

PCG Shotgun:

6 Techniques for Leveraging AI in
Content Generation

Procedurally Generated Shotguns





ARTIFICIAL
INTELLIGENCE
— SUMMIT —

Procedural Character-Based Narratives

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Independent @ The Tiniest Shark



GAME DEVELOPERS CONFERENCE® | FEB 27-MAR 3, 2017 | EXPO: MAR 1-3, 2017 #GDC17

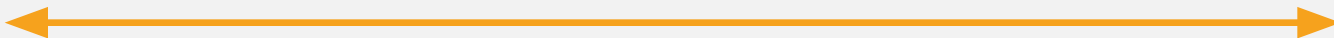


Procedural Character-Based Narratives

Agent-driven stories

VS

Story-driven agents



Agent-driven stories

I TOTALLY HAVE AN OPINION
ON WHAT THEY'RE ALL DOING RIGHT NOW.
SEE HOW I'M NOT TAKING PART?
THAT'S HOW YOU *KNOW*.



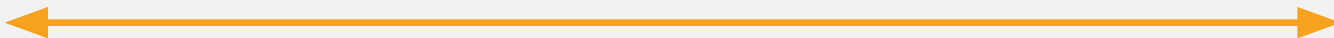
OH, I HAVE SO MANY OPINIONS ON EVERYTHING.
THE MORE YOU TALK TO ME,
THE MORE YOU'LL LEARN ABOUT MY WORLD & MY AGENDA.

Story-driven agents

Agent-driven stories

VS

Story-driven agents



THE
TINIEST SHARK



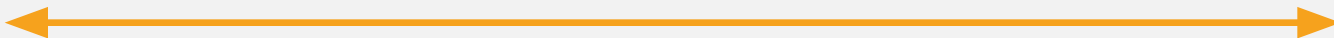


“Because it reduces human behavior into only what’s documented online, Redshirt forces you to treat relationships and hobbies as manipulable, disposable, and only useful as far as they can improve your character’s position.” - IGN Review

Agent-driven stories

VS

Story-driven agents



It's a pleasure to meet you,
anyhow. I've grown tired
of the police chief. What's
your name?

Flag Poor Response

Active Emotions: Calm

INTERVIEW RECORDING: 12:01

Distance: StandingOK / NotTouching
Position: PlayerStandingBehind

Orientation: PlayerFacingToward
Movement: NoSignificantMovement

INTRO COMPLETE

Microphone
Inactive.

Build #2017.02.14
Spirit AI Confidential

PROC GEN CONSIDERATIONS FOR AGENT-DRIVEN STORIES VS. STORY-DRIVEN AGENTS

- Writers vs. AI programmers/technical designers
- Human social models = communicated through language

NARRATIVIZING AGENT BEHAVIOURS



PROCEDURAL CHARACTERS NEED TO BE EXPRESSIVE ABOUT THEIR WORLD



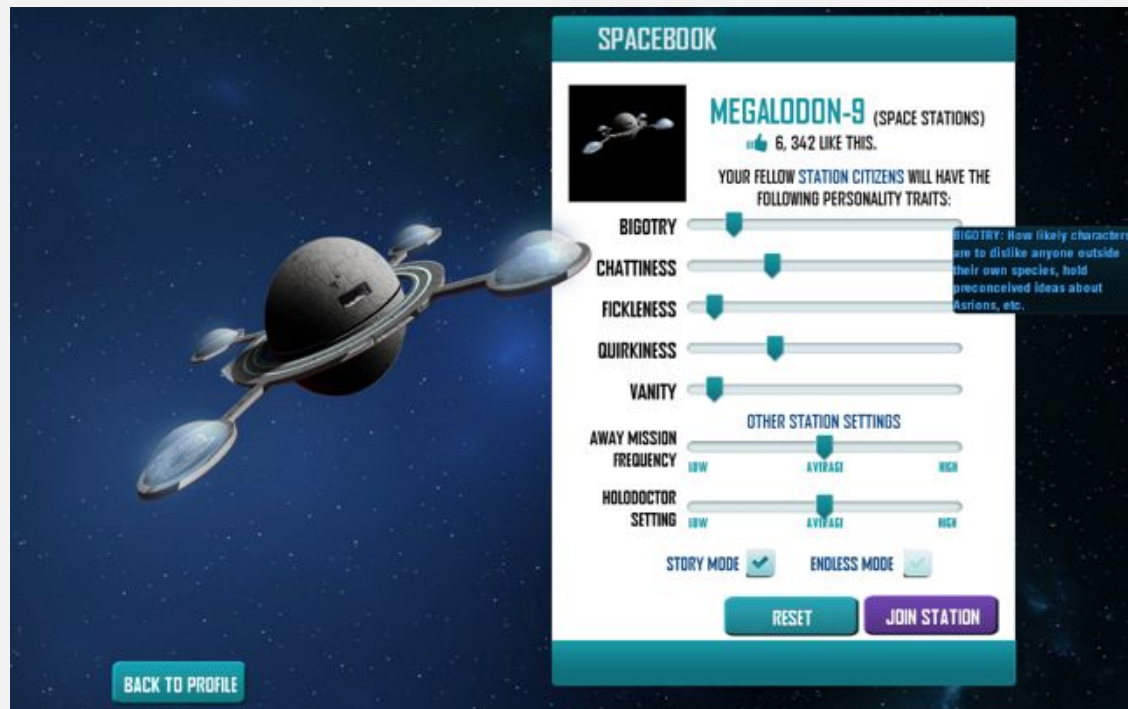
- In Redshirt, easier problem - the world space was other characters and their states.
- Procedural characters in a kind of vacuum.
 - (haha, vacuum, space, get it?)

PROCEDURAL CHARACTERS NEED TO BE EXPRESSIVE ABOUT THEIR WORLD



- NPC AI plus a query system, inspired by Left 4 Dead - “piles of state”
 - NPCs react to changes in game state according to sets of rules.
 - NPCs respond by saying something (preauthored) *and/or* (new) acting accordingly

CHARACTER CREATION AS A TOOL FOR EXPLAINING



CHARACTER CREATION AS A TOOL FOR EXPLAINING

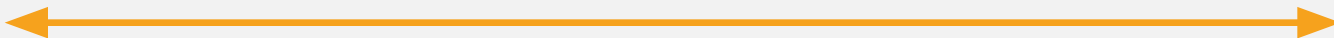


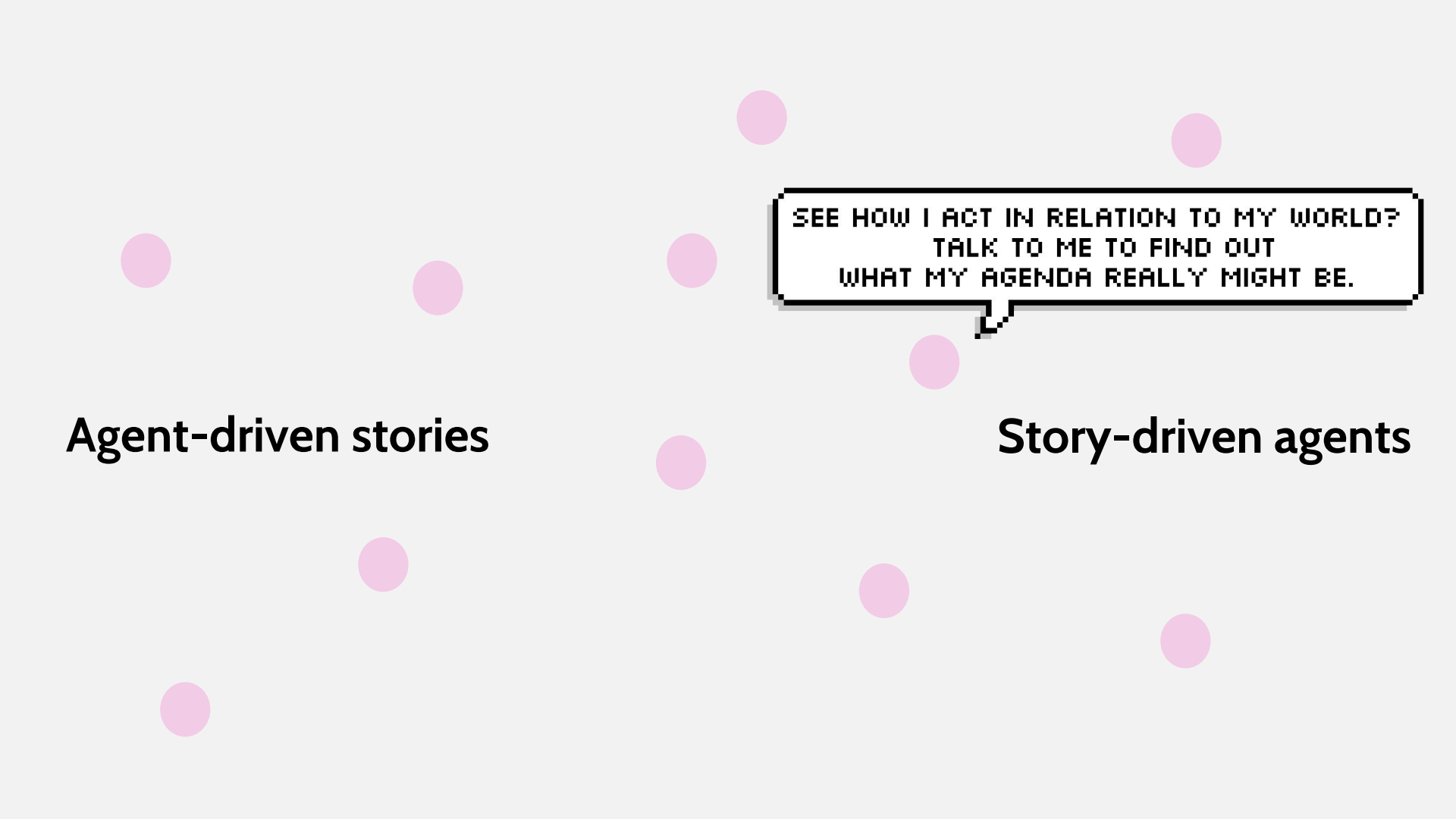
+

Agent-driven stories

VS

Story-driven agents





Agent-driven stories

SEE HOW I ACT IN RELATION TO MY WORLD?
TALK TO ME TO FIND OUT
WHAT MY AGENDA REALLY MIGHT BE.

Story-driven agents



THE
TINIEST SHARK

@Mituk



**Come see us in North
Hall tomorrow!**

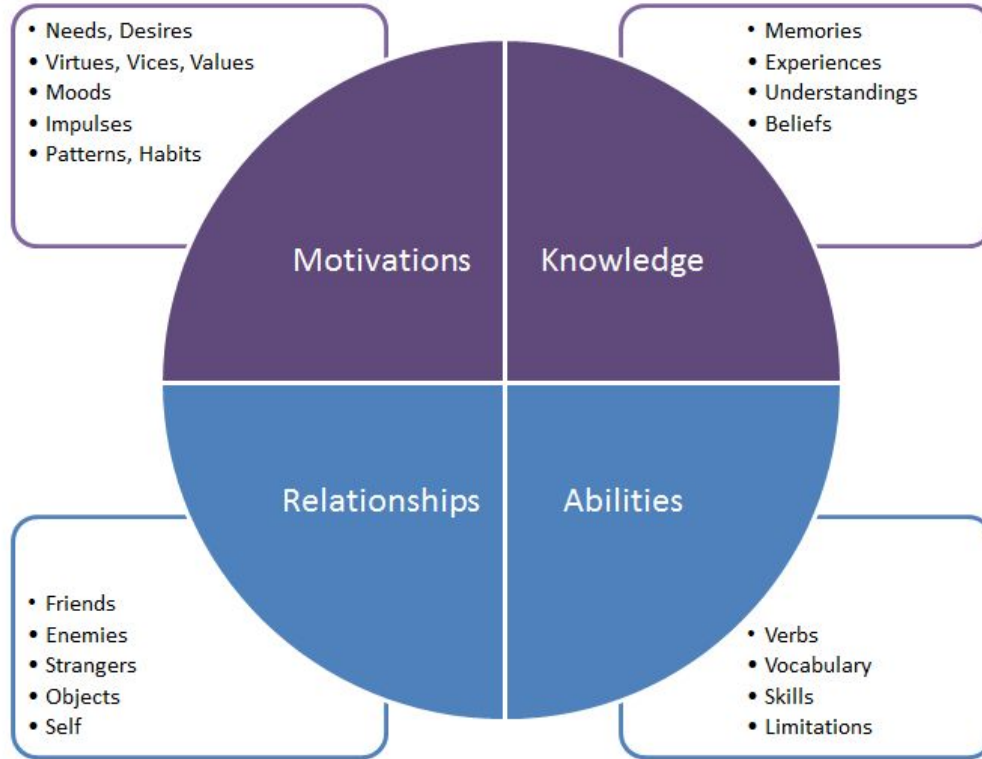
Maximizing the Impact of Generated Personalities

Tanya X. Short

Captain of Kitfox Games

@tanyaxshort

REASONING



BEHAVIOUR

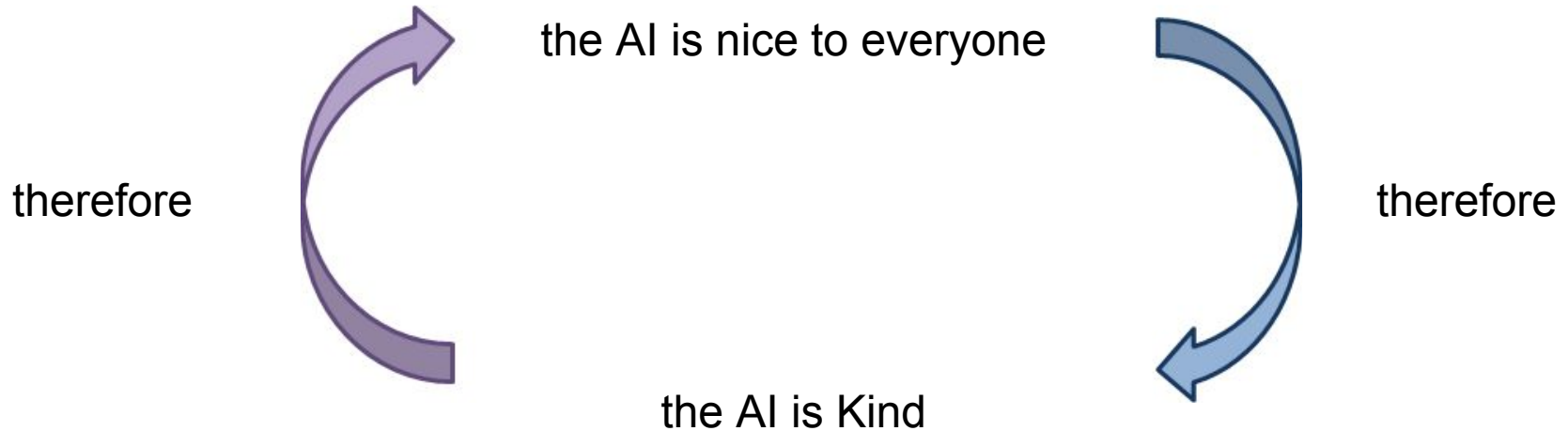
Which came first, the reasoning or the behaviour?

The AI is nice to everyone,
therefore
the AI is Kind.

