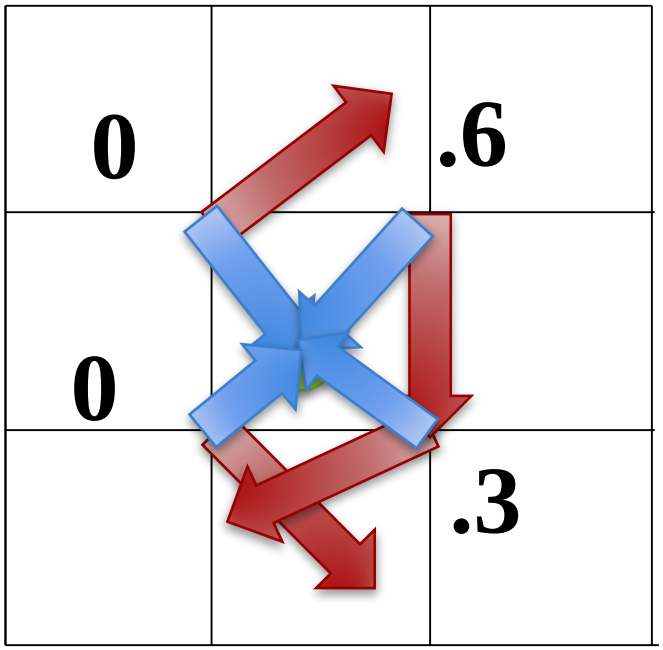


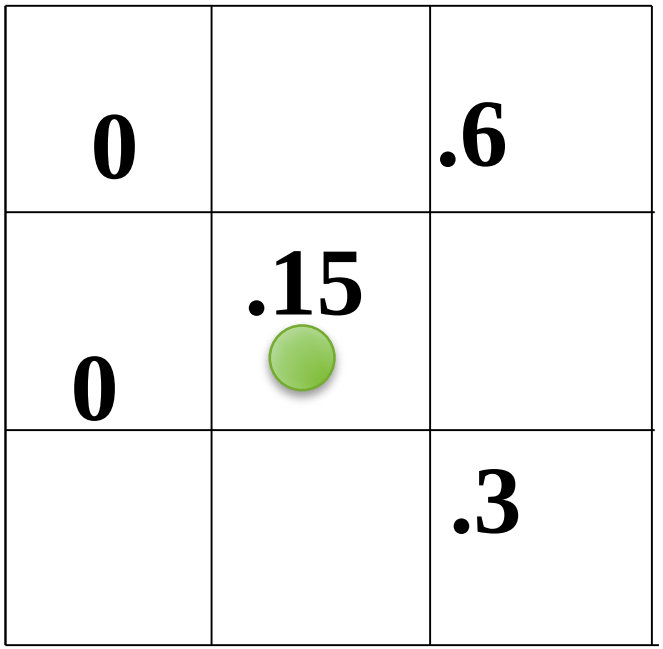









0
.6
0
.3


0
.6
.15
0
.3

Source: http://blog.movingblocks.net/2011/06/11/goodbye-perlin-noise-2d-perlin-noise-3d/

