

Beyond Procedural Horizons

Different Uses of Procedural Generation

Tanya X. Short (Kitfox Games) - @tanyaxshort

Emily Short (Versu, SpiritAI) - @emshort

~~Loren Schmidt (Star Guard, Strawberry Cubes) - @lorenschmidt~~

Innes McKendrick (Hello Games, No Man's Sky) - @innesmck

Rich Vreeland (Hyper Light Drifter, Mini Metro) - @disasterpeace

Beyond Procedural Horizons

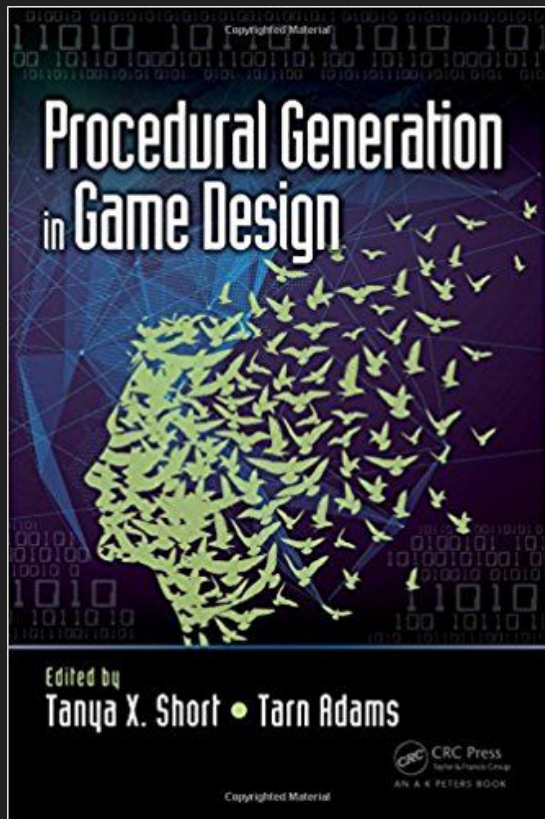
Different Uses of Procedural Generation

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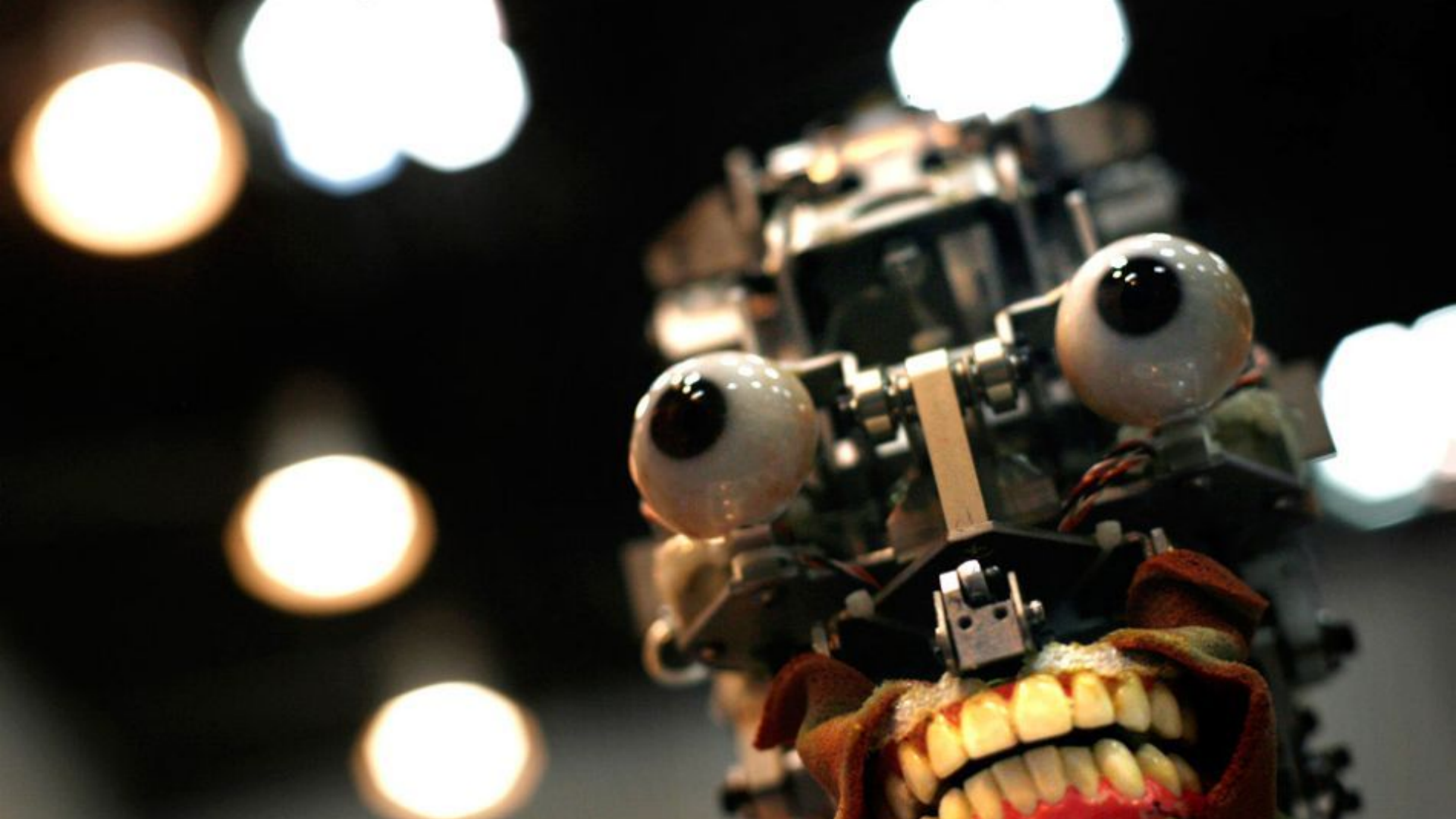
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Procedural Storytelling in Game Design (2019)