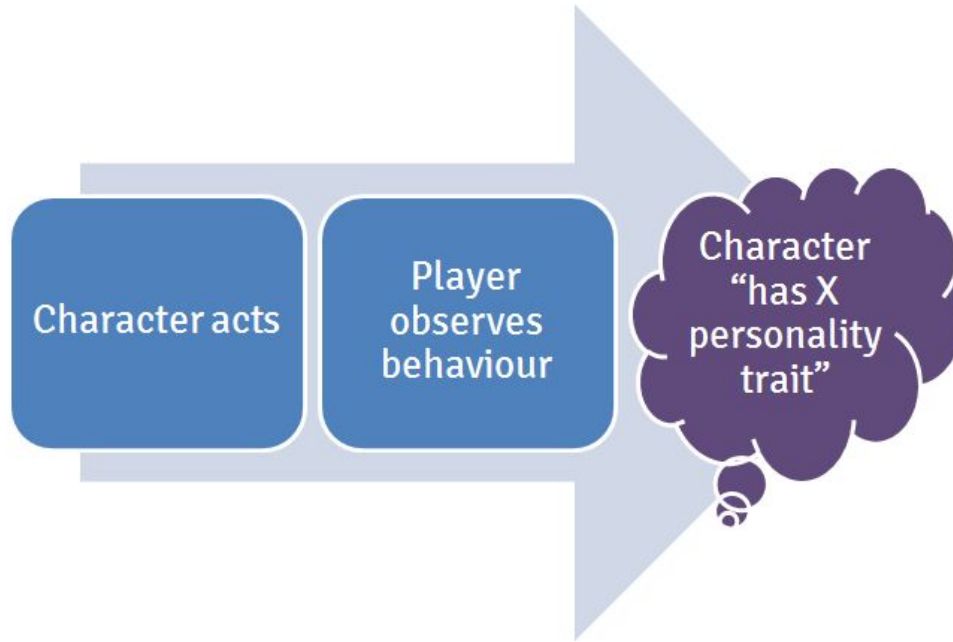


The AI is Kind
therefore
the AI is nice to everyone.

From the player perspective?

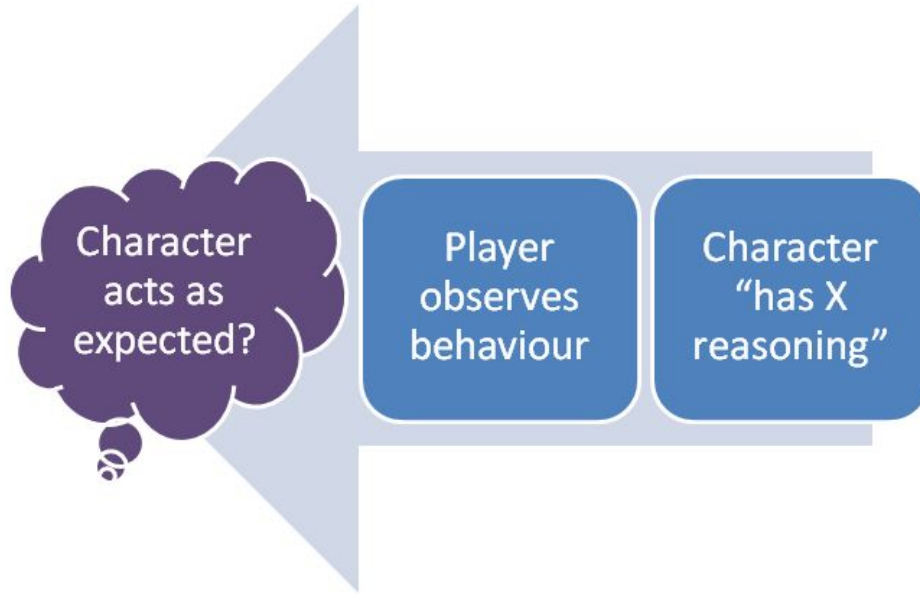


Behaviour First



"getting to know" a character
a.k.a. "Show don't tell"

Reasoning First



Procedural content = exploring the rules
a.k.a. "it's not random, I swear"

Unib Erushbisek, "Unib Handleveil", Peasant

Unib Erushbisek has been quite content lately.

He is seventy-four years old, born on the 20th of Sandstone in the year 65.

He is very fat. His very long sideburns are braided. His very long moustache is arranged in double braids. His medium-length beard is neatly combed. His hair is clean-shaven. His protruding gold eyes are very round. He has a grating, raspy voice. His upturned nose is extremely long. His teeth are widely-spaced. His somewhat splayed out ears have nearly fused lobes. His nose bridge is convex. His skin is peach.

He is strong, quite durable, quick to tire and very slow to heal.

Unib Erushbisek likes black bronze, olivine and olivine.

He has poor creativity, great intuition, a good memory and a little difficulty with words.

He is often nervous. He rarely feels discouraged. He can handle stress.

He is very active. He can be very happy and optimistic. He likes to try new things. He is not straightforward when dealing with others. He often gives

his knuckles a good crack when he's thinking hard. He needs alcohol to get through the working day. He likes working outdoors and grumbles only mildly

at inclement weather.

1. Personalities are Already Subtle

- Personalities take time & effort



Blessed news! The heavens smile upon local Admiral Strom and his loyal Red Hand! Another Resistance member has confessed information under question...

If a tree falls in the forest but players don't know the tree exists...



FREDERICK BARBAROSSA
GERMAN EMPIRE

Send Delegation
Costs 25  Gold

Make Deal

INTEL REPORT

Gossip Items: No New Items

Access Level: None

Our Relationship:  Declared Friend

Agreements: 

Agendas: Iron Crown
1 Hidden agenda

Government: Chiefdom

Relationships:  ?

OUR RELATIONSHIP



RELATIONSHIP
DECLARED FRIEND

REASONS FOR CURRENT
RELATIONSHIP

9 Unknown Reason

3 Unknown Reason

12 Unknown Reason



The Gathering Convenes...
Who will be the Sacrifice this Season?



VASILISA KEGNNI

??????

♣️♥️Complacent



SVANTE IOSEFKA

♠️♠️Stoic

♣️♥️Complacent



SVETLANA CADWELL

♠️♠️Honest

??????



SAGAN EFFERSON

??????

♣️♥️Complacent



YAROMIR BLACKBORN

??????

??????

THE
SHROUDED ISLE

1. Personalities are Already Subtle

- Personalities take time & effort → beware hiding systems *too* well
- Subtle behaviour patterns are risky



Duchess Matheode of Aquitaine

40



Liege

-57

12

Bontemps



Husband

-57

Duchess Matheode's opinion of Duke Guilhèm VIII: -57

----- Report in Bordeaux,

Personal Diplomacy: +9

Scheming Bastard: -50

Short Reign: -16

Patient vs Wroth: -10

Prestige: +5

Fabulous Feast: +5

19.6

31.7

14.5

0.0

Titles:



1. Personalities are Already Subtle

- Personalities take time & effort → beware hiding systems *too* well
- Subtle behaviour patterns are risky → beware “normal” personalities
- Passivity is hard to see





Barntadus
Big horns, big fun!

Cows: 779

Goods: 126



1. Personalities are Already Subtle

- Personalities take time & effort → beware hiding systems *too* well
- Subtle behaviour patterns are risky → beware “normal” personalities
- Passivity is hard to see → beware avoidant traits

2. Comedy is Close at Hand



2. Comedy is Close at Hand



2. Comedy is Close at Hand

The screenshot shows the Prison Architect game interface. On the left is a 'Todo list 3/16' with tasks like 'Read the CEO's letter', 'Incident Reports', 'Prisoner Intake', 'Visitors', 'Staff Exhausted', 'Education Reform Program', 'Carpentry Apprenticeship Program', 'Cell Block D', and 'Feed all Prisoners'. The main area shows a top-down view of a prison with various buildings and prisoners. A prisoner named 'Newell' is highlighted with a green circle. On the right is a detailed profile for 'Gabe "Gaben" Newell'.

Prisoner Profile: Gabe "Gaben" Newell

Category: Normal Security
Age: 37

Search Prisoner
Search Cell
Search Cell Block
Punish

Biography

Sentenced 5 years for not releasing 'Half Life 3'.

Sentenced to 1 years for multiple crimes including DrivingUnderInfluence, PossessionIntentToSupply, and DrivingUnderInfluence.

Family: Mother(65)

Convictions

Crime	Term	Status
DrivingUnderInfluence	1 years (Plea Not guilty)	
PossessionIntentToSupply	7 years (Plea Not guilty)	
DrivingUnderInfluence	2 years (Plea Not guilty)	
DeathByDangerousDriving	9 years (Plea Not guilty)	Served
Robbery	6 years (Plea Not guilty)	Served

Needs

Need	Status
Bladder	
Bowels	
Sleep	
Food	
HYGIENE	
Clothing	
Exercise	
FREEDOM	
FAMILY	
RECREATION	

Today: Escort Prisoner to Cell

Served 0.7 years **10 years**

2. Comedy is Close at Hand



3. Reactions $\geq$ Actions



3. Reactions >= Actions

The screenshot displays a game interface with a dark blue background. On the left, a 'CAREER MANAGEMENT' panel shows the current job as 'TRANSPORTER ACCIDENT CLEANUP SUPERVISOR' with '0 OF 350 XP' and 'NOT YET MASTERED'. It lists benefits: 'KARMACREDS: +100', 'SKILL: REASSURING VOICE: +10', and 'SKILL: TEDIOUS PAPERWORK: +10'. Below this is a section to 'MANAGE YOUR STATION CAREER' with an 'OPEN CAREER TREE' button. The main area on the right shows a character in a red jumpsuit in a futuristic setting. At the top right, there are buttons for 'PERSONAL LOG', 'SAVE', and 'QUIT', and a date/time display 'MONDAY 21 OCT 2363'. A social interaction notification states 'YOU ARE IN A RELATIONSHIP WITH LAD PAVONO' and 'YOU HAVE INTERACTED TODAY.' Below this is a 'SOCIAL MAP' button. A red circle highlights a list of social interactions: 'ASTRA: ---15 (JEALOUS OF YOUR PROMOTION)', 'SESKA DYAR: ---15 (JEALOUS OF YOUR PROMOTION)', and 'BRADY HIDE: ---15 (JEALOUS OF YOUR PROMOTION)'. At the bottom, there are buttons for 'TRASHA YOOD' and 'MAINTENANCE DROIDS'.

CAREER MANAGEMENT

YOUR CURRENT JOB
TRANSPORTER ACCIDENT CLEANUP SUPERVISOR

0 OF 350 XP NOT YET MASTERED

BENEFITS THIS IS A RANK 0 JOB.
KARMACREDS: +100
SKILL: REASSURING VOICE: +10
SKILL: TEDIOUS PAPERWORK: +10

MANAGE YOUR STATION CAREER:
OPEN CAREER TREE

USE THE CAREER TREE TO APPLY FOR A NEW JOB, AND TO PLAN YOUR ILLUSTRIOUS FUTURE ABOARD THE STATION.

"MONDAY"
21 OCT 2363

PERSONAL LOG SAVE QUIT

YOU ARE IN A RELATIONSHIP WITH
LAD PAVONO
YOU HAVE INTERACTED TODAY.
SOCIAL MAP

ASTRA: ---15 (JEALOUS OF YOUR PROMOTION)
SESKA DYAR: ---15 (JEALOUS OF YOUR PROMOTION)
BRADY HIDE: ---15 (JEALOUS OF YOUR PROMOTION)

TRASHA YOOD
IS RECOMMENDED FOR MAINTENANCE DROIDS.

2 ACTIONS
BUY
PRESS
CAREER
CHARISMA

4. Change it Up



Your emissaries approach the Varmandi clan, known for its martial fervor, and for a history of mad chieftains. Mad-Blood Orlgandi says, "How do I know this is not a trick? We Varmandi are better off without a tribe, do you not think?"

1. Abandon negotiations.
2. "Your deeds are more likely to be remembered if you are part of a tribe."
3. "Together, we will have protection from our foes."
4. "A tribe can support heroquests more easily than a clan."
5. "When the Varmandi face hard times, the rest of the tribe can help feed you."

Many tribes form in order to better perform heroquests.



Counter-point

Games with procedural personalities have successfully achieved subtlety and drama.

You can't avoid risks entirely – choose carefully and prepare for the consequences.