Management of Randomness

more random

Random numbers

Perlin Noise

Grammars

more structured

Grammars

$S \rightarrow a$

a

Grammars

$S \rightarrow a \mid b$

a

b

Grammars

$S \rightarrow Sb \mid a$

S

Sb

Sbb

abb

$S \rightarrow Sb$

$S \rightarrow Sb$

$S \rightarrow Sa$

Grammars

$S \rightarrow Sb \mid a$

a

ab

abb

abbb

Grammars

$S \rightarrow aSc$

$S \rightarrow b$

abc

aabbcc

aaabccc

Grammars

$S \rightarrow X \mid Y$

$X \rightarrow XX \mid ab$

$Y \rightarrow YY \mid bc$

ab

ababab

bcbc

bcbcbcbcbc

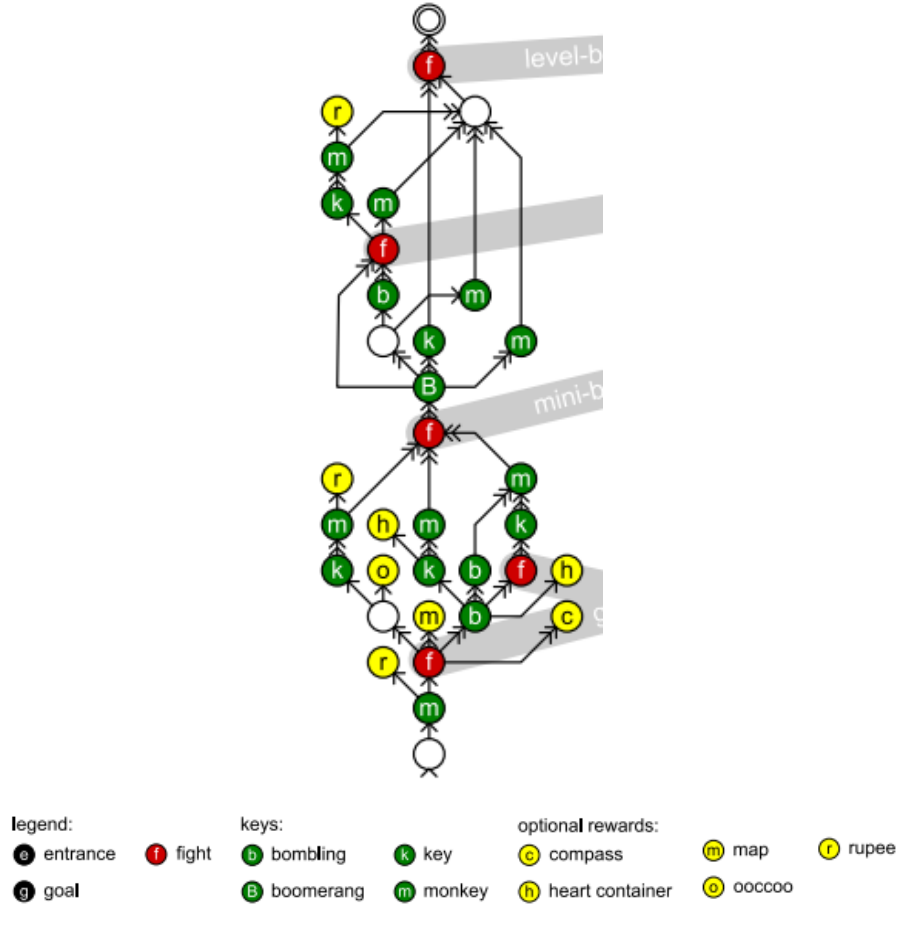
NOT: ababbc