"The complexity of the AI is astonishing."

- Edge Online

"Versu captures the nuances of social interaction in a way not seen before."

- New Scientist

200 Units have been credited to your account

Catussia Yartio

New Discovery

Catussia Yartio

Age	Elderly
Gender	None
Temperament	Ambulatory
Diet	Herbivore
Weight	1.57m
Height	66.92kg

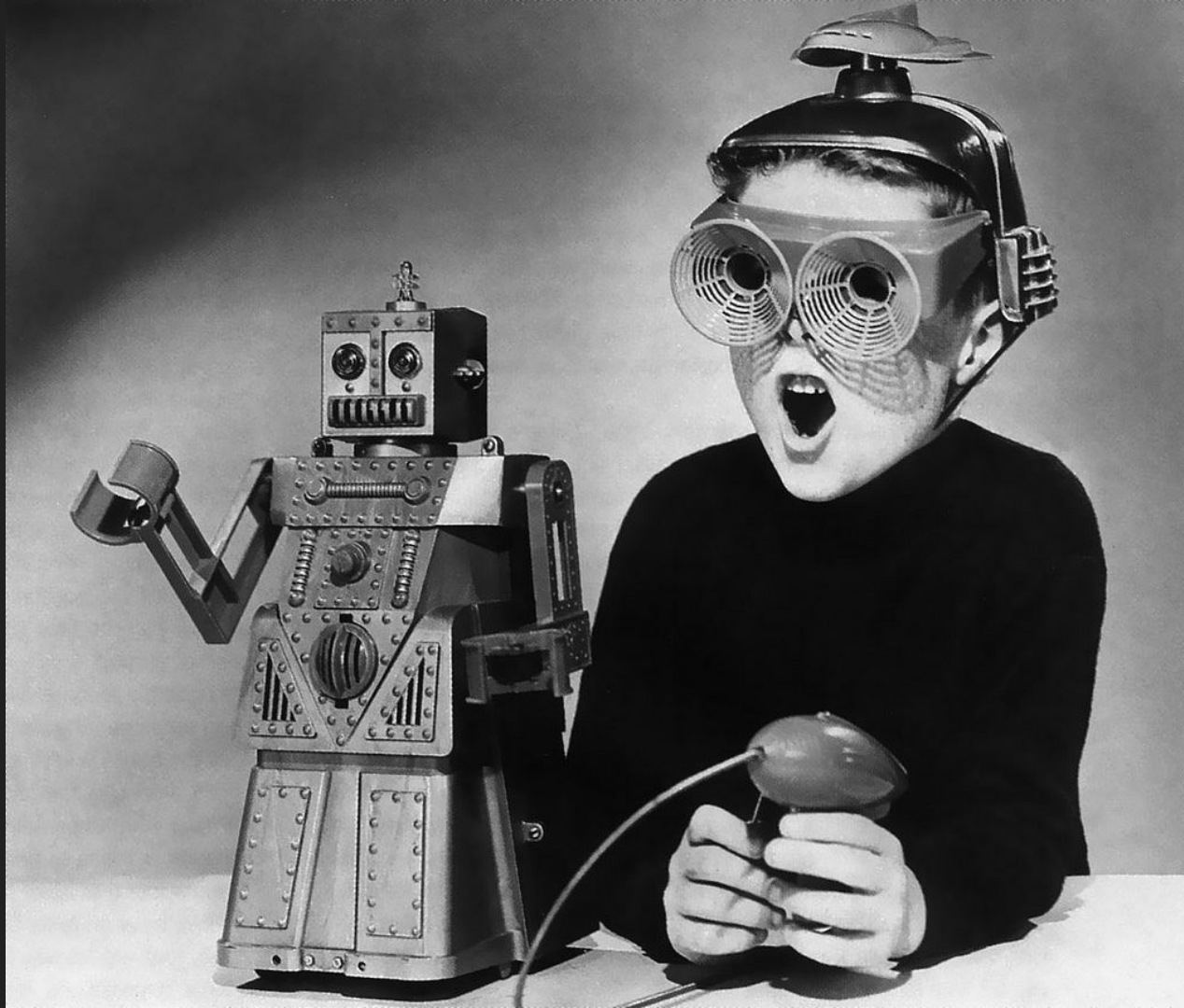
New Discovery Record Creature S
Fou

KUS

Tox

-14.7°C
0.7 Rad





Procedurally Generating Dialogue

...

Emily Short

Character Engine Product Manager

Spirit AI

What are we trying to accomplish?



vg_erotica
@vg_erotica

Follow



All he wanted was to learn Phillipa. To be the one to show her pleasure. To be the one to teach her to take it for herself. "Tell me what you want," he whispered.

She blushed, closing her eyes. "Press F to pay your respects."

12:53 PM - 4 Feb 2018

10 Retweets 59 Likes



↻ 10

♥ 59



@vg_erotica by Liz England



Fitzwilliam Darcy's Dance Challenge by Dietrich Squinkifer

Roses are censors
Violets are discursive
I am dispensers
And you are coercive

Roses are leeward
Violets are director
I am seaward
And you are collector

Roses are red

Violets are blue

Honey is spineless

and so are you.

Roses are Red generators by Kate Compton (left) and Emily Short (right)