1. Hidden personality systems can disappear.
2. Comedy comes naturally.
3. Reactions are economical.
4. Change is gold.

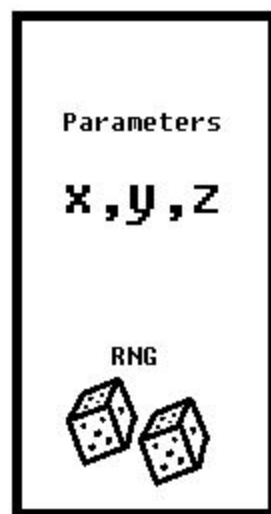
tanya@kitfoxgames.com

@tanyaxshort

In-Game Content Generation by AI Agents

Tarn Adams

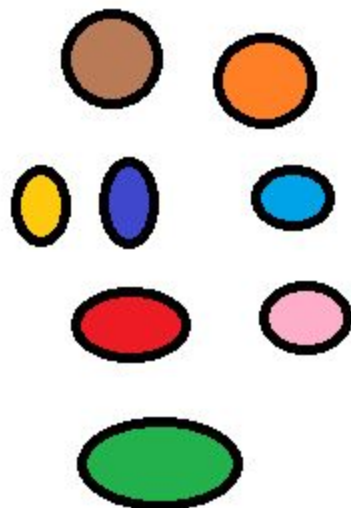
Co-founder @ Bay 12 Games

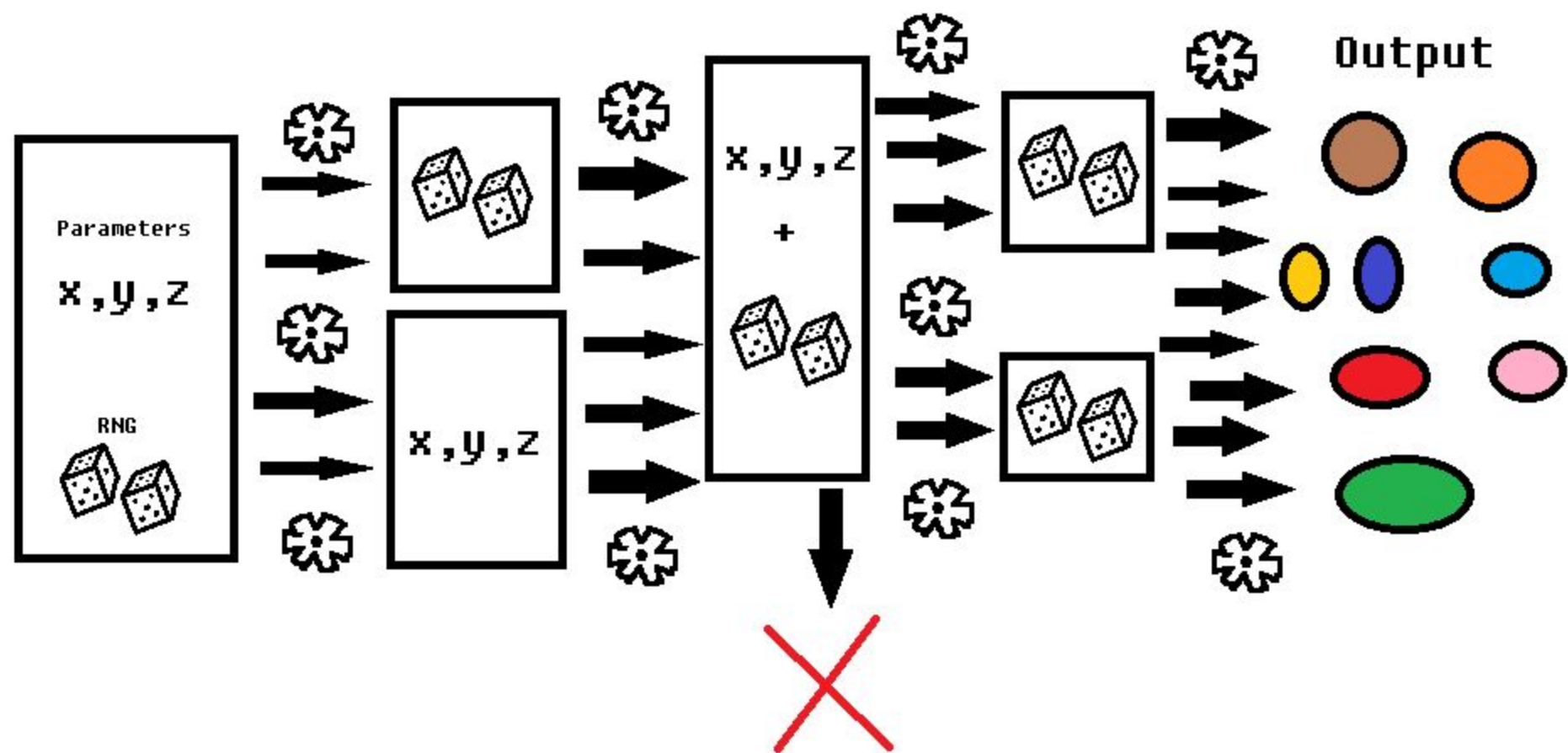


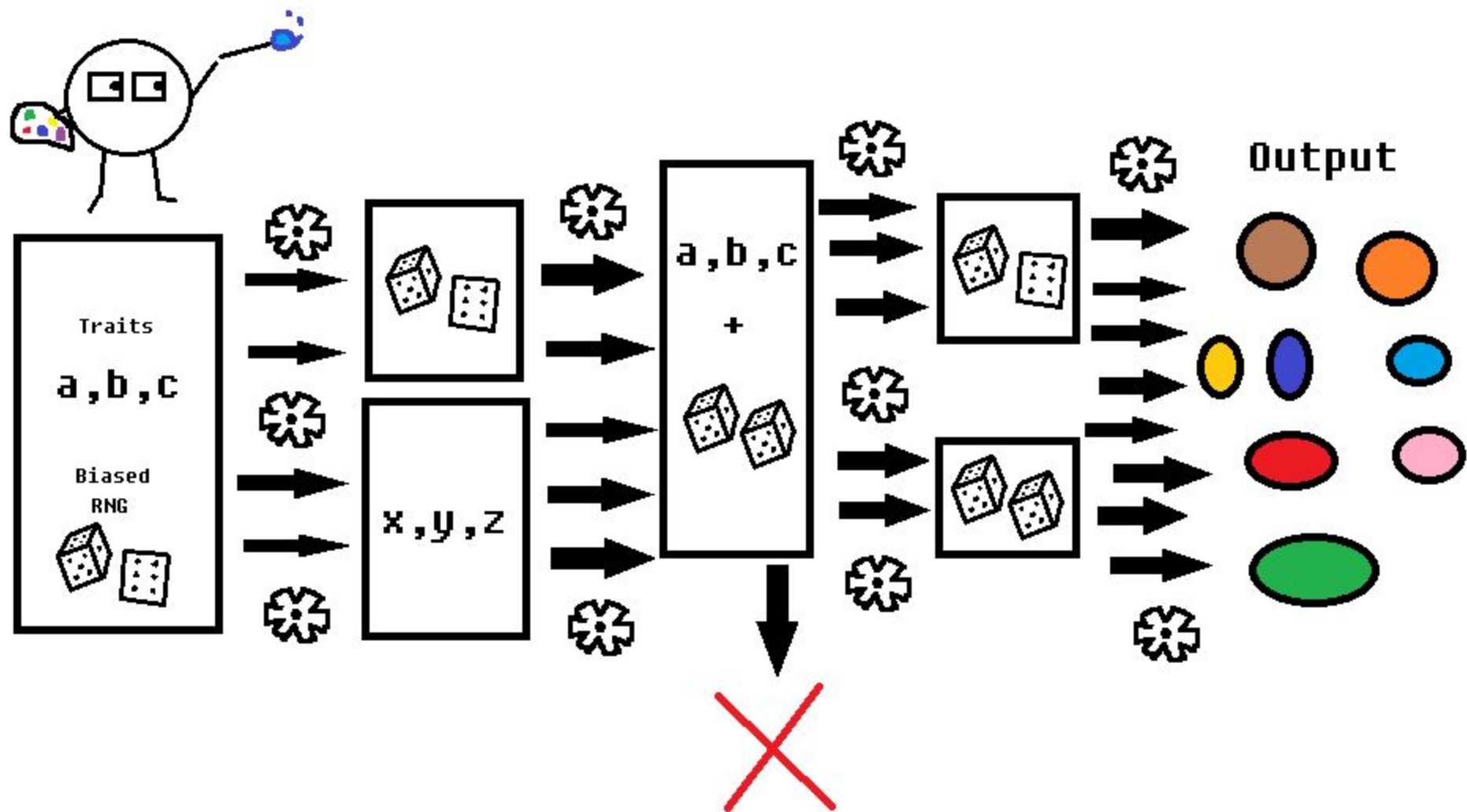
PCG Algorithm

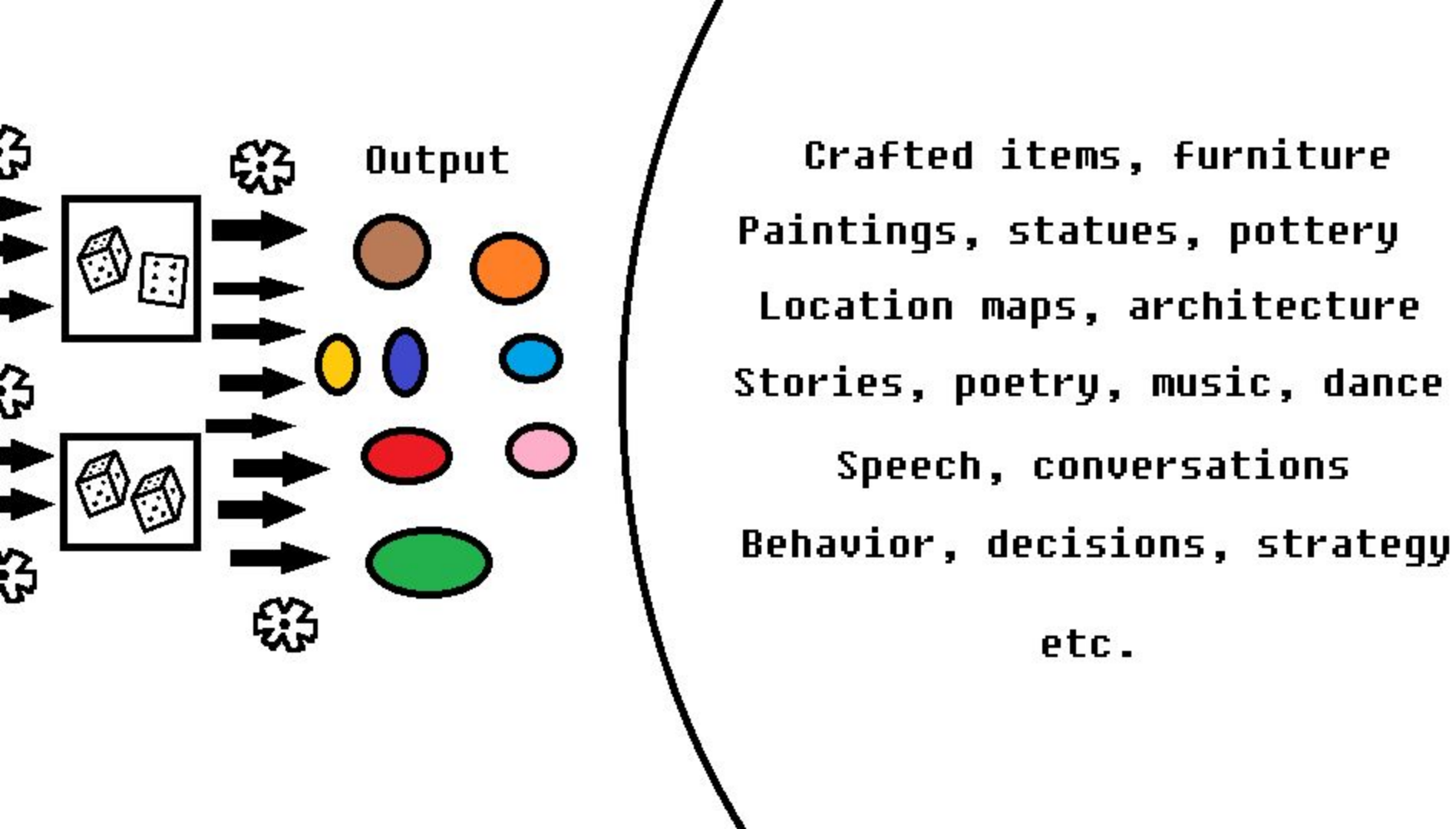


Output





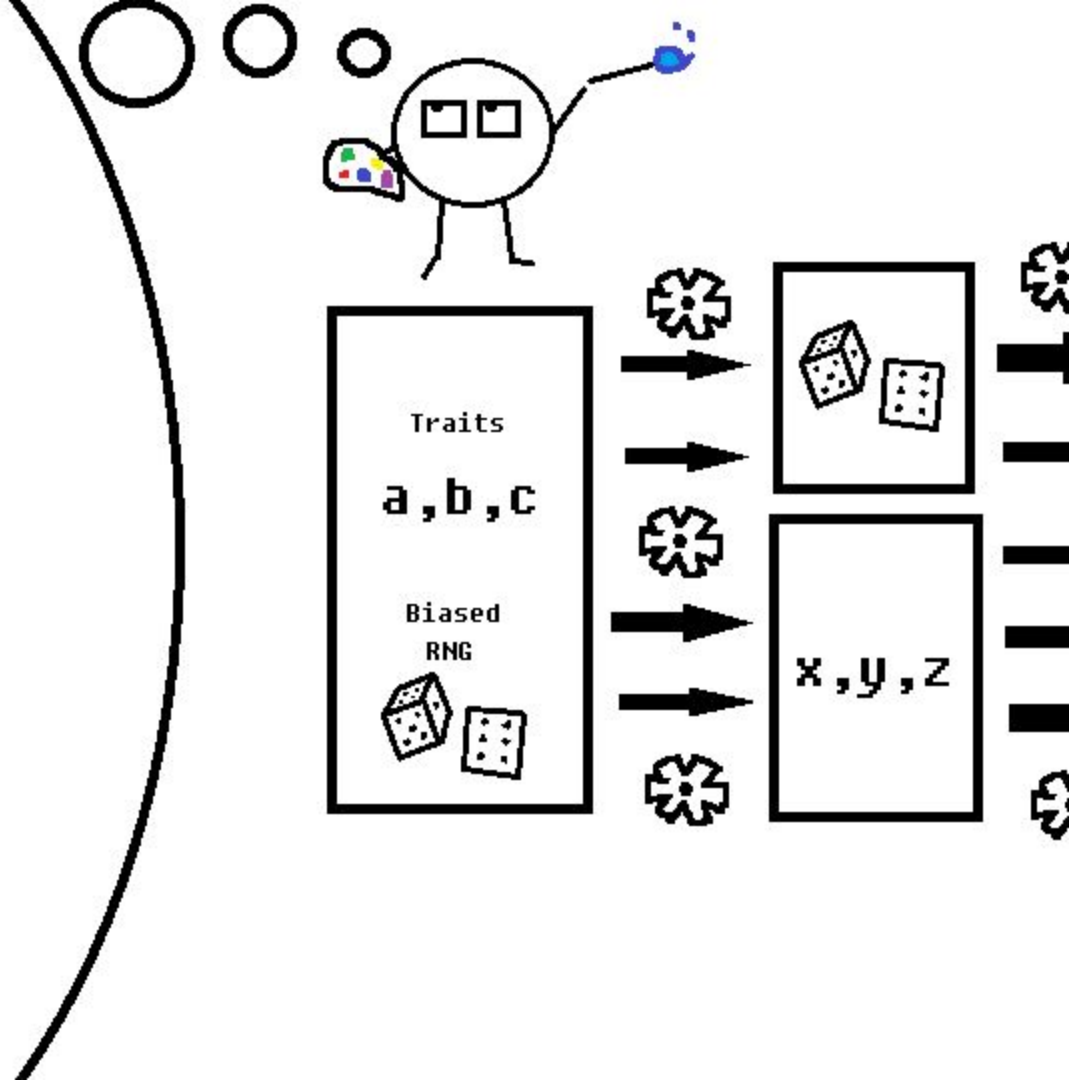




Knowledge of World State
Events
Locations
People

Relationships
Interpersonal
Property and position
Reputation

Internal
Personality
Beliefs and values
Profession and skills



Events

Player

AI

Backstory/Lore/IP

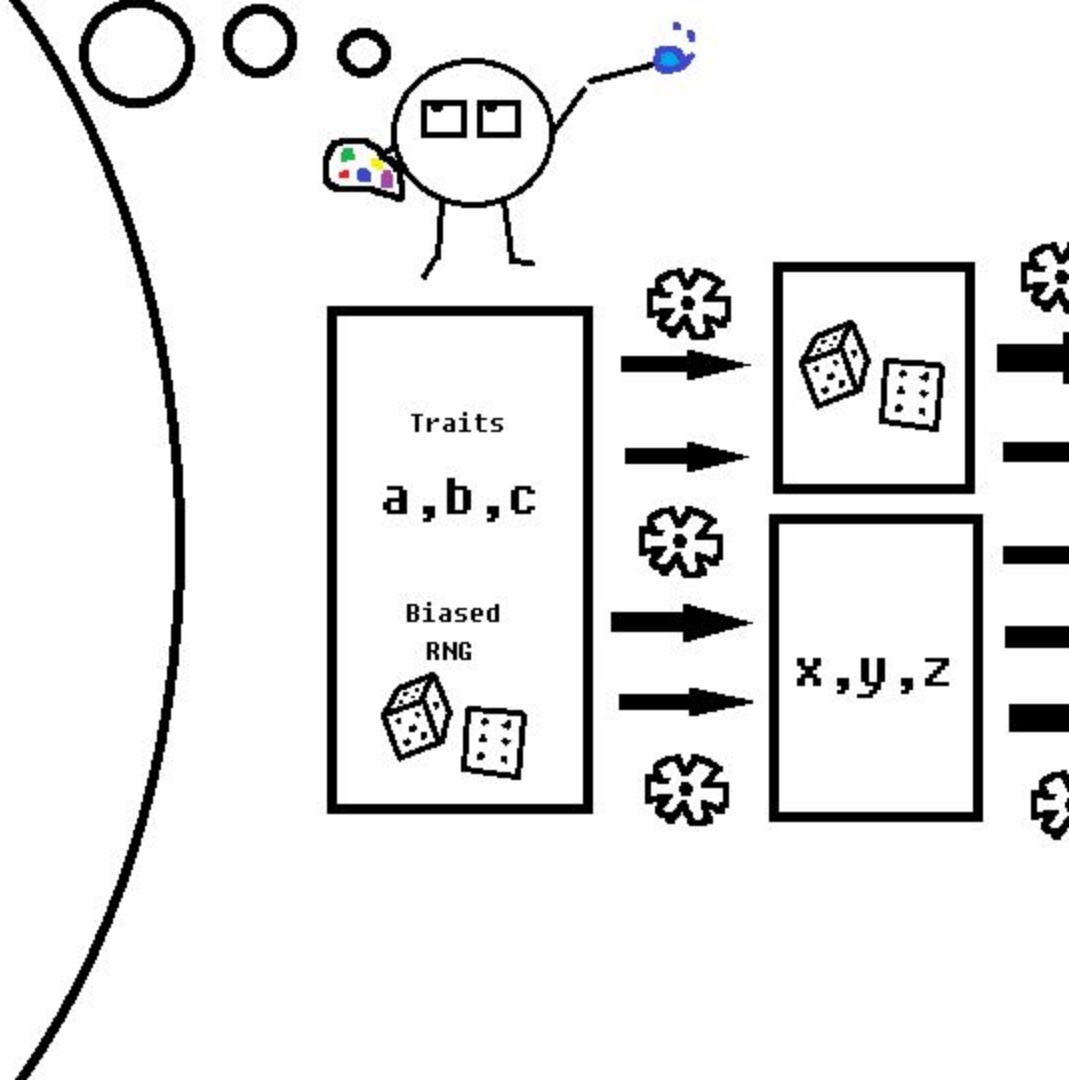
Systematized Groupings

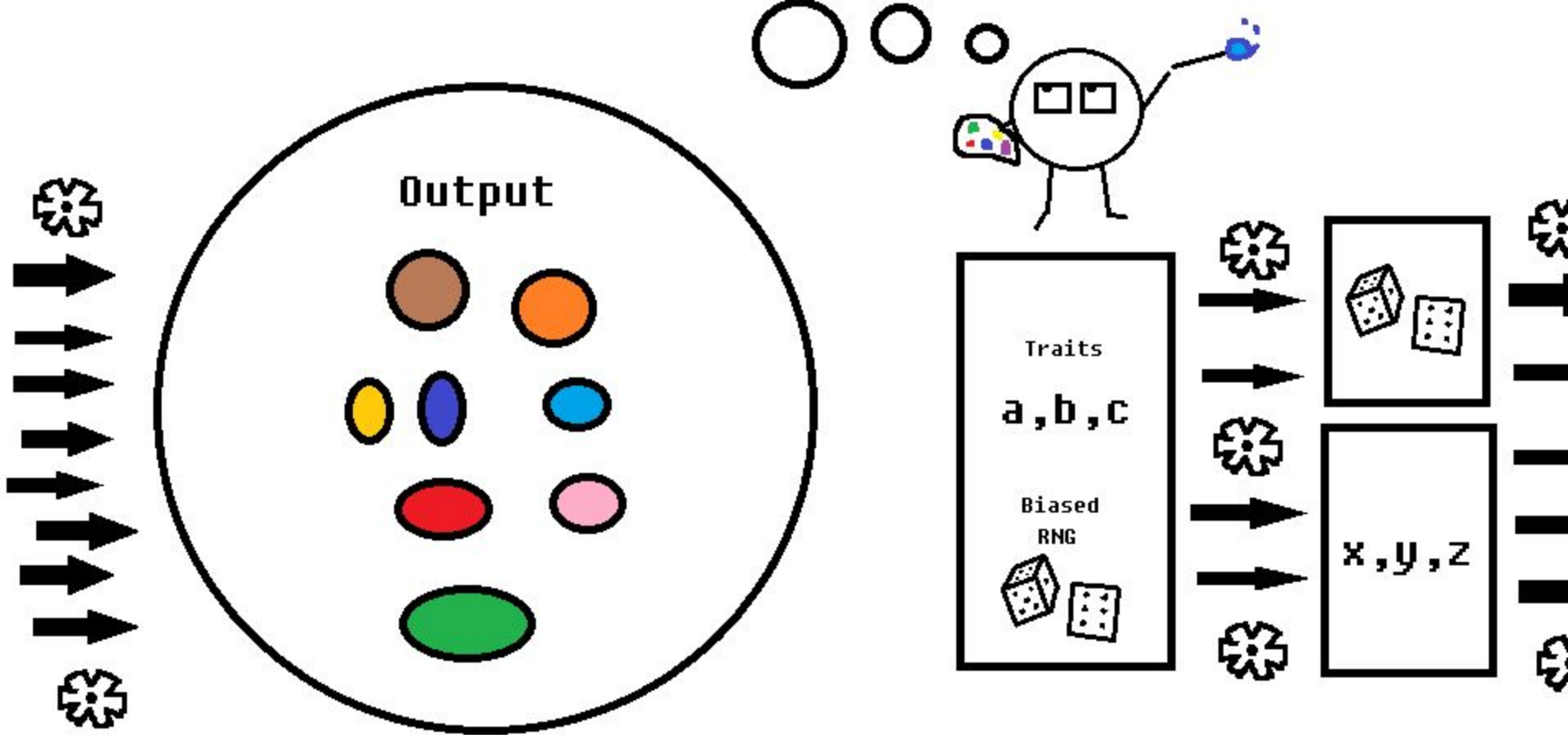
Story

Biography

Era

etc.







Statue

Player

Event

(Elected Mayor)



Book