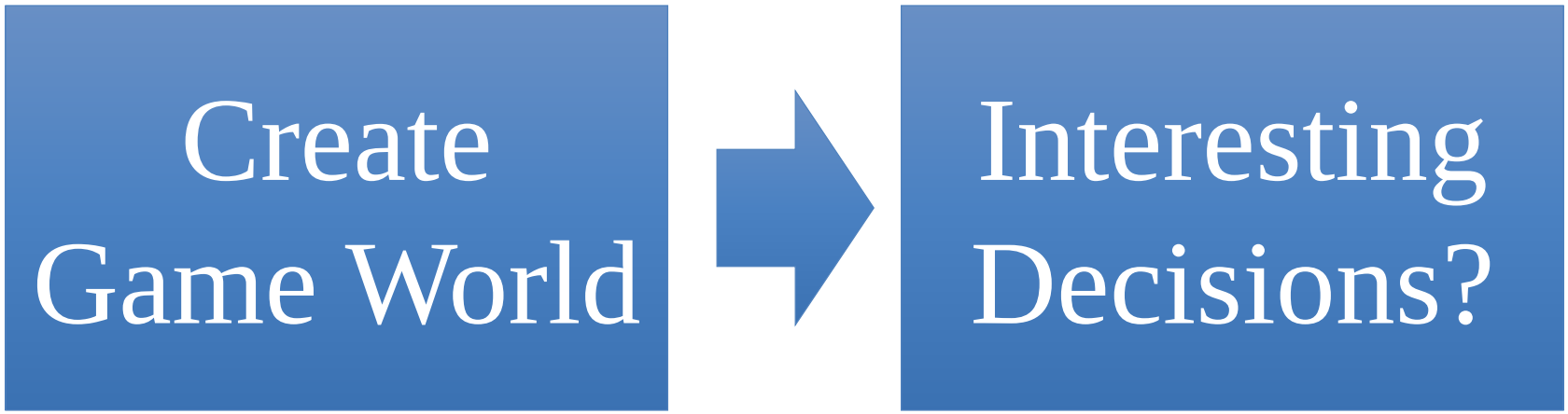
Zelda: Twilight Princess

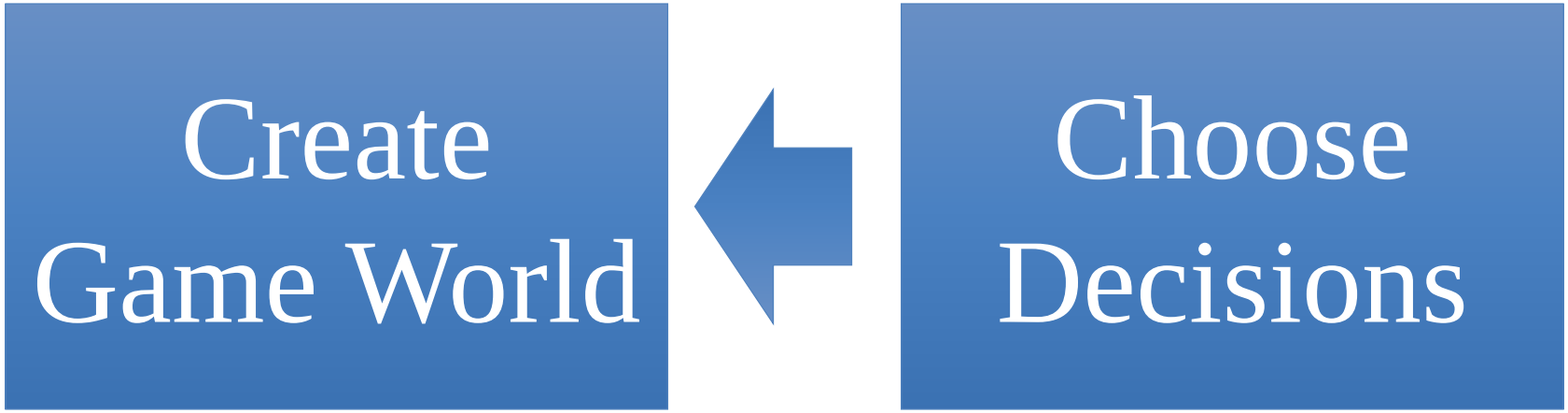
Source: ZorZelda Youtube

Missions

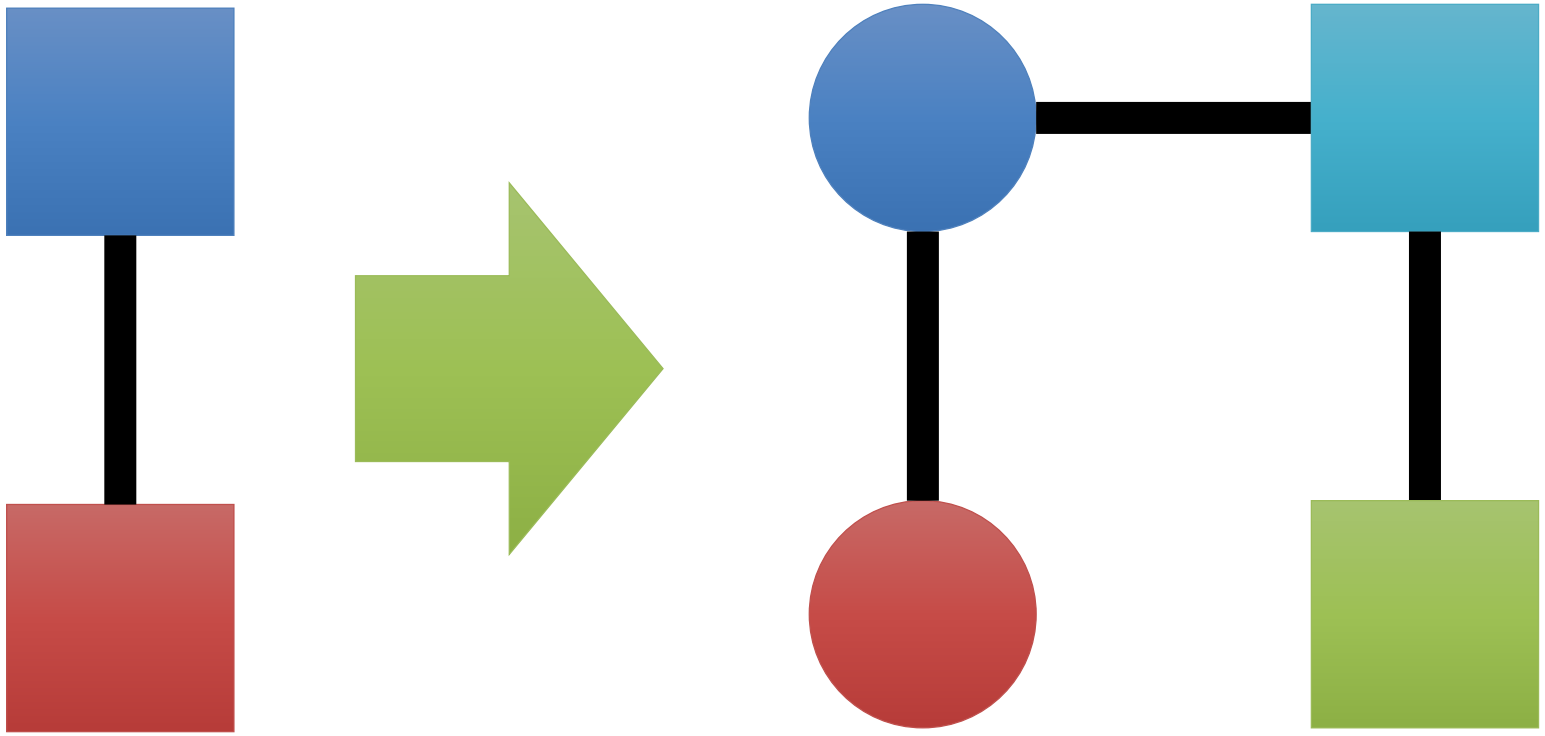

Twilit Parasite—Diababa
Monkey
Monkey
Monkey
Gale Boomerang
Monkey
Monkey
Monkey
Monkey
H-02
H-03
Monkey
Monkey
Entrance
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

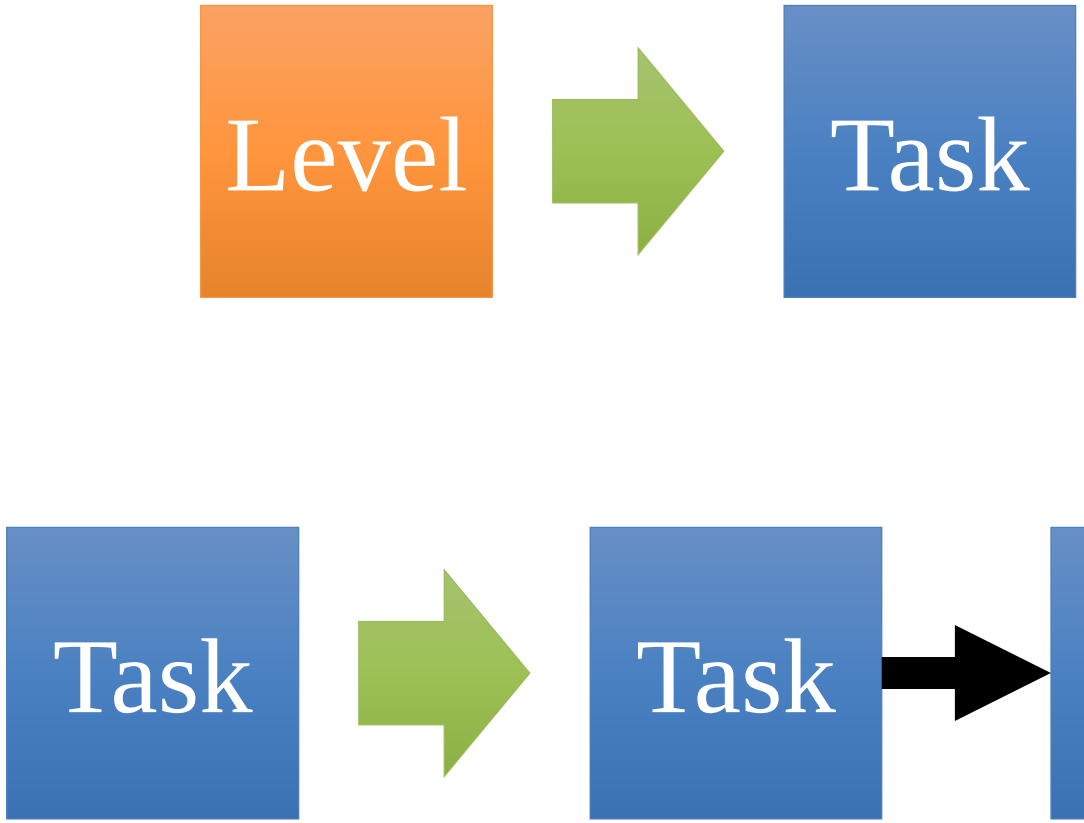

level-b
mini-b
legend:
entrance
fight
goal
keys:
bombling
key
boomerang
monkey
optional rewards:
compass
map
rupee
heart container
ooccoo


Create
Game World
Interesting
Decisions?