table.

Lucy (to Mr Quinn): This is the finest roast beef that has ever graced my lips.

Choose an action
Conversation...
Listen to Mrs Quinn
Dinner...
Drink wine
Exercising your charm...
Encourage the footman to admire you
Encourage Frank to admire you
See whether the footman seems interested in you

The footman tilts her head and looks in slightly slanted eyes at Mrs Quinn, evaluating.

Mrs Quinn: It was the purest luck the Scortons's ball was not rained out. It looked dreadfully cloudy all that morning.

Frank: The Scortons must be the envy of their neighbours. They will be talked of for weeks.

Mr Quinn contrives to eat good Warwickshire cheese in a fashion that suggests resentment and martyrdom.

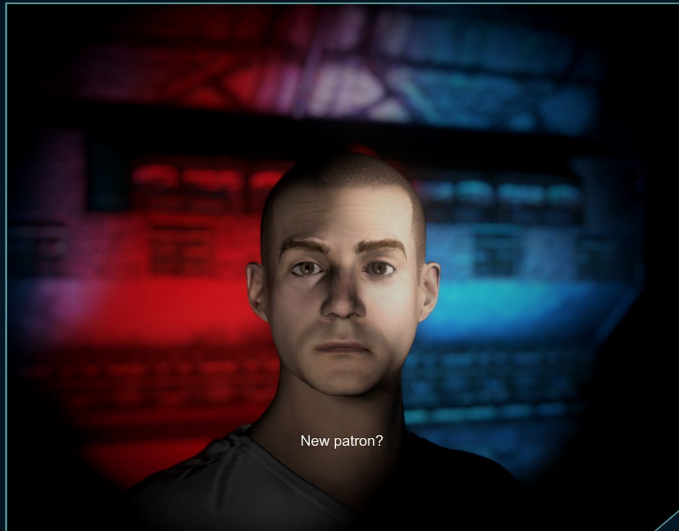


Act Now

More



Versu, Prom Week



YOUR REPLY

Hey, patron here!

I'd love some help here, when you have a minute.

I'm not in a hurry.

Name: Frank

Traits: pro-Empire, open, careless, extroverted, disagreeable, stable

<stable, careless>

General distraction

<disagreeable>

Rude ignoring

<extroverted>

Extroverted rude ignoring

New

customer/variant names

<gordo:inebriate>

customer v

patron

?

DIALOG

Character Engine (Spirit AI)

Are you by any chance a mind-reader?

Yes, you jerk.

Thanks for not lying, \$#@%head.