AI Value

(Friendship)

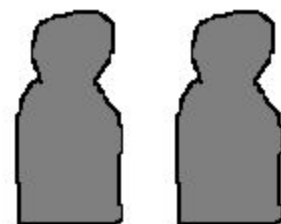


Statue

Player

Event

(Elected Mayor)



Feedback: Copy



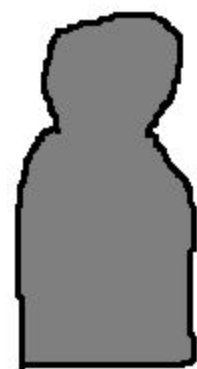
Book

AI Value

(Friendship)



Feedback: Review



Statue

Player

Event

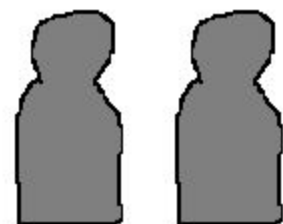
(Elected Mayor)



Book

AI Value

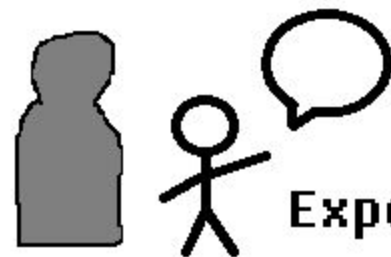
(Friendship)



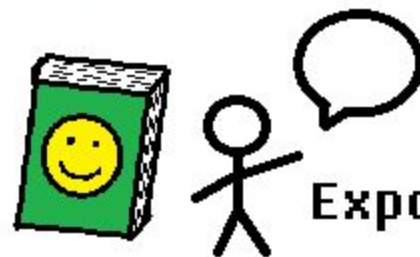
Feedback: Copy



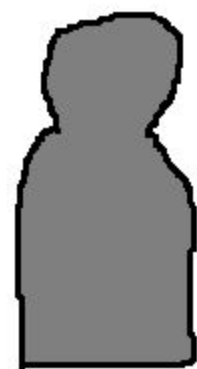
Feedback: Review



Exposition: Event



Exposition: Value



Statue

Player

Event

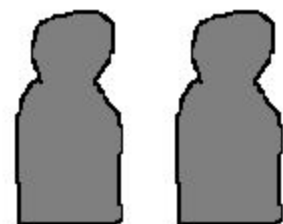
(Elected Mayor)



Book

AI Value

(Friendship)



Feedback: Copy



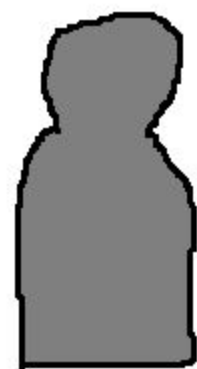
Feedback: Review



Betrayed by Player



Hates Friendship



Statue

Player

Event

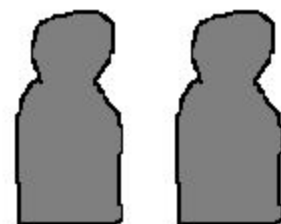
(Elected Mayor)



Book

AI Value

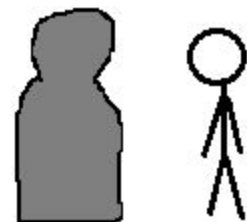
(Friendship)