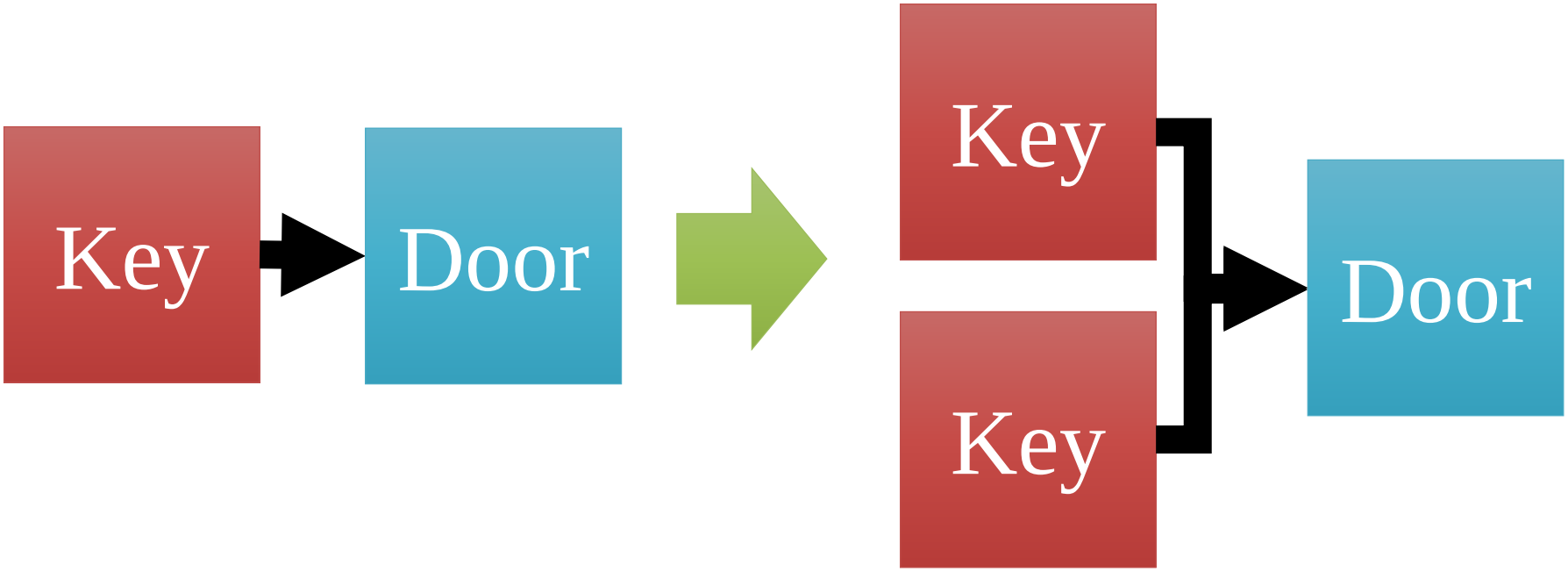

Create
Game World
Choose
Decisions

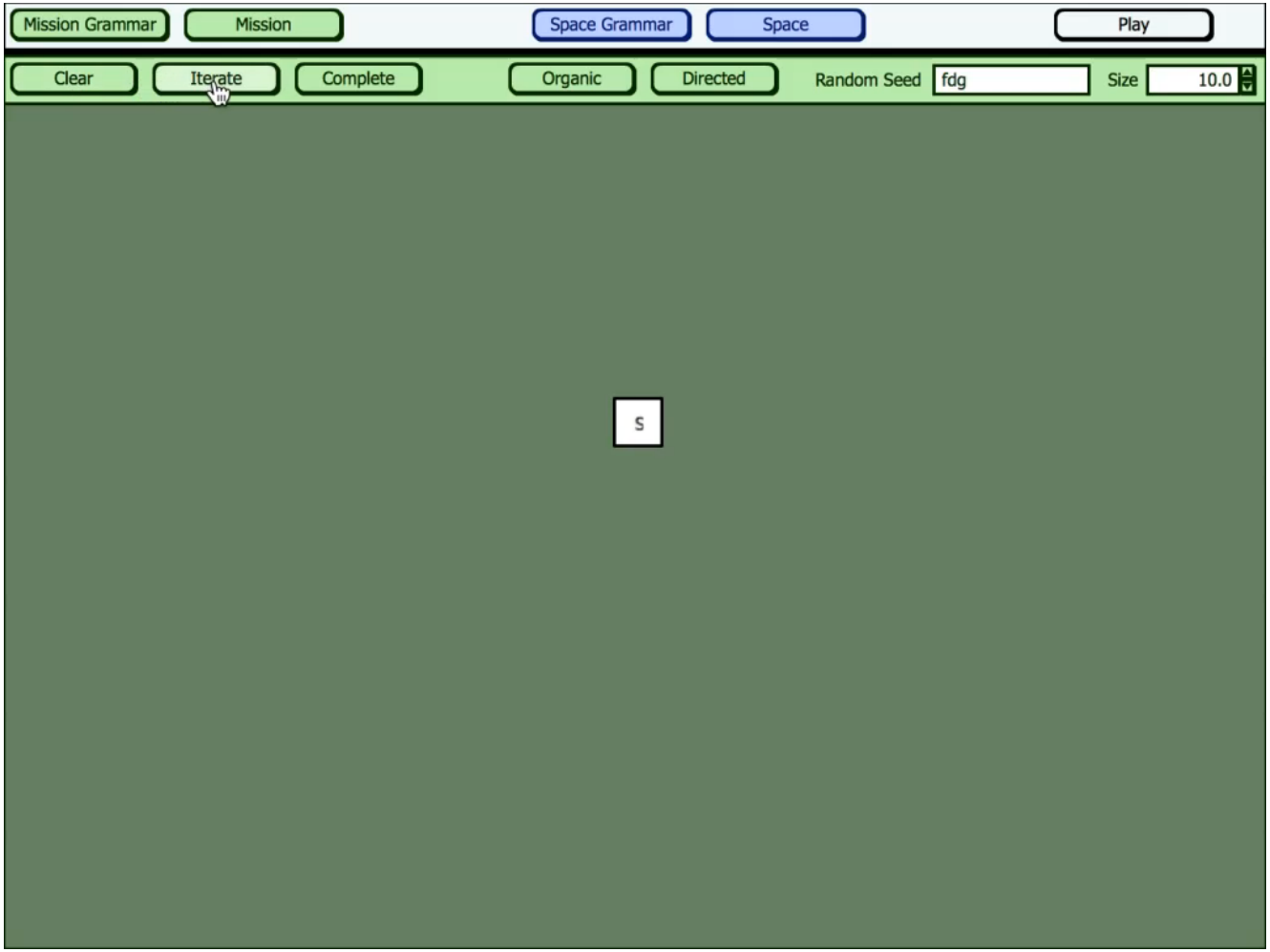
Graph Grammars

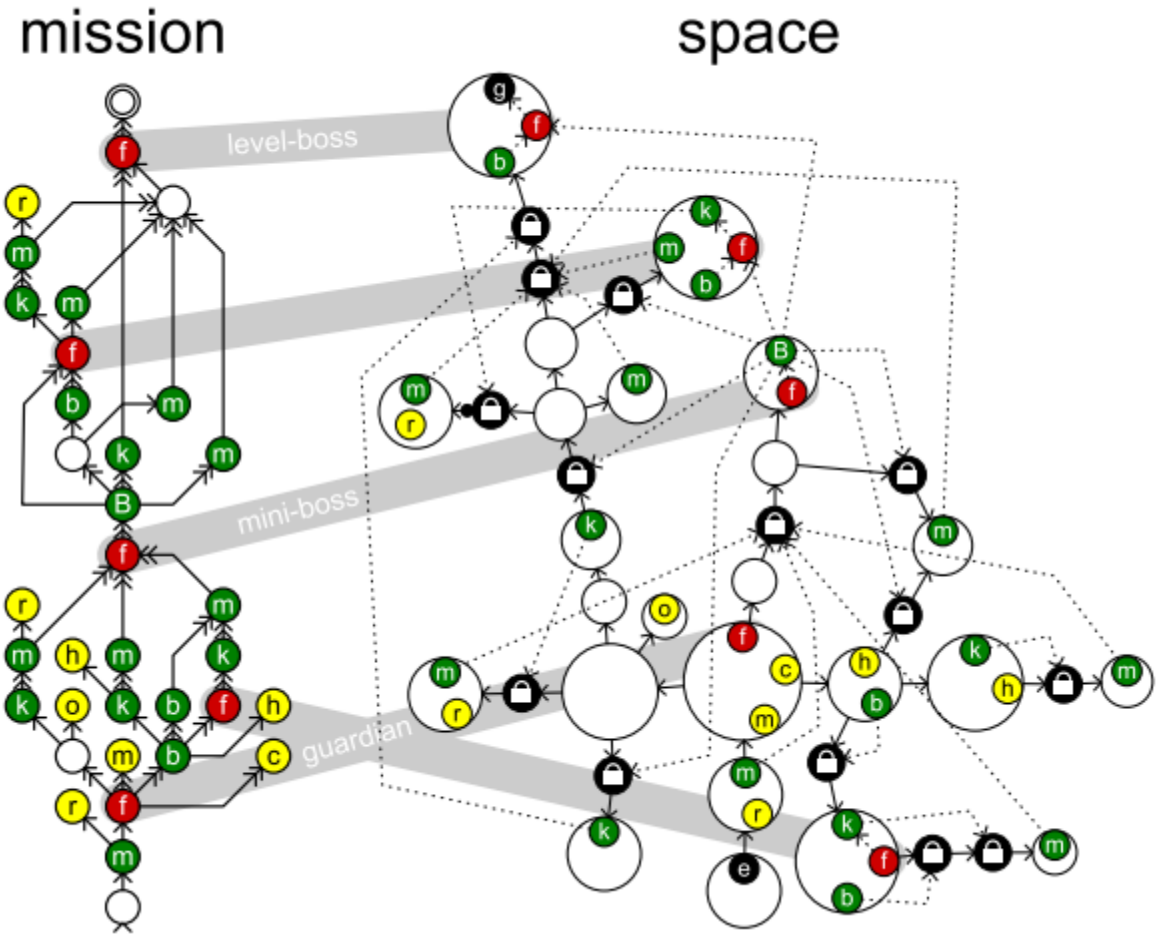



Level
Task
Task
Task
Task