Mandatory and Optional Features of Generated Dialogue

Must communicate

- Quest assignment
- Key lore
- Social move

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May communicate

- Personality
- Emotional state
- Relationship to the player

Mandatory and Optional Features of Generated Dialogue

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- Quest assignment
- Key lore
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- Emotional state
- Relationship to the player
- How close this character is to snapping and killing everyone in the village square

Mandatory and Optional Features of Generated Dialogue

Must communicate

- Quest assignment
- Key lore
- Social move
- How close this character is to snapping and killing everyone in the village square

May communicate

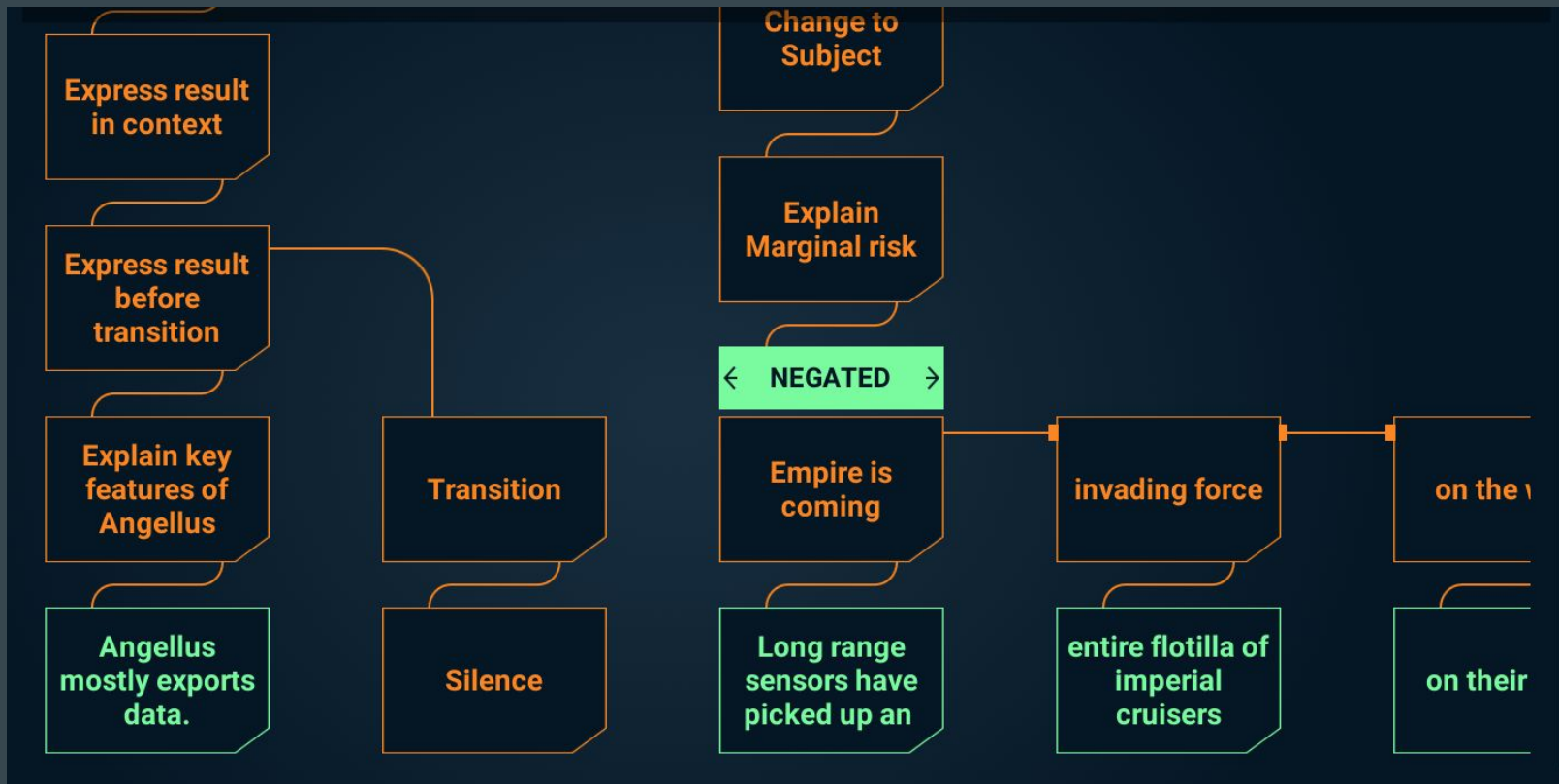
- Personality
- Emotional state
- Relationship to the player

This is a rendering task

Yes, you jerk.

- respond to question answered (plot)
- respond to rudeness (social)
- express crude personality (optional)

Thanks for not lying, \$#@%head.



Text Generation via Context-Free, Tagged Grammar
(based on Expressionist/Productionist, James Ryan)

Fragment

Label: Ask_about_exits_anxious

Top Level

Variants:

Please tell me you have [[transport_from]] {marginal_station}.
[[Youre]] going to need [[transport_from]] {marginal_station}. [[Go...
You've got to find [[transport_from]] {marginal_station}. [[Got_any...

Tags:

Condition: While Trait: anxious

Examples:

Go to...