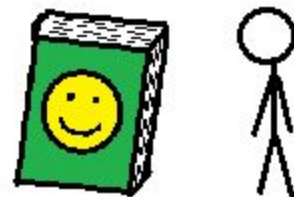
Feedback: Copy



Feedback: Review



Learns that the
Player is Mayor



Learns the Value
of Friendship

Events in Play

Start

End

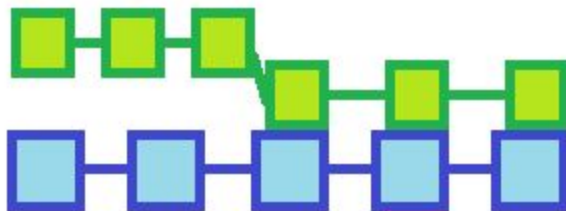


Player

Events in Play

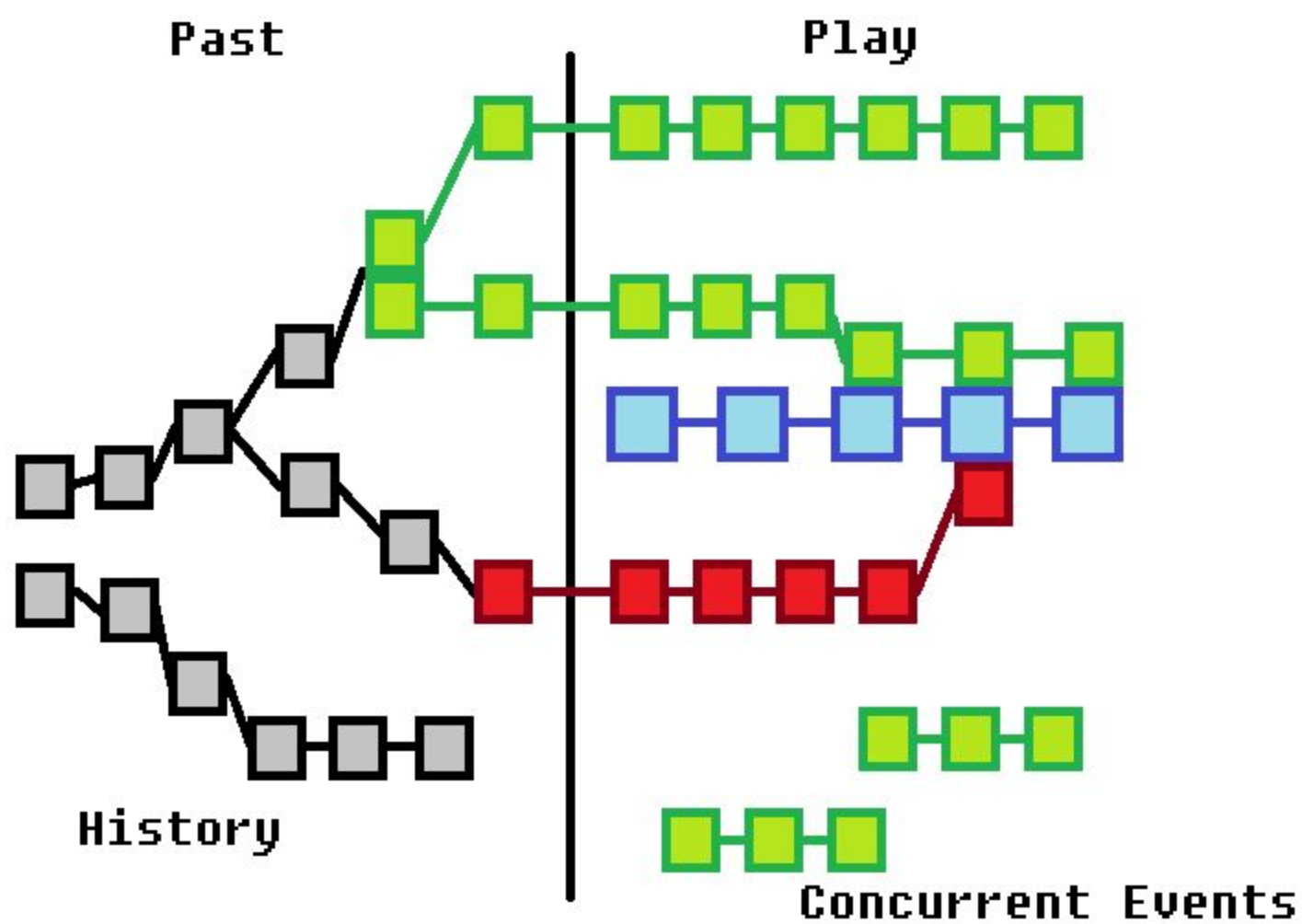


AI Agents



Player

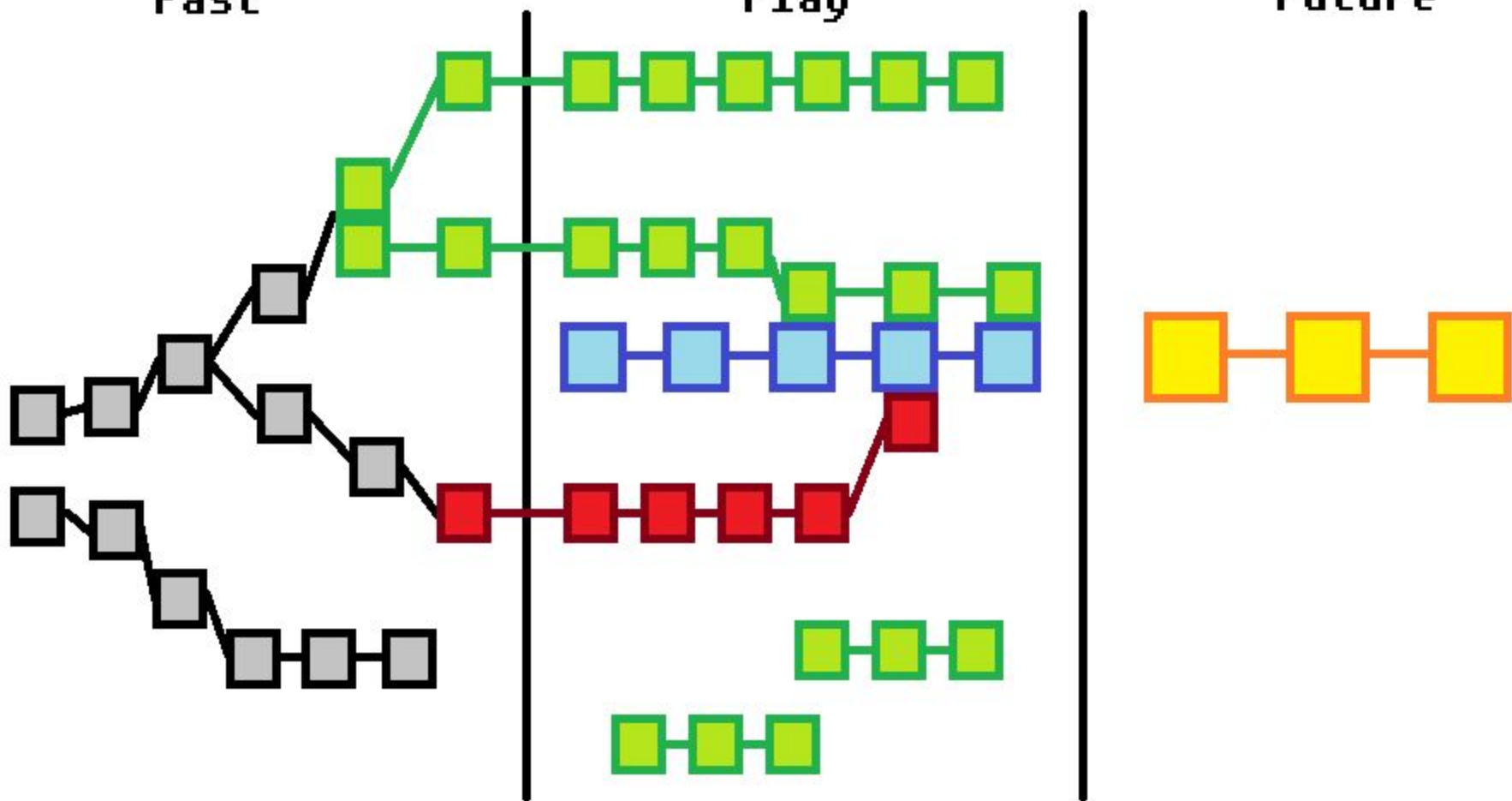




Past

Play

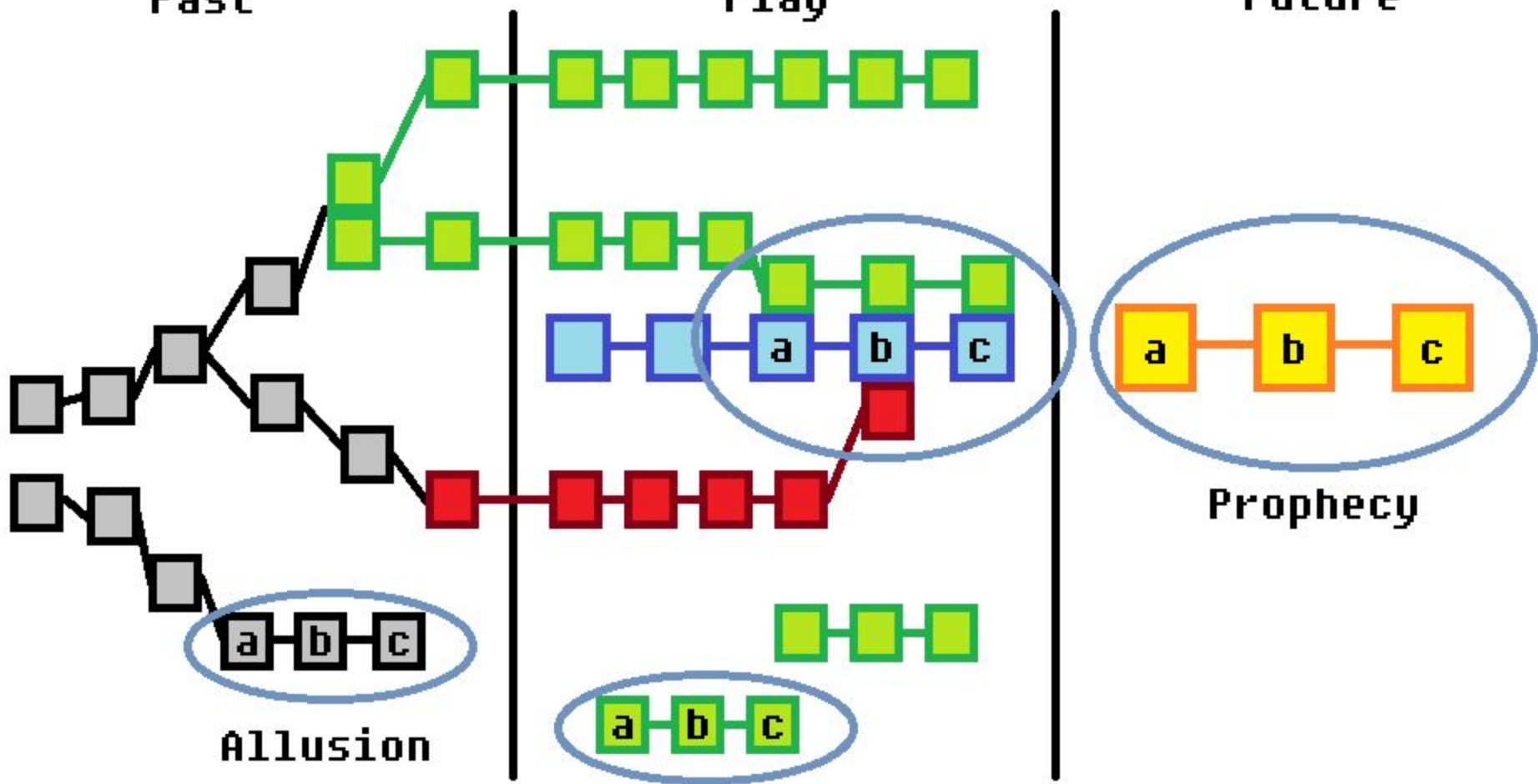
Future



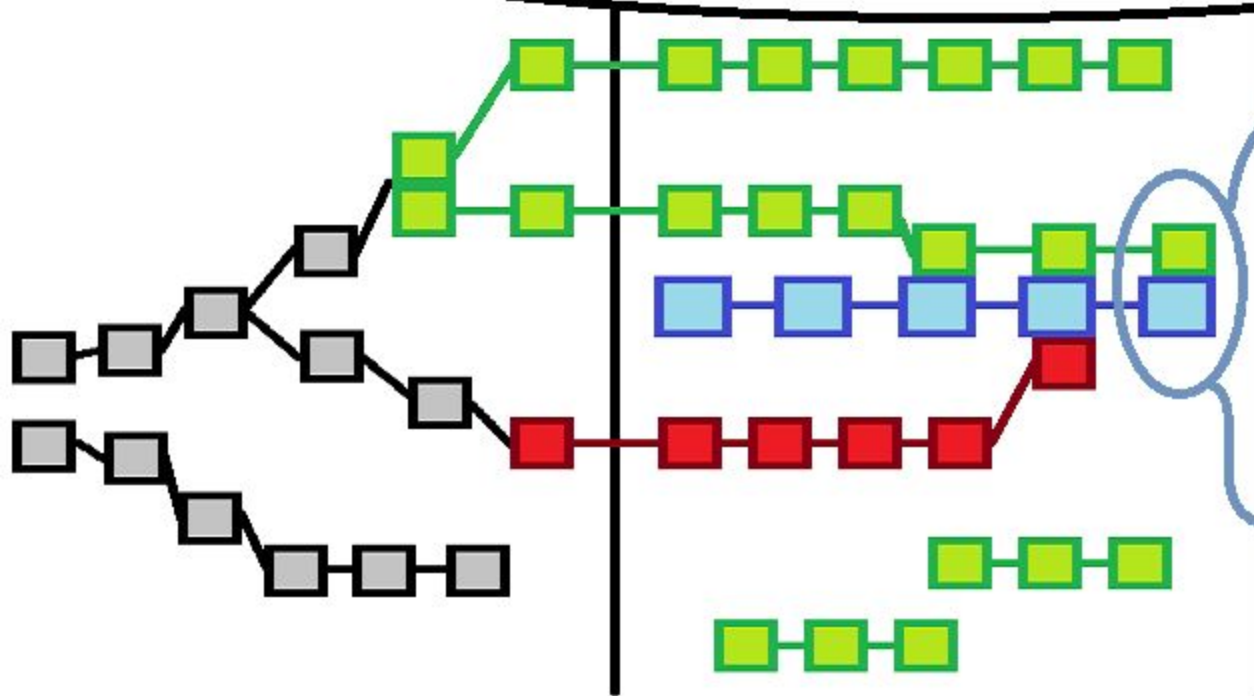
Past

Play

Future



Conceptual Game Objects



Symbols

Allegory

Fiction



Procedural Systems and AI in Galak-Z

Zach Aikman

Technical Director @ 17-BIT

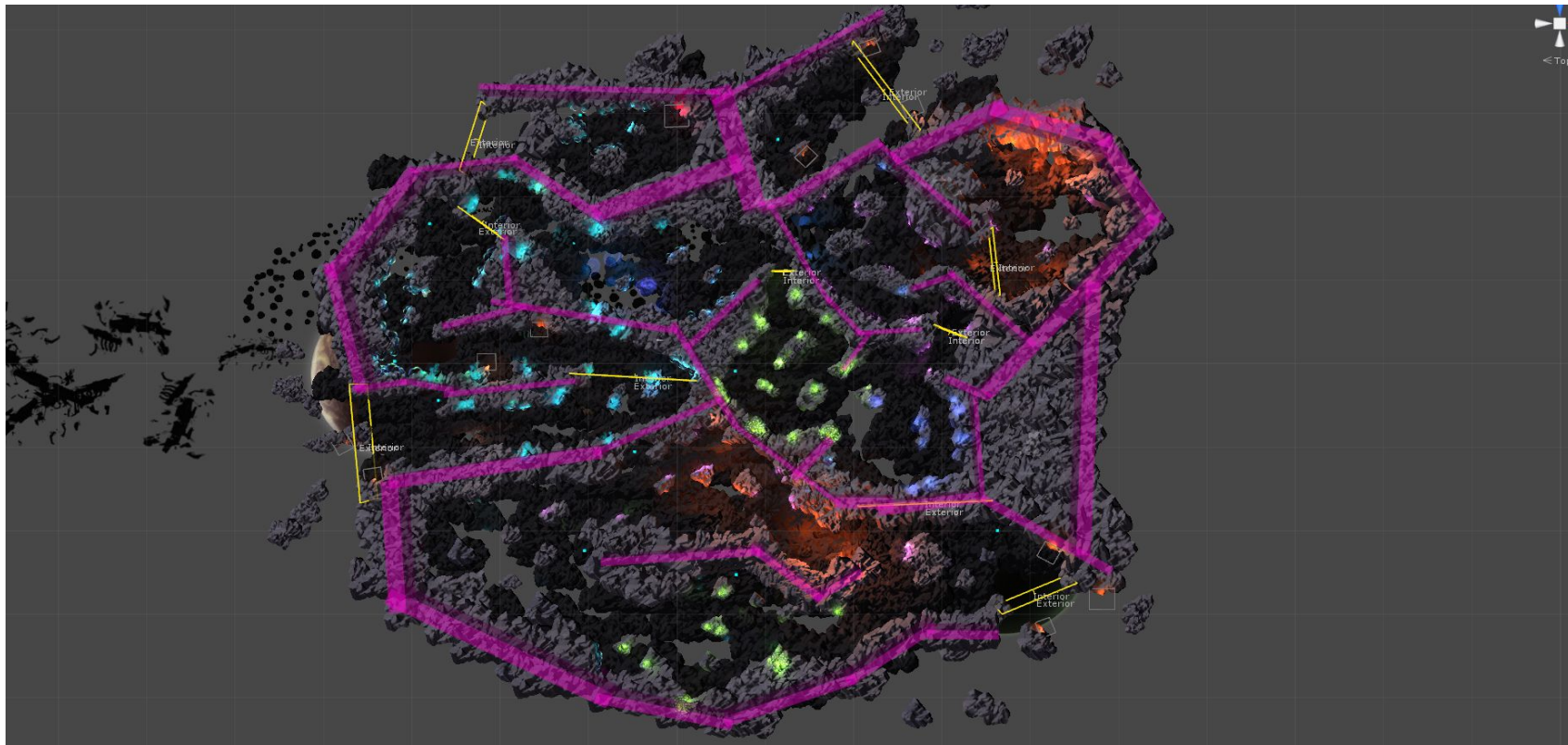


宇宙戦士 **ガラク**

GALAK-**L** ★

THE DIMENSIONAL





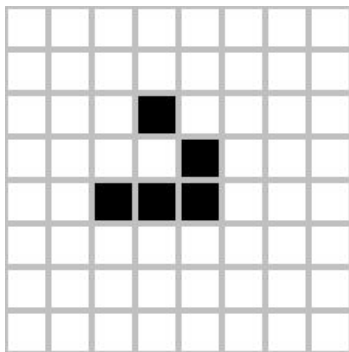


Work in Progress March 2014

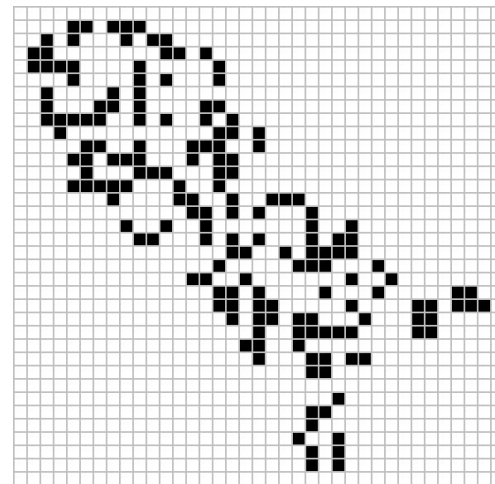




Cellular Automata



Glider

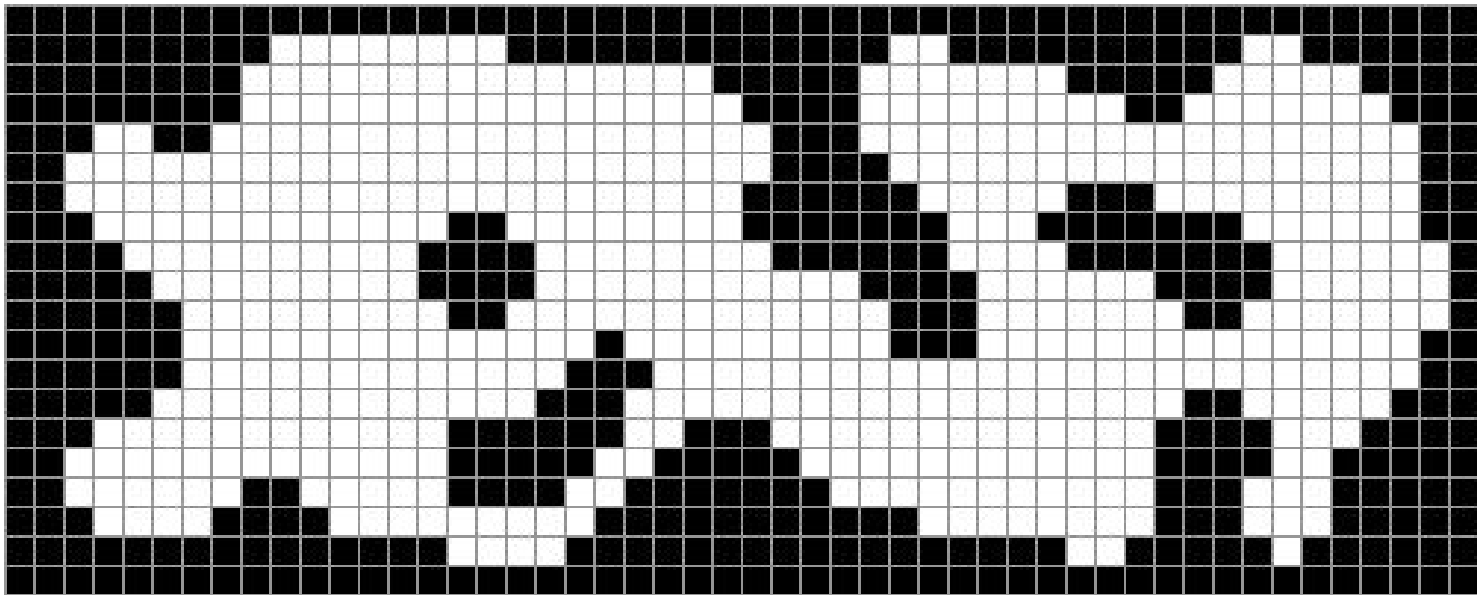


Seal



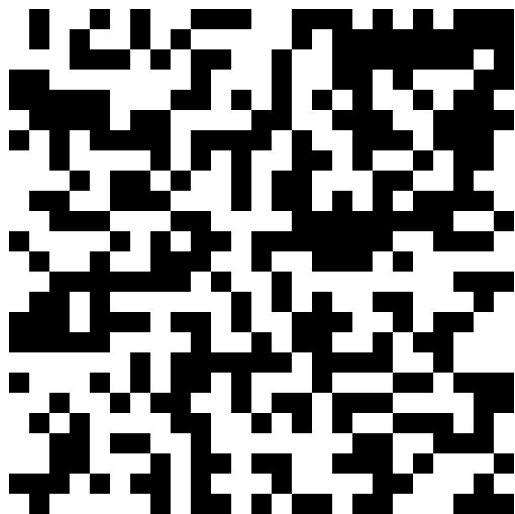


Cellular Automata





Cellular Automata



Iterations



Spaciousness





Cellular Automata - Takeaways

- Too unpredictable without human guide
- Used as a tool for designers





Cellular Automata - Takeaways

- Store seed and iterate at runtime
- Inefficient - better to generate offline
- Store RLE cell data