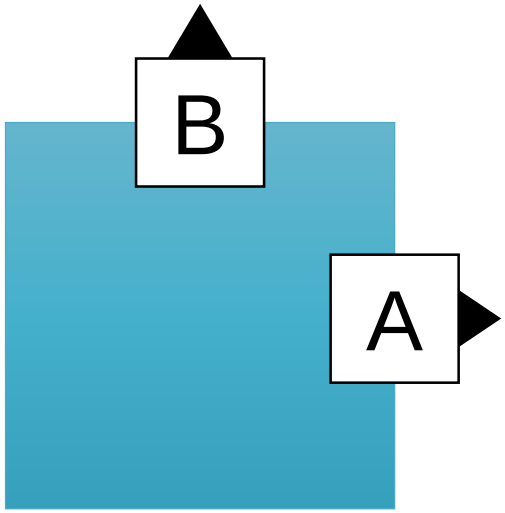

Task
Key
Door


Key
Door
Key
Key
Door

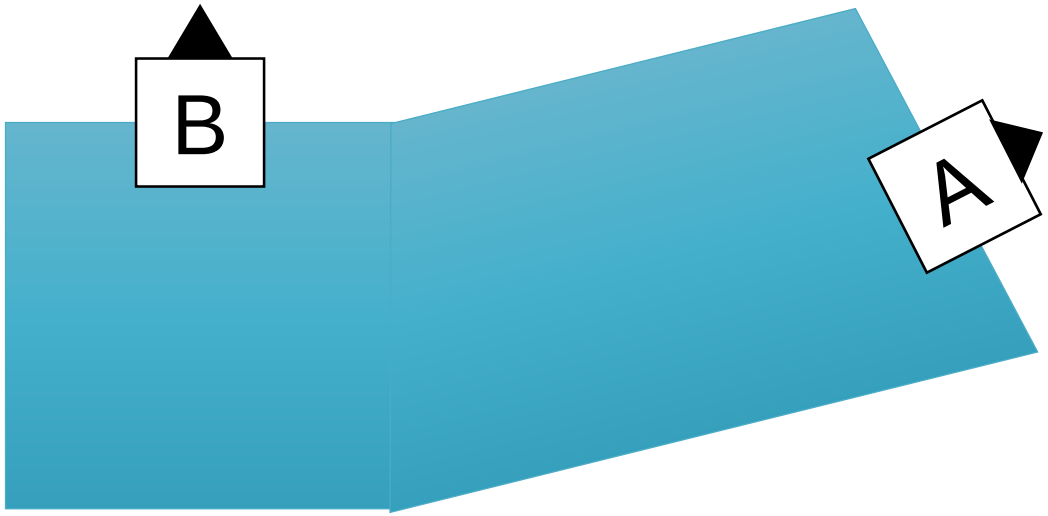

Mission Grammar
Mission
Space Grammar
Space
Play
Clear
Iterate
Complete
Organic
Directed
Random Seed
fdg
Size
10.0
S