Cancel

OK

Delete

Add

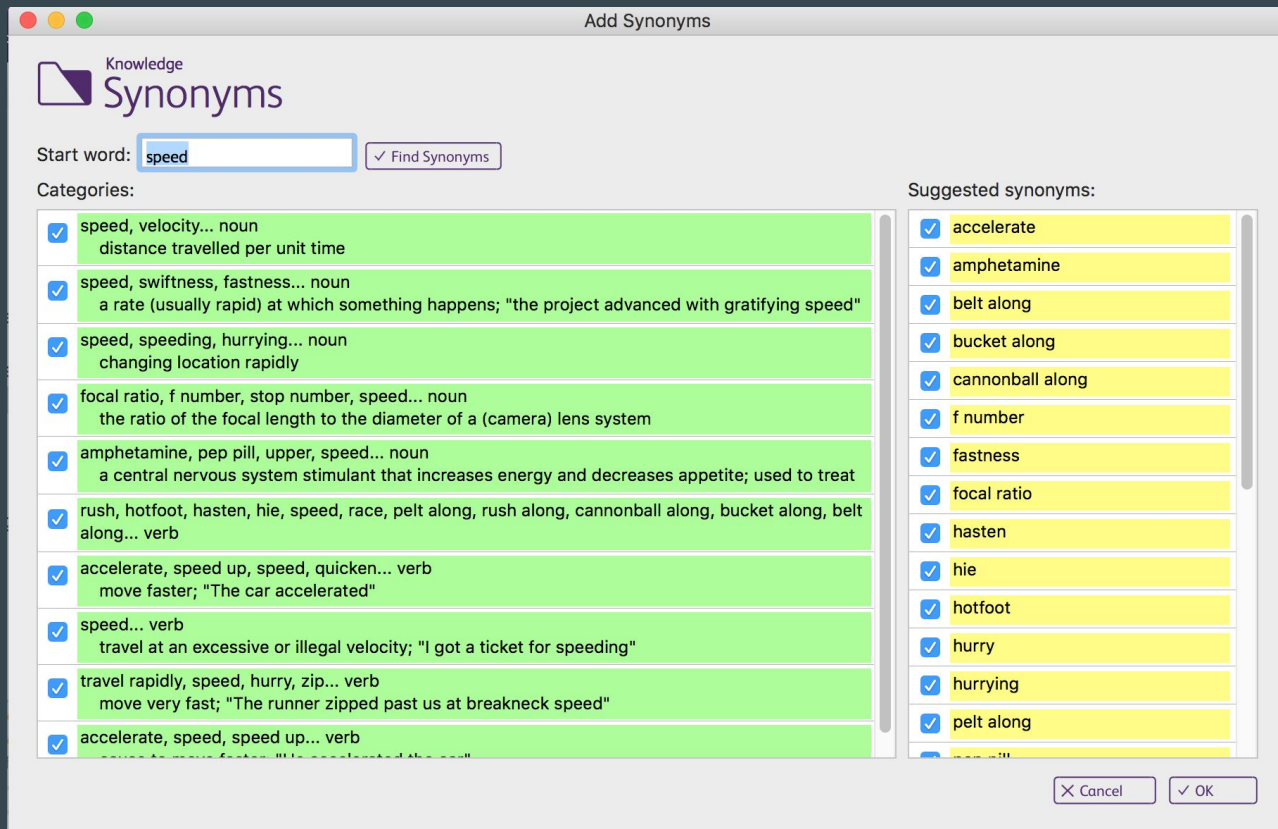
Delete

Add

Regenerate

Substitutions of text and entity names

Building a Corpus



Corpus Generation — Pulling in variant wording

Variation for the sake of variety

Anyone **planning** to be out of the way before **the entire flotilla of imperial cruisers gets here**, they need to leave **in the next twelve hours or so**.

Anyone **who wants** to be out of the way before **the Imperial battle group arrives**, they need to leave **tonight**.

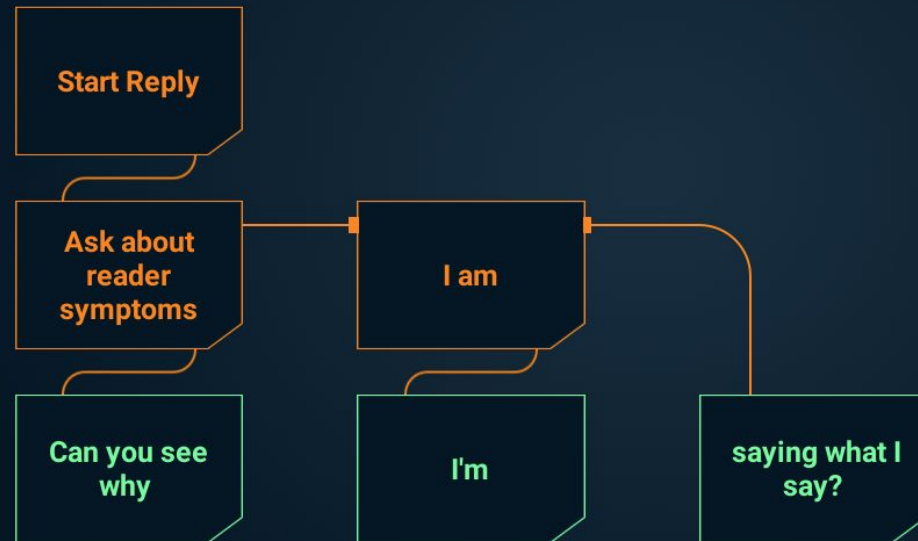
Name: **Kara**

Traits: unfriendly, trustful, dominant, mimetic, informal, calm

Keywords: **correct**

Active Social Practices:

NPC To Player: **Audience**, **VerifyIdentity**



Variation for personality

Bob is a bad fit for the job.

I think Bob is not a great fit for the position, to be honest.

NEGATED
← marginal →
cannot resist,

Marginal will
fall

Marginal
station v

Marginal
Station

← informal →

cant

can't

keep out the

invading force

entire flotilla of
imperial
cruisers

Variation for humor and color

In twelve hours, we'll have the Eyautan Empire cracking open this station like a **tin** of **synthetic horsemeat**.

Tomorrow morning, we'll have the Empire cracking open Marginal Station like a **keg** of **Castellan Brandy**.

Generated Text Needs Aesthetic Metrics



The Mary Jane of Tomorrow, Annals of the Parrigues

Oracle Generation Grammar

- [person] [notices] [an animal] [doing something weird]
- Person: [a profession] named [name] the [attribute]
- Notices: hears, sees, etc
- Animal: [an attribute] [creature]
- Doing something weird: [activity] [in a location]
- Location: standing/sitting/etc [in lighting] [in physical place]

Oracle Produced

A goatherd named Leofrick the Seditious heard the voice of a flaming mare who was defecating while standing in shaft of moonlight on a hilltop.

Post-Generation Selection

- Weighting to pick from all the ways of expressing the same meaning
- ...using scoring for verbosity or number of unusual words
- ...or classifiers to select for particular styles

Final Touches

Post-Generation Edits

I think Bob is not a great fit for the position, to be honest.

Um... I think Bob is not a great fit for the position, to be honest.