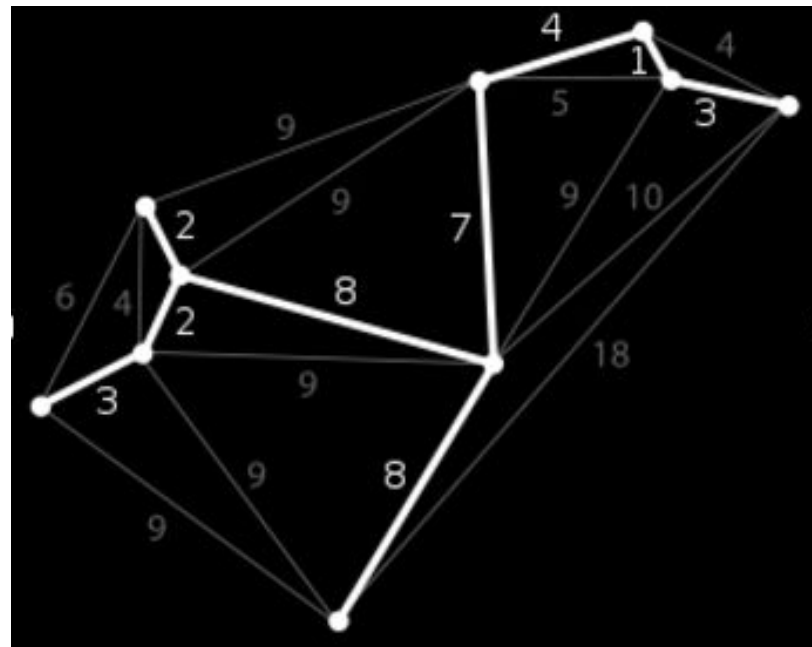
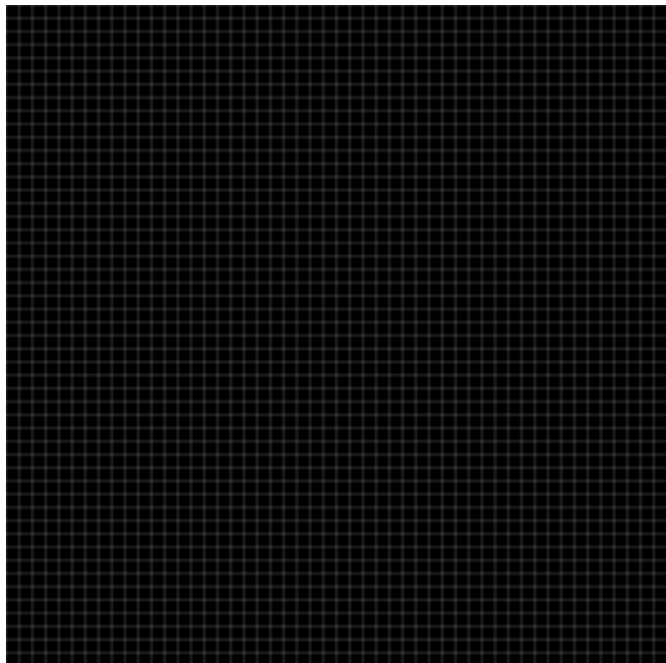
Dungeon Constraints

- Levels occupy a fixed amount of space
- Fixed cell dimensions
- Orthogonal exits



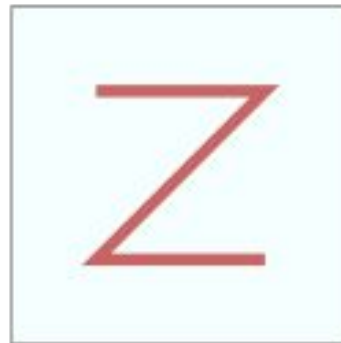


Dungeon Layouts



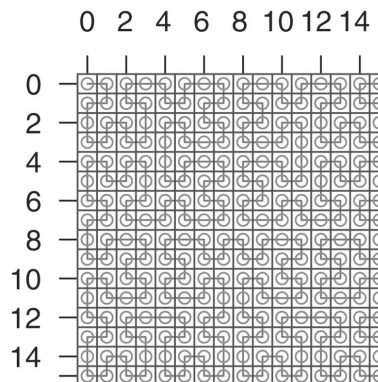
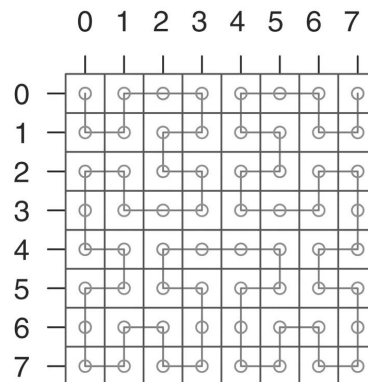
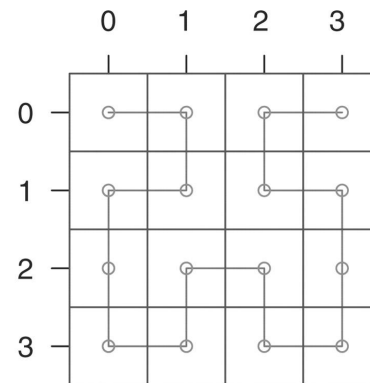
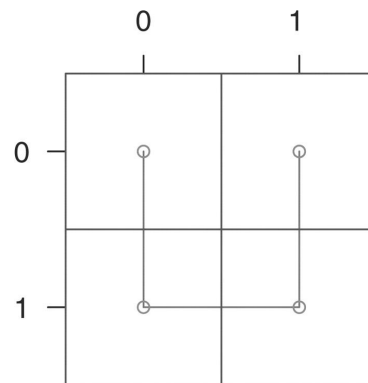


Z-Order Curves





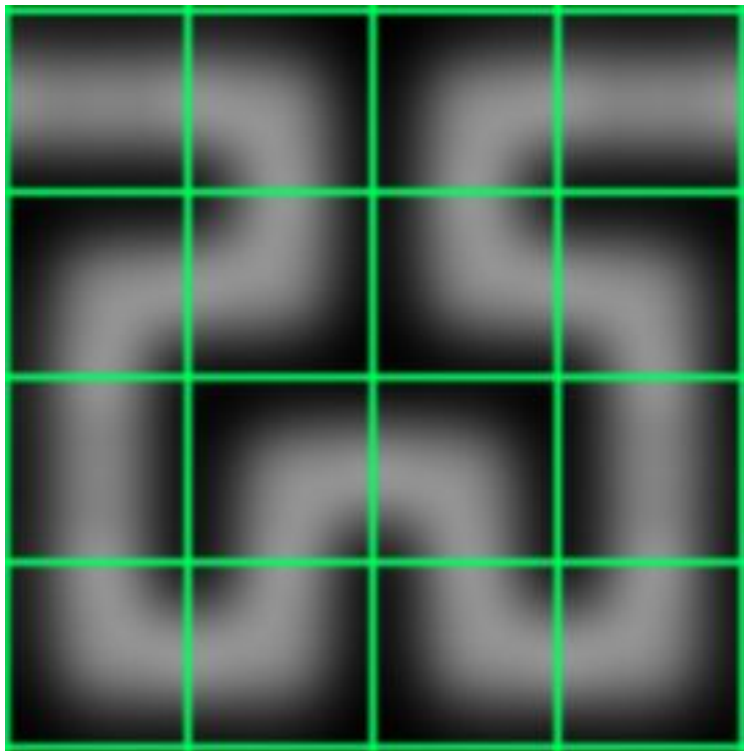
Hilbert Curves





Hilbert Curves

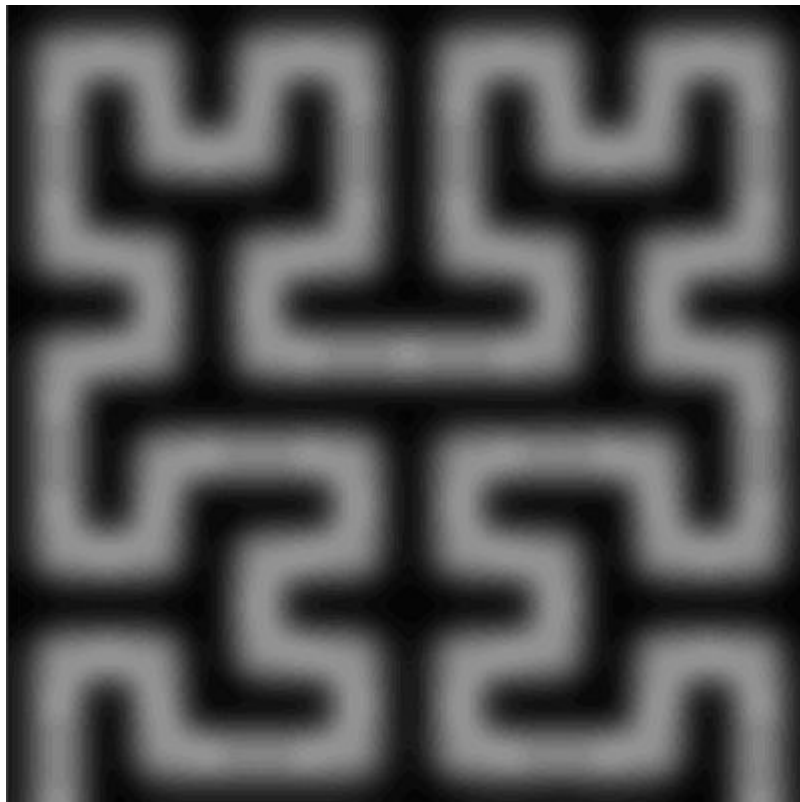
- Filling a 4x4 grid
- $h = [0...15]$
- Hilbert functions map (x,y) coordinates to path index





Hilbert Curves

- Increase dimension to next power of 2
- Randomly offset the kernel
- Start at $h = 0$ and walk the path until it lies within the kernel
- Increment h until the end of the curve is reached
- If h leaves the kernel, pick up when it comes back on





Hilbert Curves - Takeaways

- Experiment with non-conventional methods
- Talking about your findings may lead to others improving on your ideas





Contextual Barks

- "I see him!"
- "Help, I'm under attack!"
- Valve's Left 4 Dead





Contextual Barks

- Elan Ruskin - GDC 2012
- Maintain a global state of world facts
- Maintain many local states of character facts

http://www.valvesoftware.com/publications/2012/GDC2012_Ruskin_Elan_DynamicDialog.pdf





Contextual Barks

- Writers generate dialogue as a pile of rules (query)

IF (levelActiveTime > 300 && playerHealth < 5 && isUpgradeItemNearby) THEN "Just in time!"

http://www.valvesoftware.com/publications/2012/GDC2012_Ruskin_Elan_DynamicDialog.pdf





Contextual Barks - Failings

- Too much complexity
- Difficult to QA / bug test
- Bad content pipeline
 - Spread across multiple sheets
 - Relied on Access Database merging





Thanks!

zach@17-bit.com

@TheZaikman



Procedurally Generated FPS

Luiz Kruei

Senior Technical Artist @ SideFX



Intro

Luiz Krue - Sr Tech Artist - SideFX Software

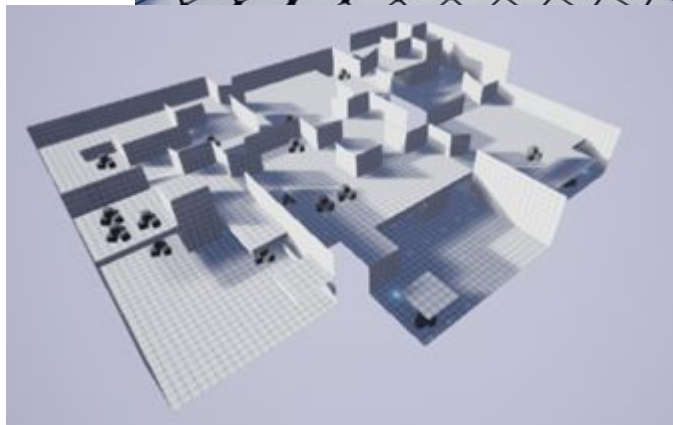
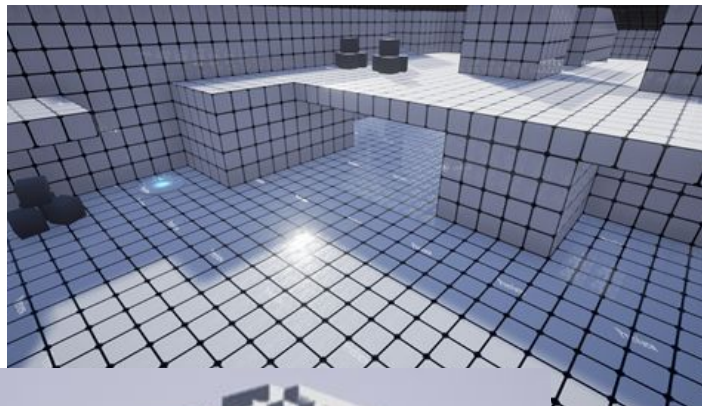
Antoni **Liapis** - Lecturer at the Institute of
Digital Games (University of Malta)





Project Nautilus

Small Team, AAA Content
Leverage Proceduralism
Multiplayer FPS





Proceduralism + AI

Automate the Input
Map Generator

Blind email into
academia ether





Sentient Sketchbook

Constraint based evolutionary map generator

sentientsketchbook.com





Modifications

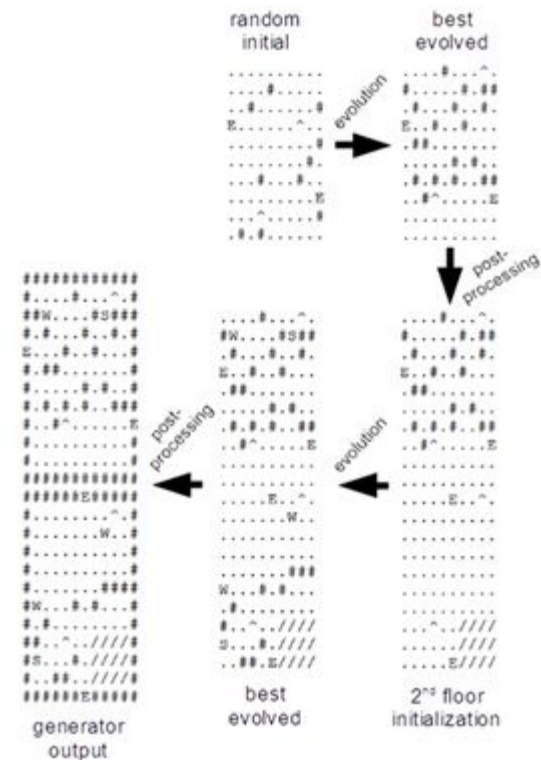
2nd Floor

Evaluations

Entrances

Open Air Constraints

Wall Constraints





Output Data

E – Entrance

^ – Stairs/Jump Pad

S – Spawn

W – Weapon

. – Open

– Wall

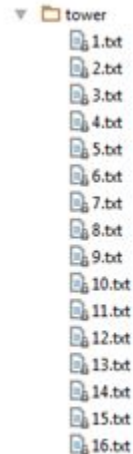
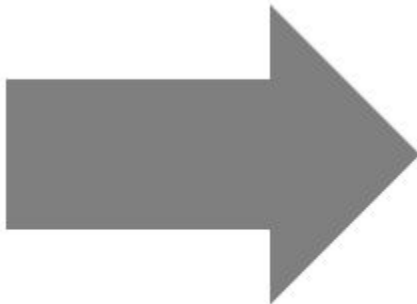
/ – Second floor open





Input Data

```
args['mapSizeX'] = '5'  
args['mapSizeY'] = '5'  
args['minStairs'] = '1'  
args['maxStairs'] = '2'  
args['minSwitches'] = '1'  
args['maxSwitches'] = '2'  
args['minWeapons'] = '1'  
args['maxWeapons'] = '3'  
args['minEntrances'] = '2'  
args['maxEntrances'] = '4'  
args['symmetryType'] = '-1'  
args['biasOpenAir'] = '.3'  
args['population'] = '200'  
args['maxGeneration'] = '50'  
args['mirrorEntrances'] = '0'  
args['outputFolder'] = './tower_3/'  
args['numRuns'] = '30'
```



crossroads

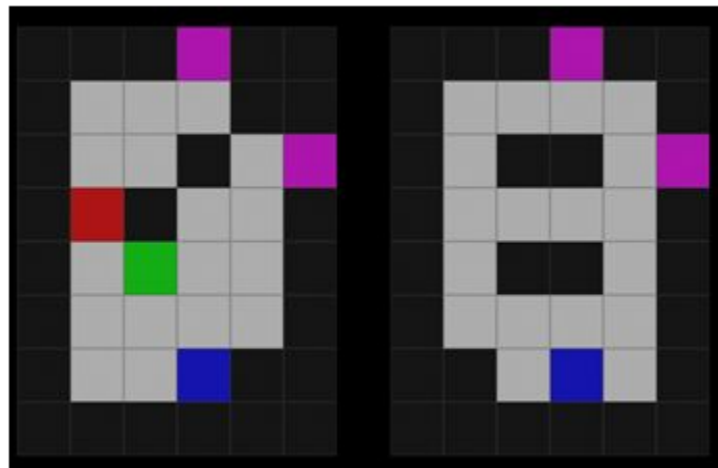
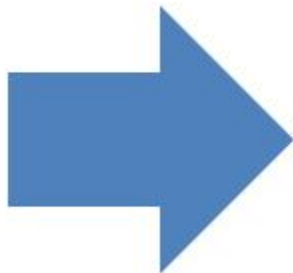
[illegible]

...