mission
space
level-boss
mini-boss
guardian

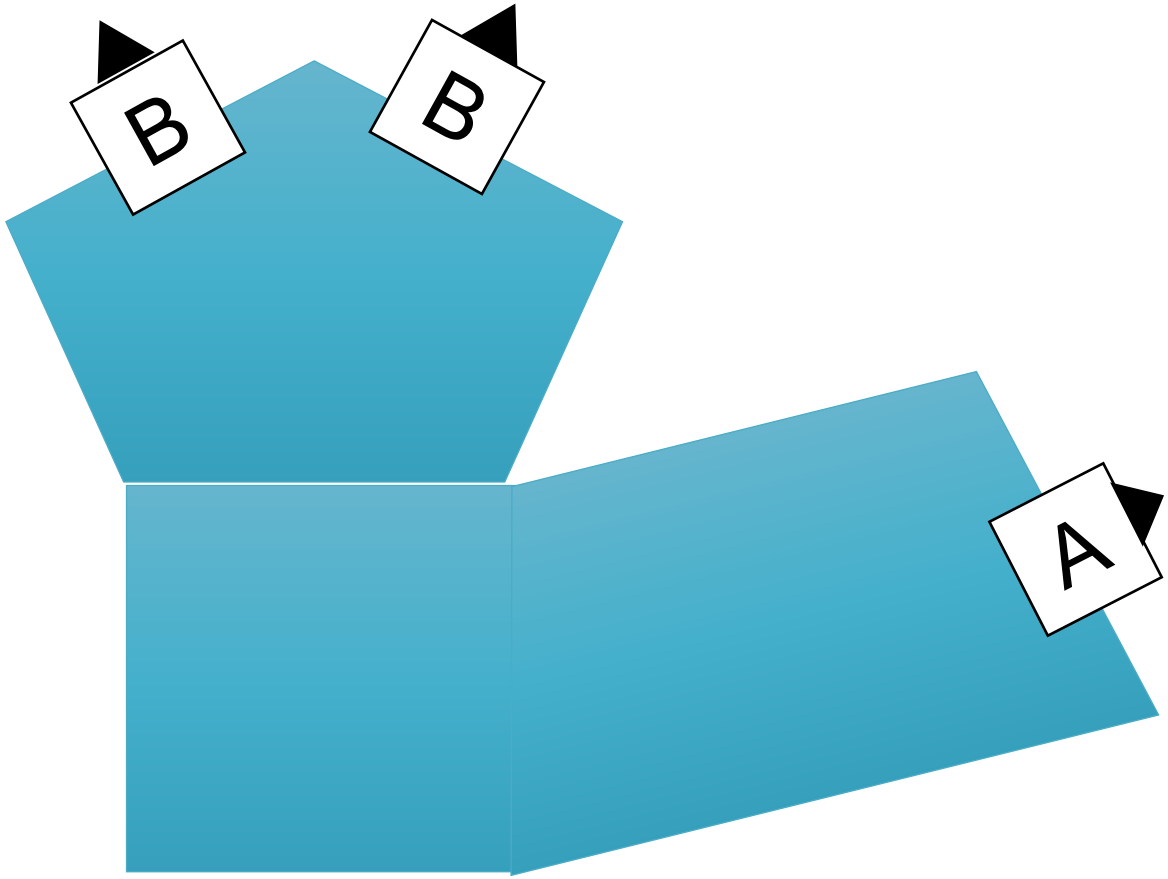
Shape Grammar



Shape Grammar



Shape Grammar




Mission Grammar
Mission
Space Grammar
Space
Play
Clear
Iterate
Complete
Use Mission
Random Seed
fdg
E