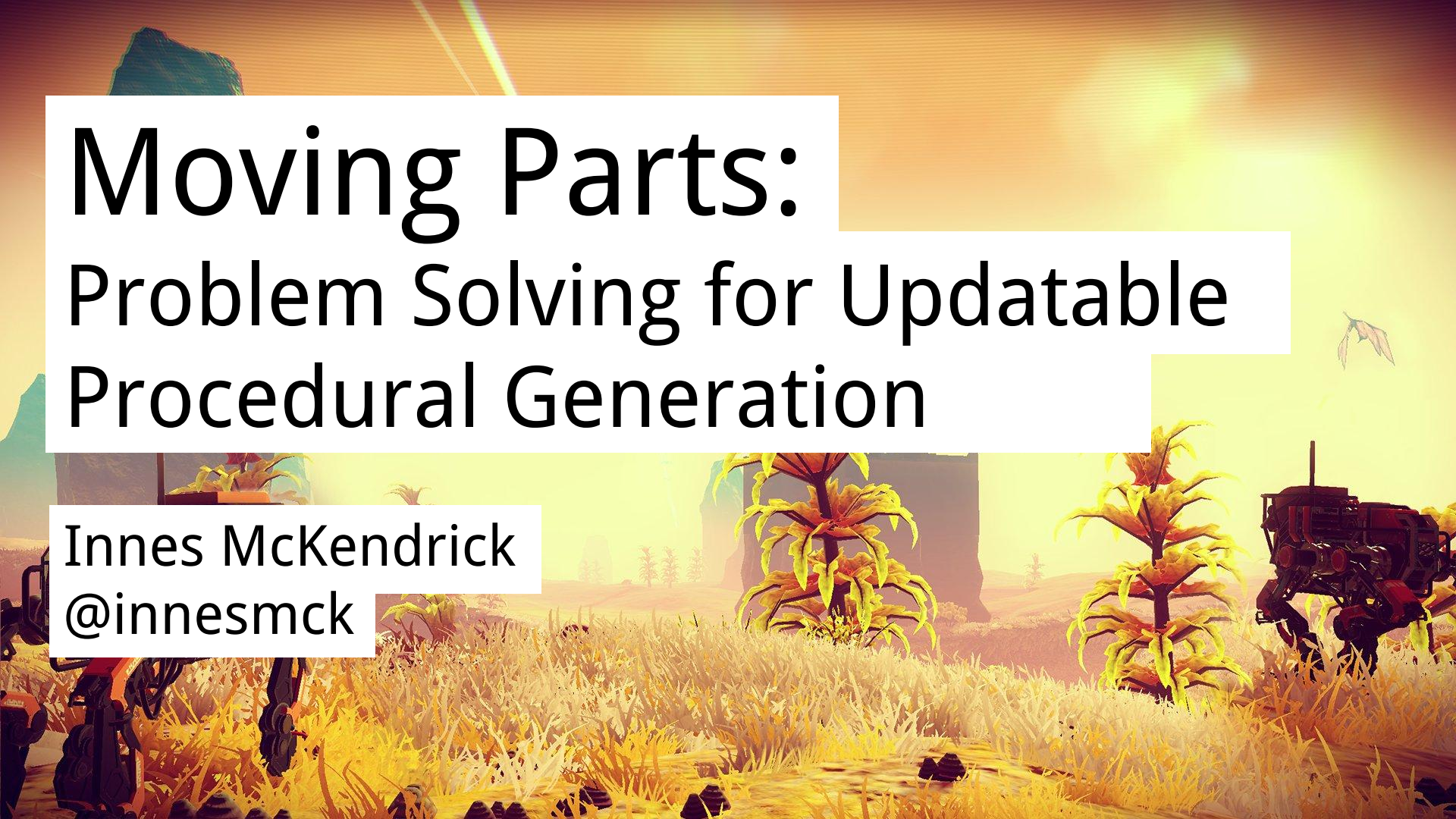
Procedurally Generating Dialogue

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Emily Short

Character Engine Product Manager

Spirit AI



Moving Parts: Problem Solving for Updatable Procedural Generation

Innes McKendrick
@innesmck



You have a game

It uses procedural generation

You want to update and improve
your generators



Games don't just ship once



You **need** to think about change
from the very beginning



Allowing for iteration is critical to
authorship

Top-Down Generation



```
graph TD; A[Solar System] --> B[Lush Planet]; A --> C[Frozen Planet]; A --> D[Dead Planet]; B --> E[Inhabitants]; B --> F[Creatures]; C --> G[Terrain]; D --> H[Foliage]; D --> I[Buildings];
```

The diagram illustrates a top-down generation process. It begins with the 'Solar System' at the top, which branches into three planet types: 'Lush Planet', 'Frozen Planet', and 'Dead Planet'. 'Lush Planet' further branches into 'Inhabitants' and 'Creatures'. 'Frozen Planet' branches into 'Terrain'. 'Dead Planet' branches into 'Foliage' and 'Buildings'. The background features a space-themed illustration with a spaceship, a planet, and a star.

Solar System

Lush Planet

Frozen Planet

Dead Planet

Life Level

Terrain

Inhabitants

Creatures

Foliage

Buildings

Top-Down Generation



```
graph TD; Dungeon --> FirstFloor[First Floor]; Dungeon --> SecondFloor[Second Floor]; Dungeon --> ThirdFloor[Third Floor]; FirstFloor --> Room1[Room]; SecondFloor --> Room2[Room]; SecondFloor --> Corridor[Corridor]; ThirdFloor --> Room3[Room]; Room1 --> Enemies[Enemies]; Room1 --> Treasure[Treasure]; Room1 --> Decoration[Decoration]; Room2 --> Enemies; Room2 --> Treasure; Room2 --> Decoration; Room3 --> Enemies; Room3 --> Treasure; Room3 --> Decoration;
```

Dungeon

First Floor

Second Floor

Third Floor

Room

Room

Corridor

Enemies

Treasure

Decoration

Common Problems

Small changes which make dramatic difference to output

Common Problems

Small changes which make dramatic difference to output

Generative systems dependent on other systems

Common Problems

Small changes which make dramatic difference to output

Generative systems dependent on other systems

Maintaining player state

Common Problems

Small changes which make dramatic difference to output

Generative systems dependent on other systems

Maintaining player state

Tracking consequences

Common Problems

Small changes which make dramatic difference to output

Generative systems dependent on other systems

Maintaining player state

Tracking consequences

Identifying and measuring change

Small changes which make dramatic difference to output

Assume Your Inputs Will Increase



Small changes which make dramatic difference to output

Assume Your Inputs Will Increase

Assume you will add more content

Reduction is simple removal/replacement

Can you increase in-world density?

How do we decide what to replace?