Making Sense of the Data

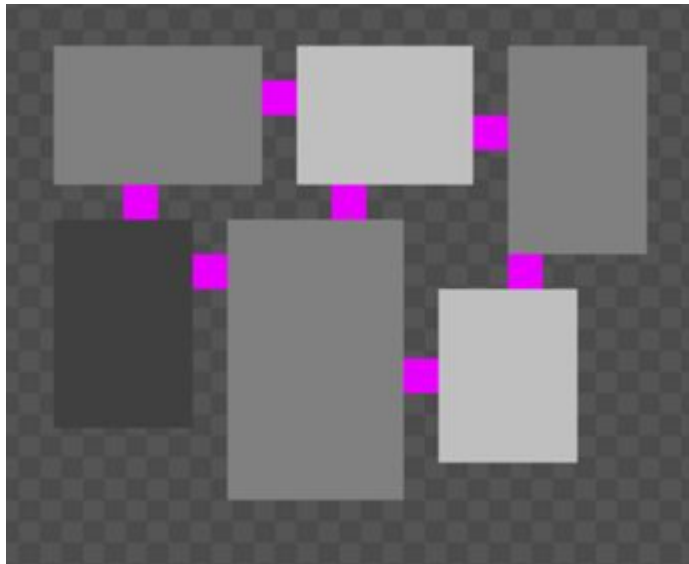
```
###E##  
#...##  
#..#.E  
#W#..#  
#.S..#  
#...##  
#..^##  
#####  
###E##  
#...##  
#..#.E  
#...##  
#..##.  
#...##  
#..^.  
#####
```





Great Room, Now what?

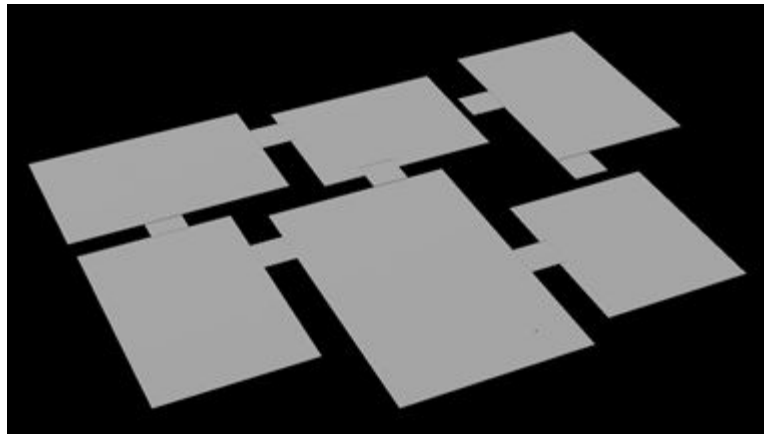
Reverse Approach
High Level Input
Flow Control





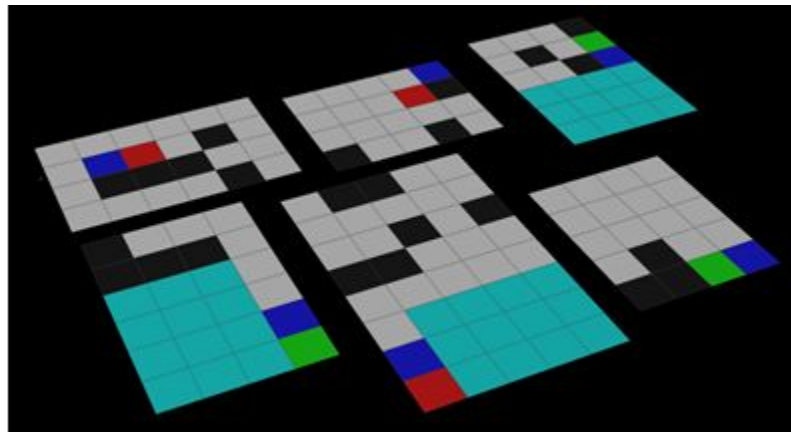
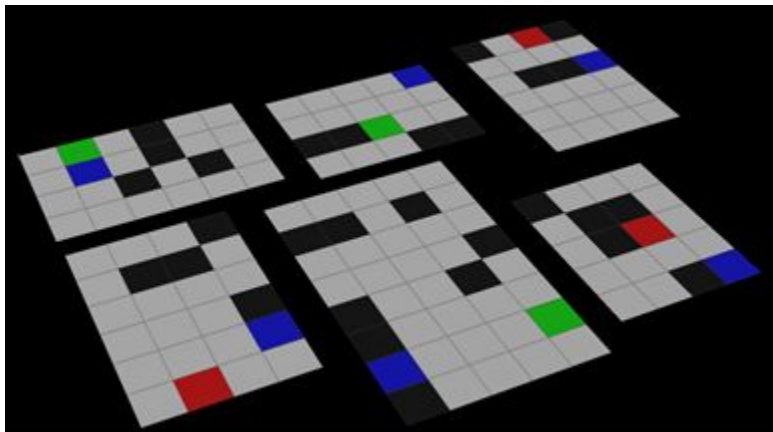
Parse The Map Shapes

Height based on Color
Calculate Dimensions
Door Placements



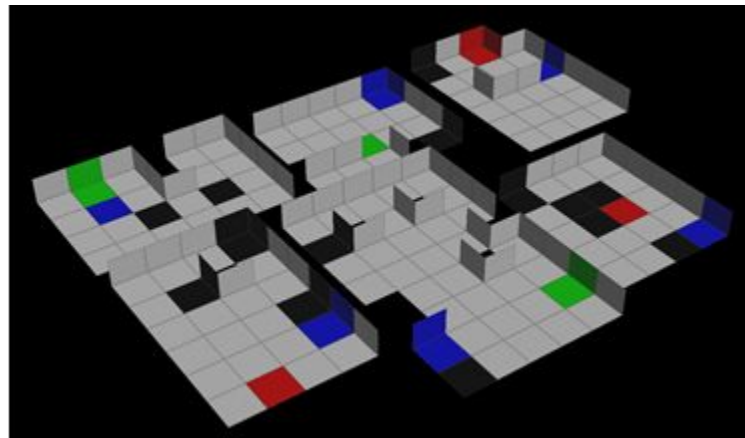
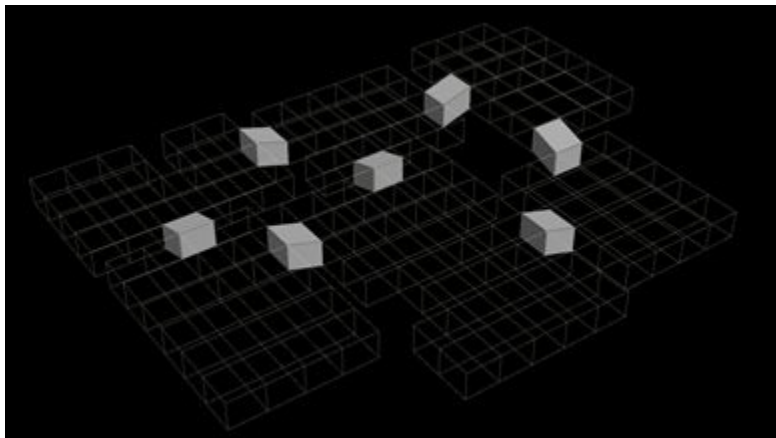


Get Rooms Back



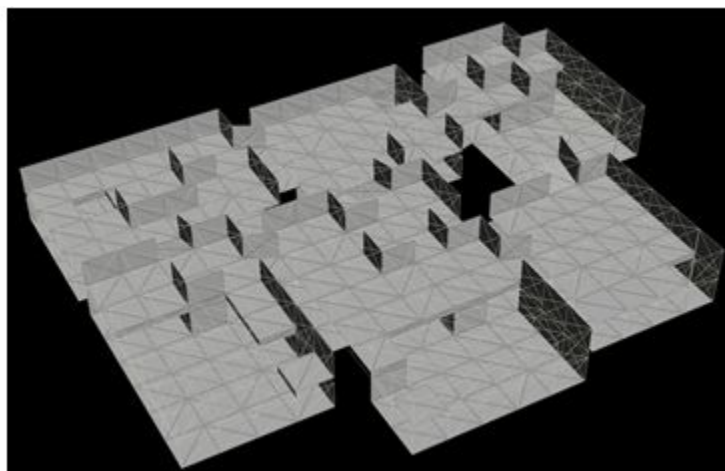
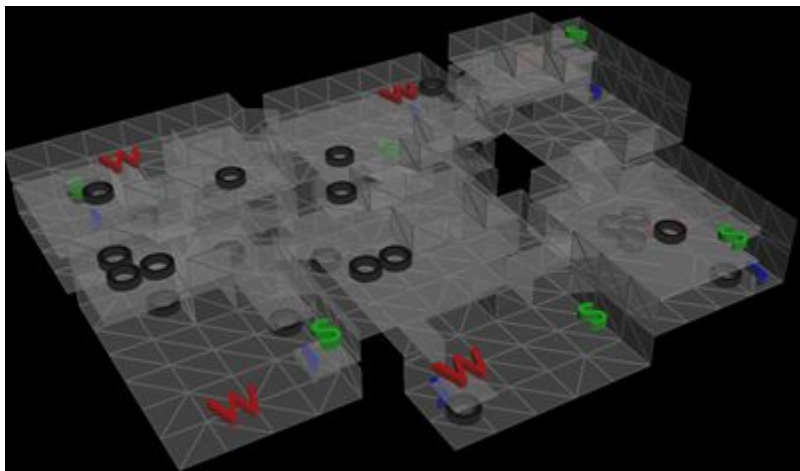


Extrude Shapes



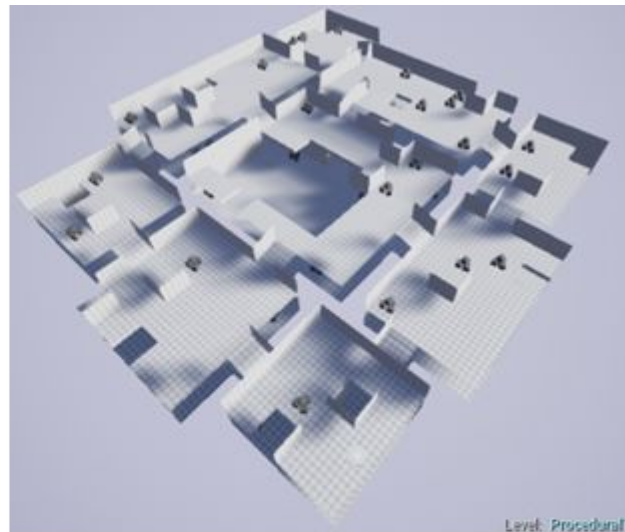


Place Gameplay Objs



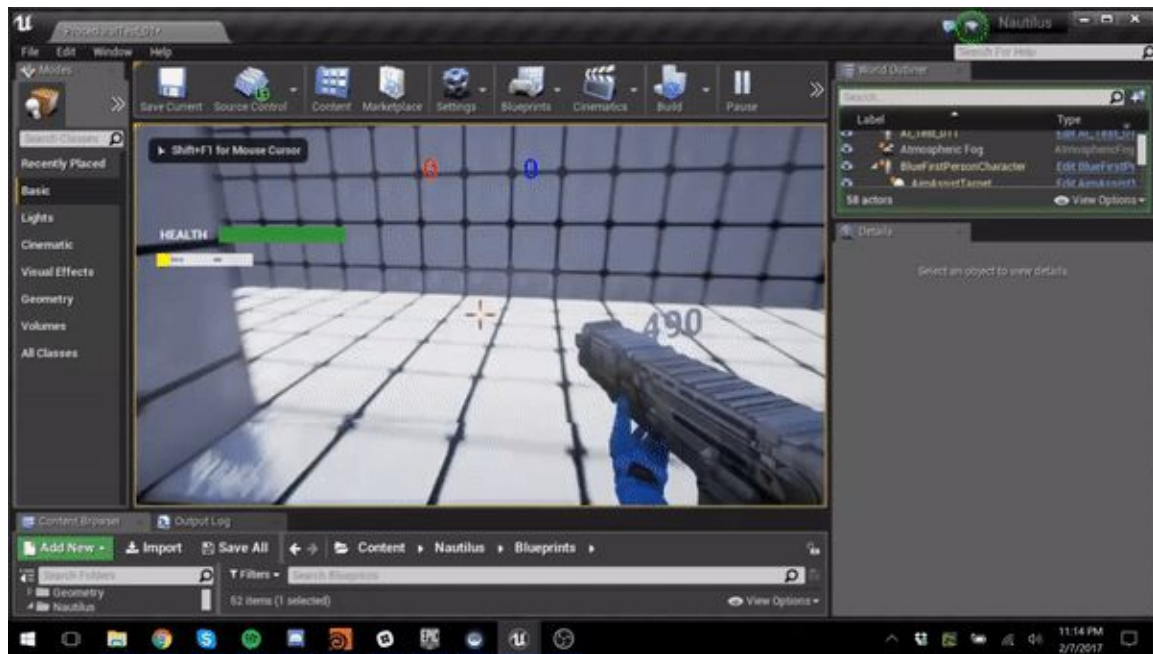


Results





Results





Thanks!

luiz@sidefx.com

@luizkruei



Pseudo is your Friend

Tyler Coleman
Founder @ Retora Games



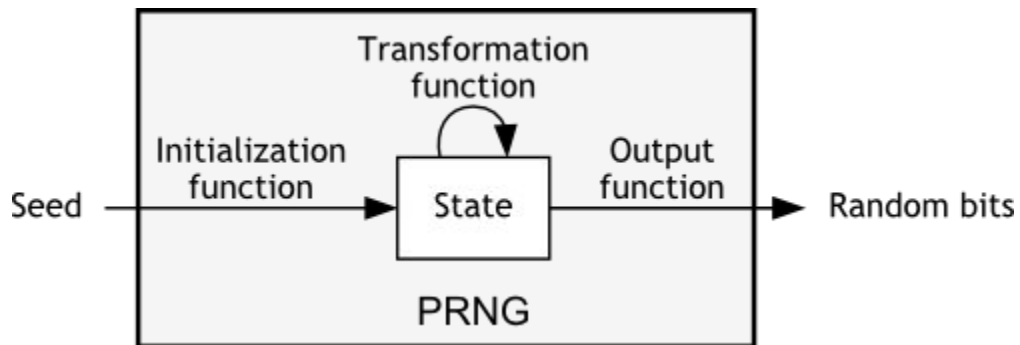
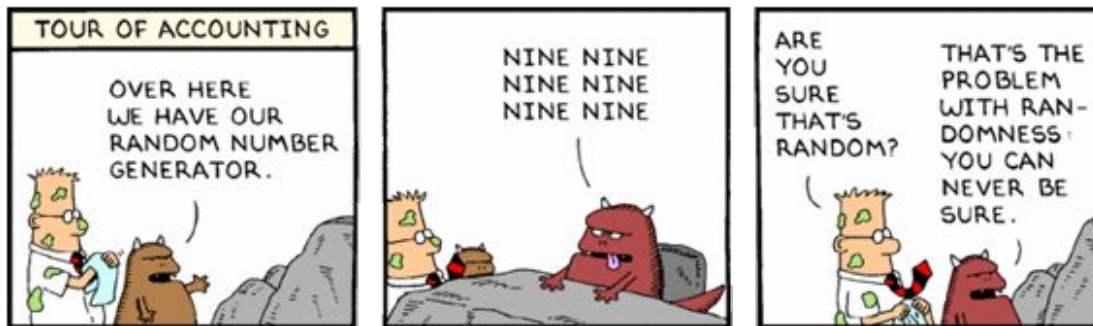
Pseudorandom Number Generation





Use **Pseudo** to your advantage







Now more than OS Time!