Mission Grammar
Mission
Space Grammar
Space
Play

Example: The Triplicates

Management of Randomness

more random

more structured

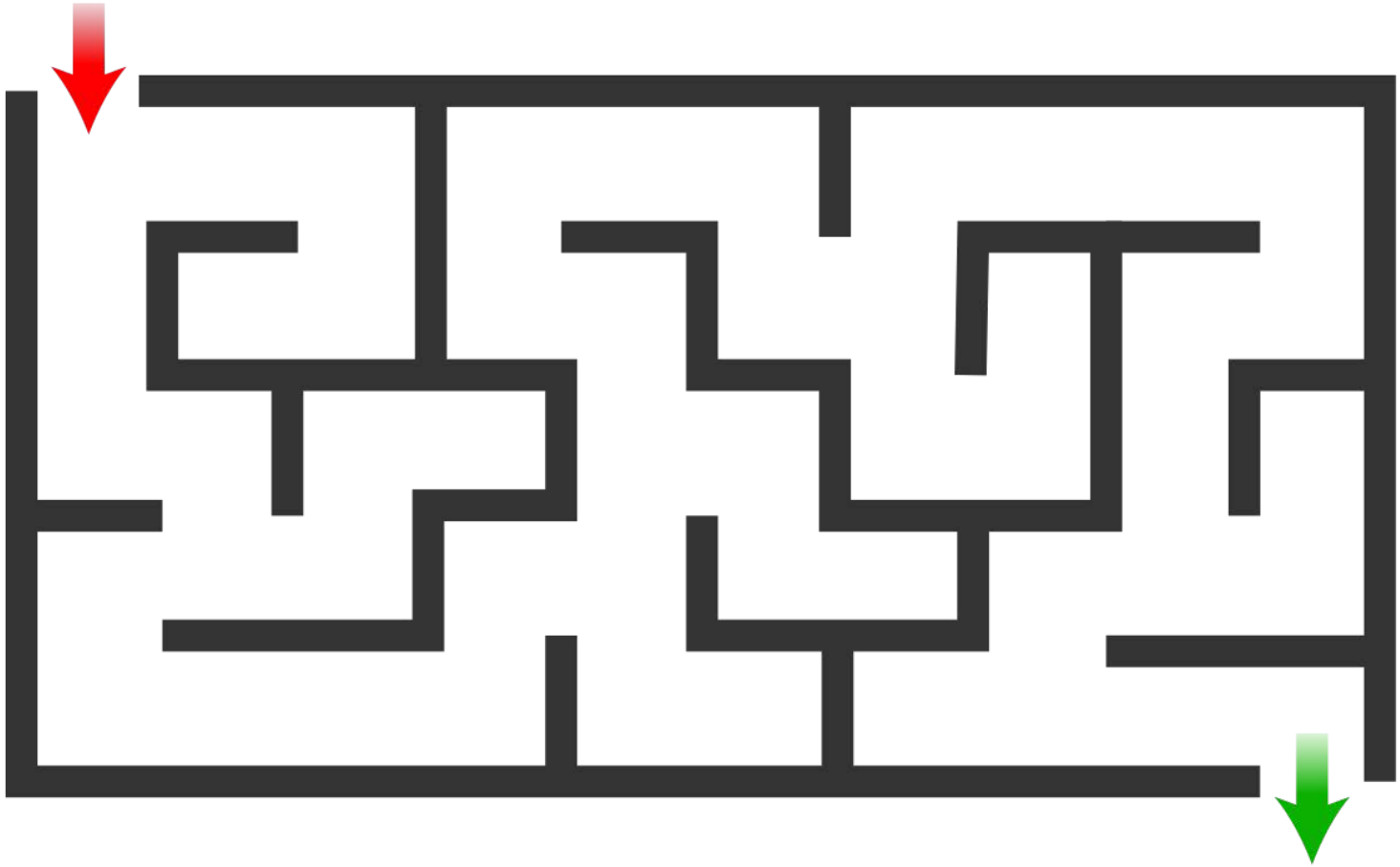
Random numbers

Perlin Noise

Grammars

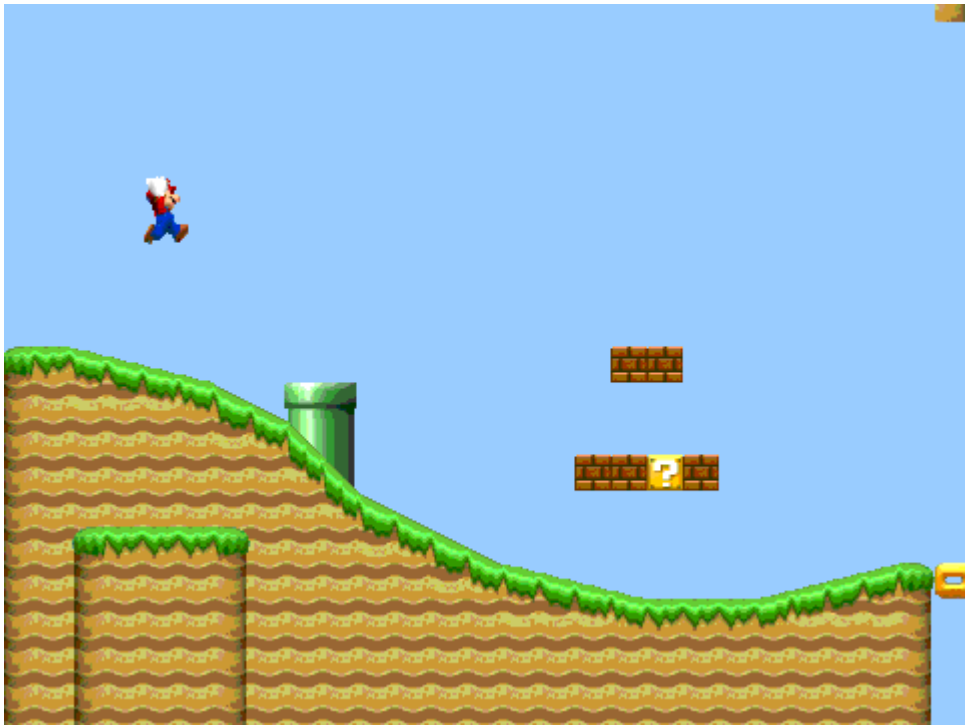
Constraint satisfaction

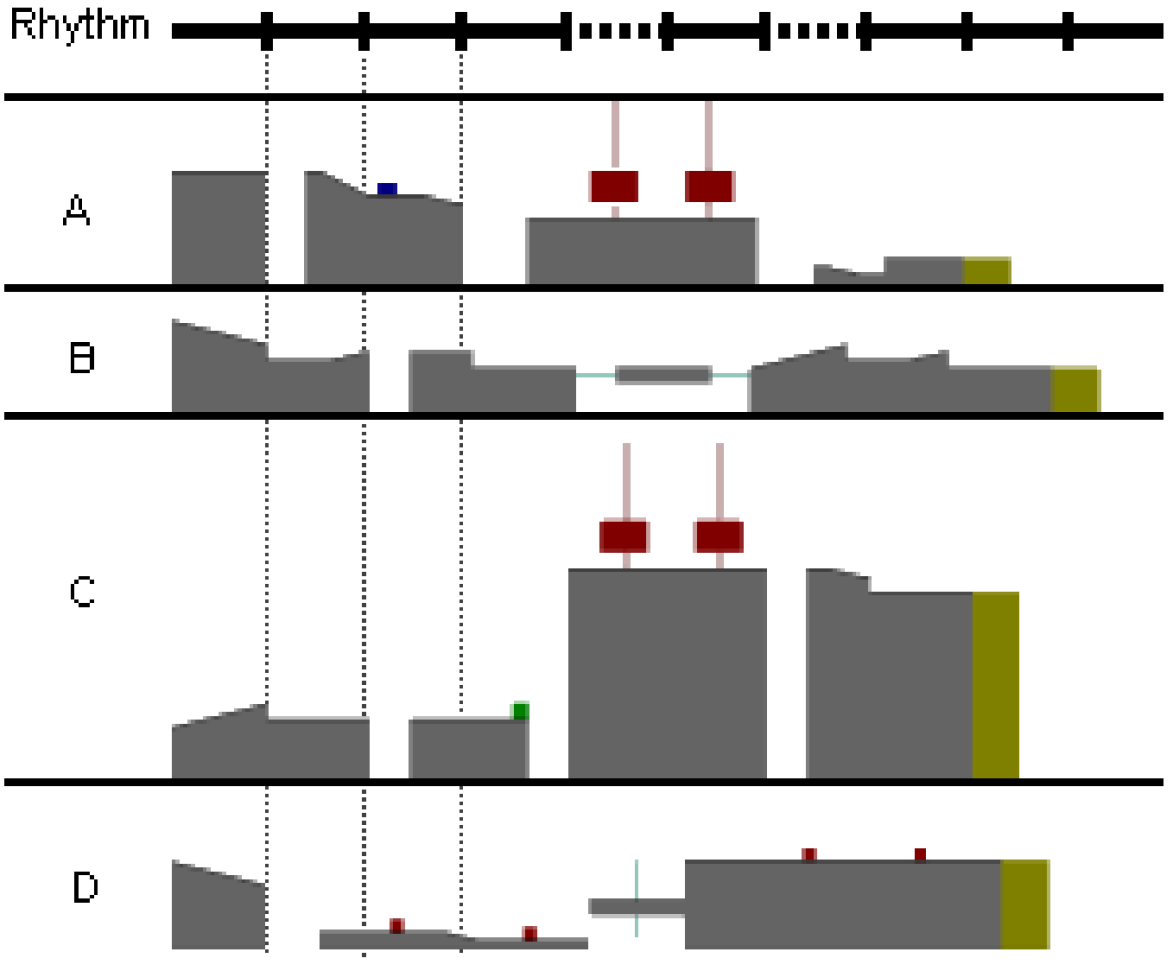
Maze



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




Rhythm
A
B
C
D

Source: Gillian Smith, ***Launchpad***

Management of Randomness

more random

more structured

Random numbers

Perlin Noise

Grammars

Constraint satisfaction

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

Alpha Postmortem Peer Feedback

will be LIKE THIS, not necessarily these questions

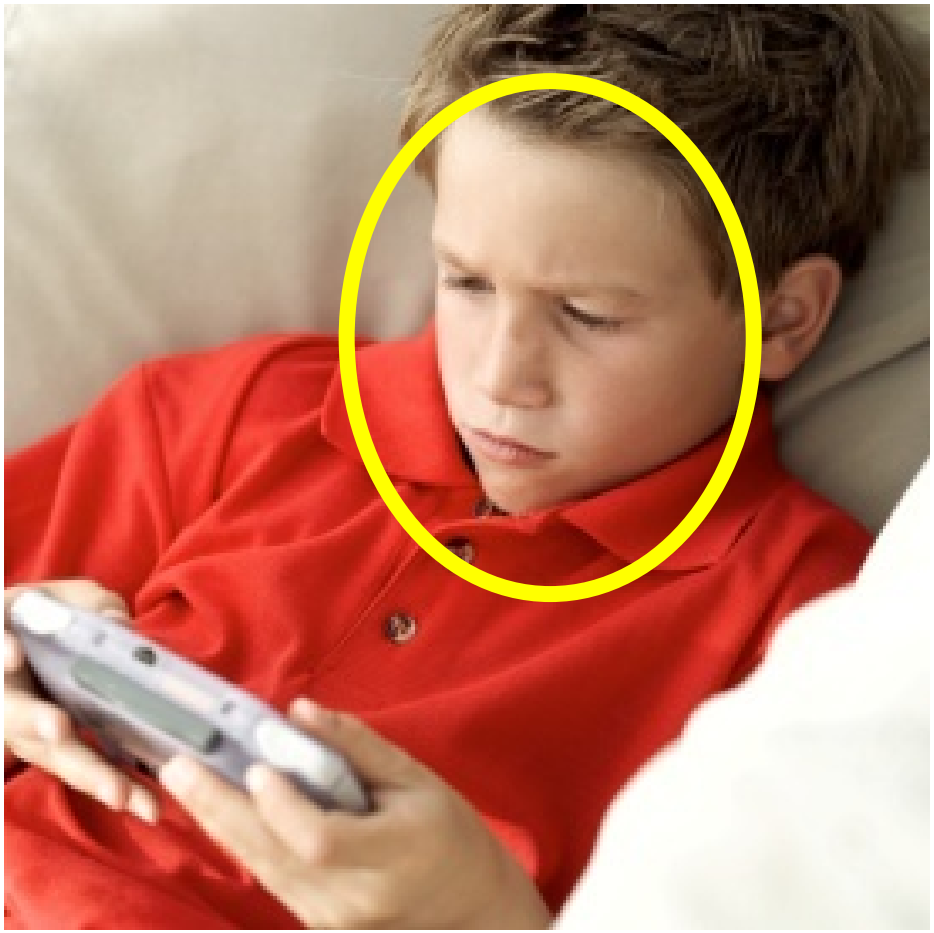
1. What are the two design questions? _____
2. What methods did the team use for the first question? _____
3. What were the results? _____
    1. Are you convinced? YES SORT OF NO