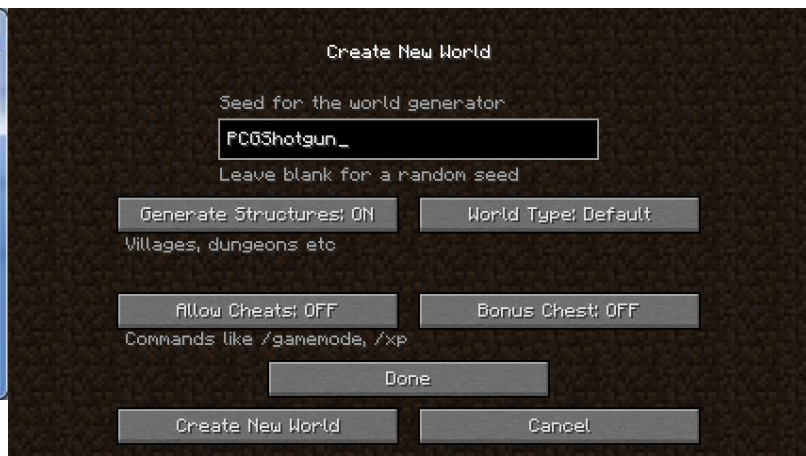


Let the user input a seed





Input a Seed





Use their input





Character Creation



**Images are suggestions*



The Sims 3





Loading Screen



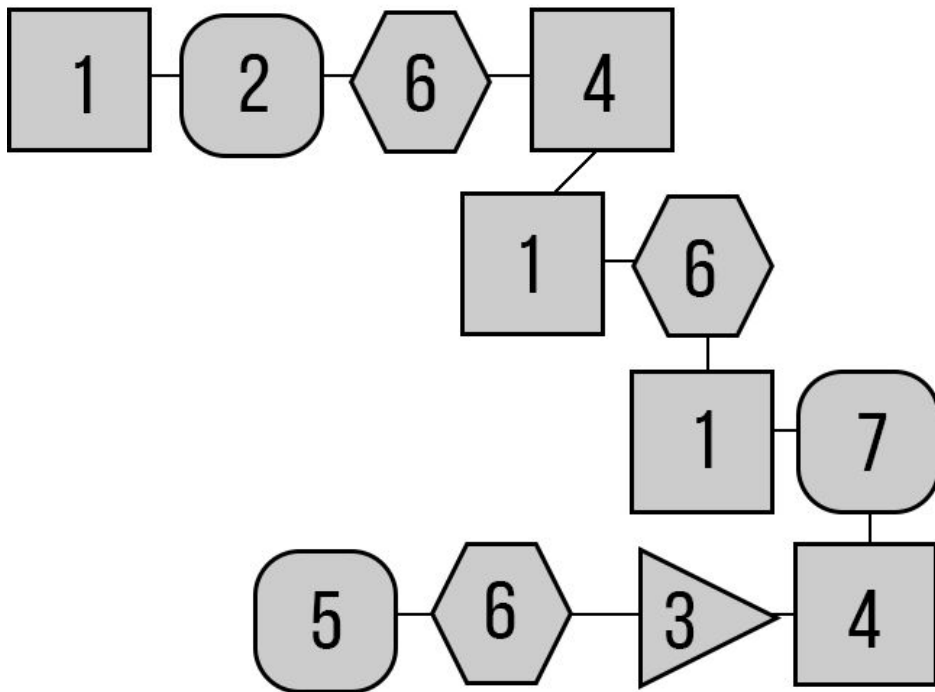


Break seed into sub elements





SEED: 126416174365



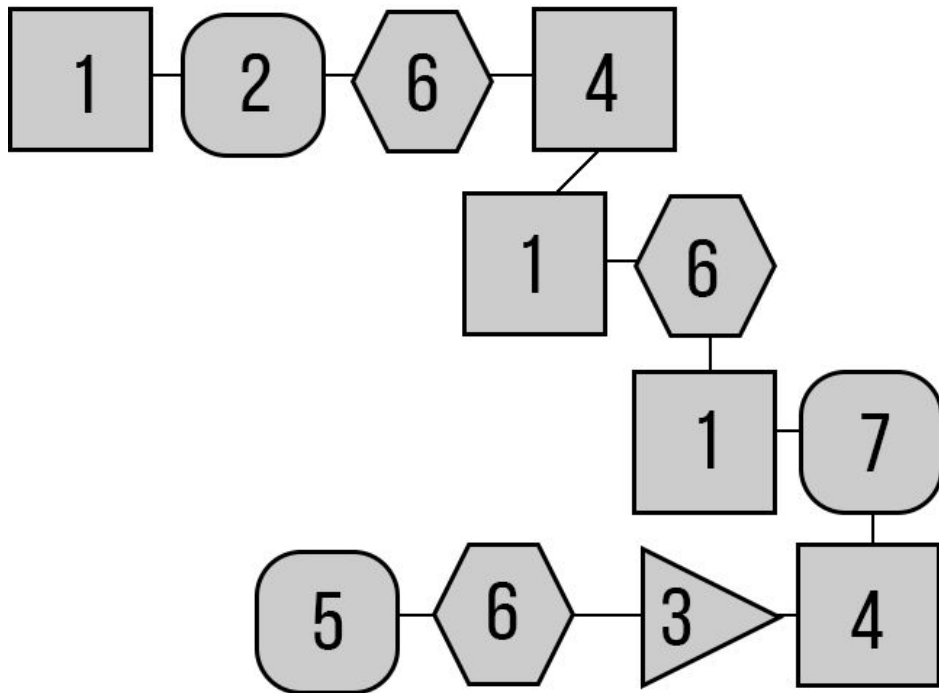


Treat the seed like a flexible number



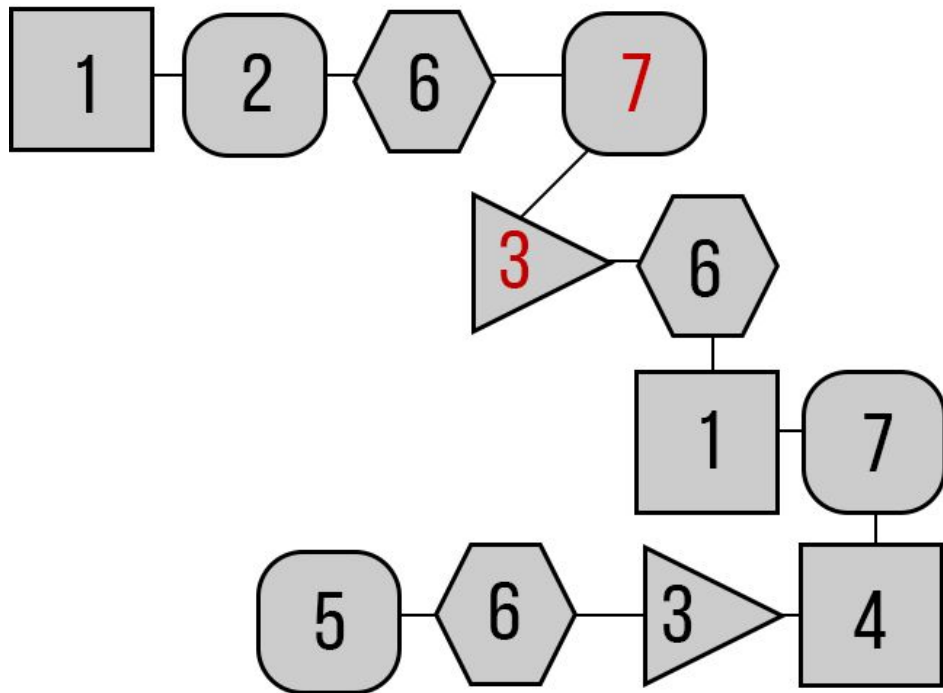


SEED: 126416174365





SEED: 126736174365





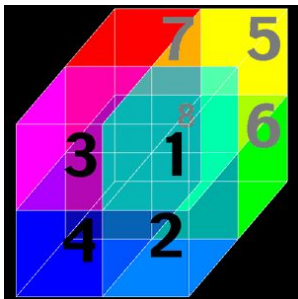
Seed from many values





Vector3 to Seed:

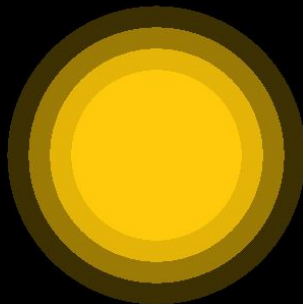
1st digit- Octant ID



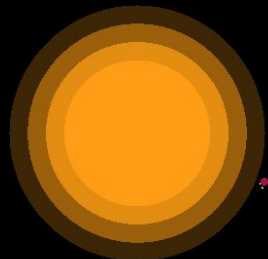
X* digits per X,Y,Z

**Can use 5 digits per if
int64 seed is possible*

Loquen
X: -755, Y: 5395, Z: -1541
Seed: 3075553951541



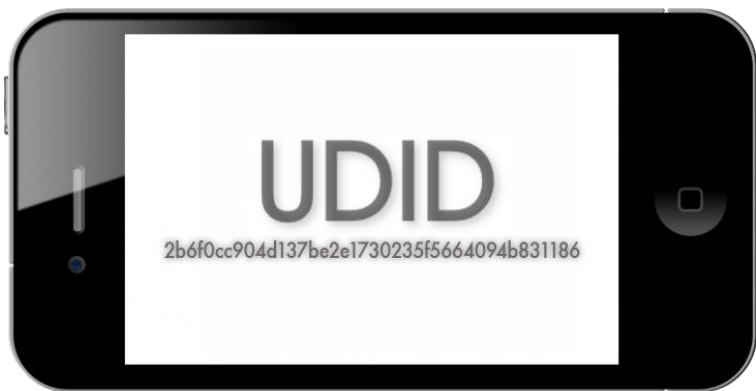
Teini
X: -5861, Y: 759, Z: -929
Seed: 3586107590929



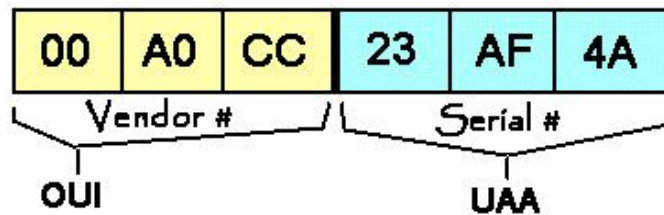


User ID for Seed





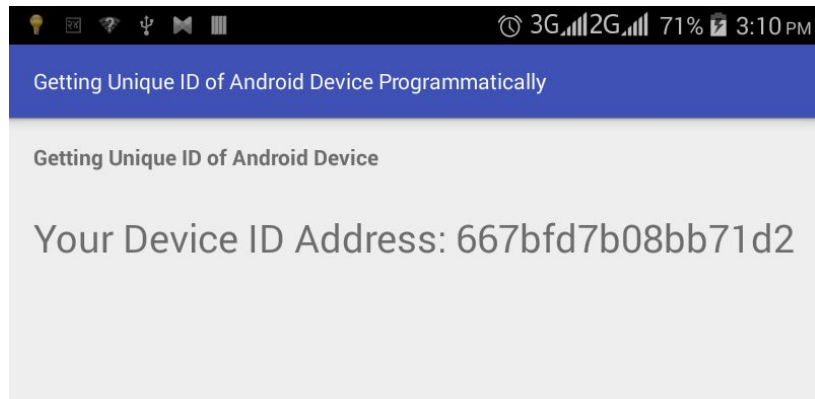
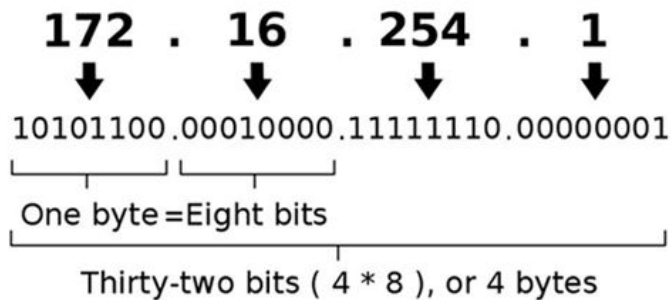
MAC Address
(Media Access Control Address)



(Organizationally Unique Identifier)

(Universally Administered Address)

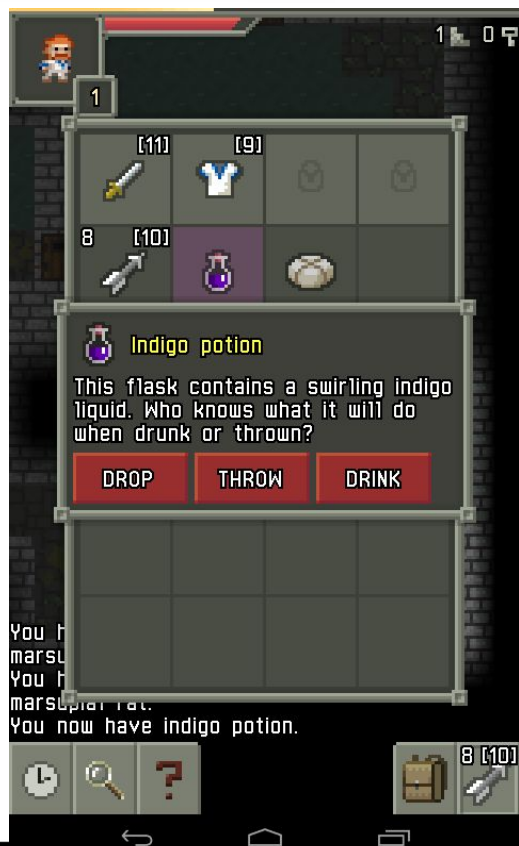
An IPv4 address (dotted-decimal notation)





Lifetime Seed





PCG Shotgun Contact Info:

@TylerMakesGames

@tanyaxshort

@bay12games

@luizkruel

@TheZaikman

@MituK