4. What will the team change? _____
    1. Are you convinced this will work?

       YES SORT OF NO

Traditional playtesting methods

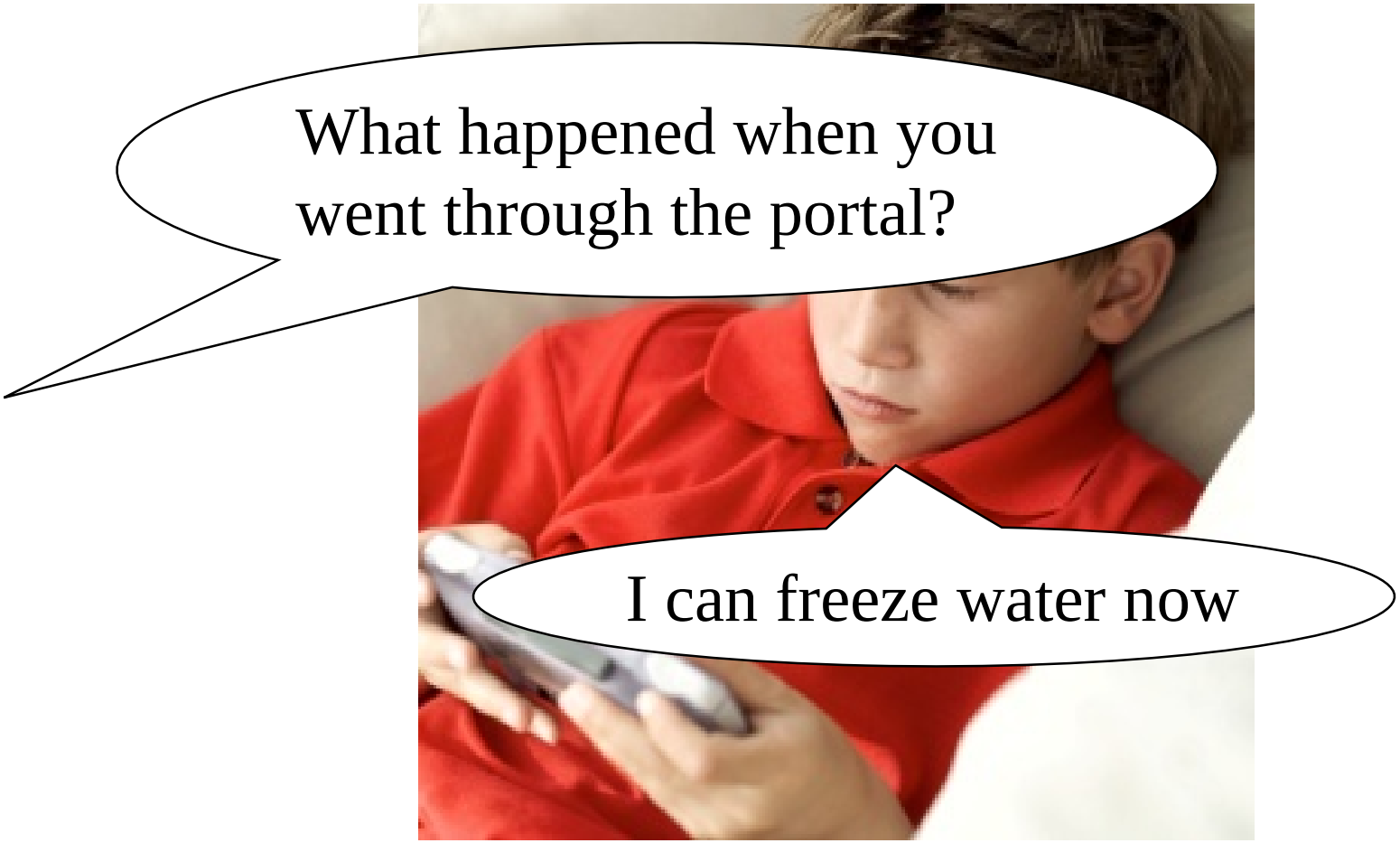
- Direct observation
- Think-alouds
- Q&A
- Surveys

Direct Observation



Think-alouds

Questions and Answers



Survey

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

Deciding where to go	**1**	**2**	**3**	**4**	**5**
Jumping on platforms	**1**	**2**	**3**	**4**	**5**
Defeating enemies	**1**	**2**	**3**	**4**	**5**
Solving puzzles	**1**	**2**	**3**	**4**	**5**
Using the controls	**1**	**2**	**3**	**4**	**5**

More specific survey

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

Freezing	**1**	**2**	**3**	**4**	**5**
Heating	**1**	**2**	**3**	**4**	**5**
Flash Freezing	**1**	**2**	**3**	**4**	**5**
Flash Heating	**1**	**2**	**3**	**4**	**5**

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