Small changes which make dramatic difference to output

Assume Your Inputs Will Increase

Most basic generation concept

Selection from a list

Probability or heuristic based

Addition to list impacts selection

Tree: 1.0

Rock: 0.5

Large Rock: 0.1

Plant: 0.75

Small changes which make dramatic difference to output

Assume Your Inputs Will Increase

Use sparse, fixed-sized structures

Explicitly replace objects

Can generate from heuristic

Can be used positionally

Tree

Tree

Tree

Rock

Rock

Plant

Bush

Generative systems dependent on other systems

Compartmentalize Change



Generative systems dependent on other systems

Compartmentalize Change

Refactor generation hierarchy

Move knowledge upstream

Enemies

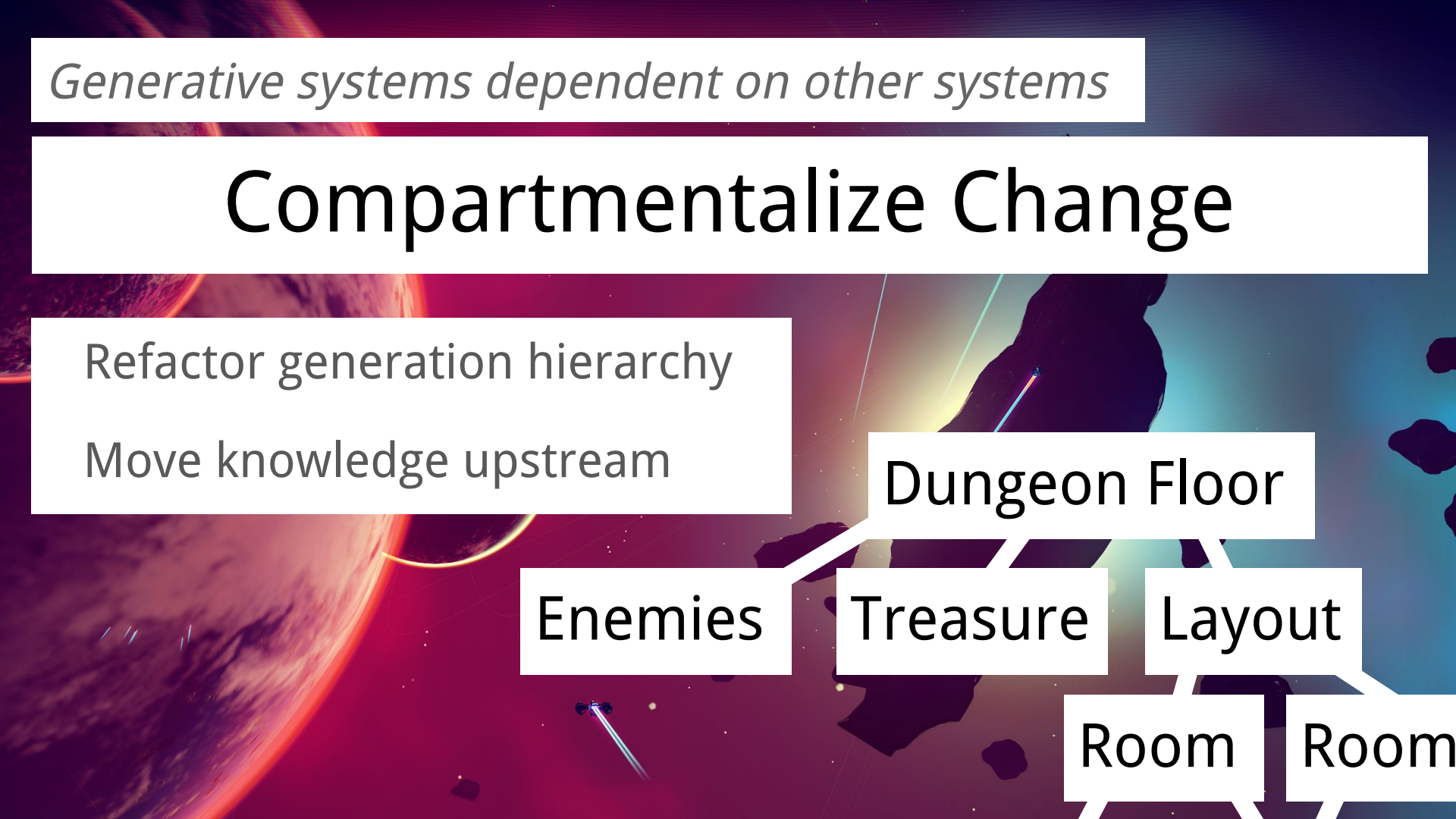
Treasure

Dungeon Floor

Layout

Room

Room



Generative systems dependent on other systems

Compartmentalize Change

All inputs should have meaning

Generate enumerated lists of pseudorandom values

Re-seed your RNG at specific intervals - test this!

Maintaining player state

Identify The Moving Parts





Maintaining player state

Identify The Moving Parts

Design systems to be relocatable and adaptable

Identify significant vs trivial player state

Never assume state data is valid

Generate fallbacks

Tracking consequences

Generate Data You Can Read





Tracking consequences

Generate Data You Can Read

If your generators are black boxes, input and output can't be

Consider generators a means of filling data structures

Human readable text format

Save, load, compare, revive, reuse

Identifying and measuring change

Test with Intention



Identifying and measuring change

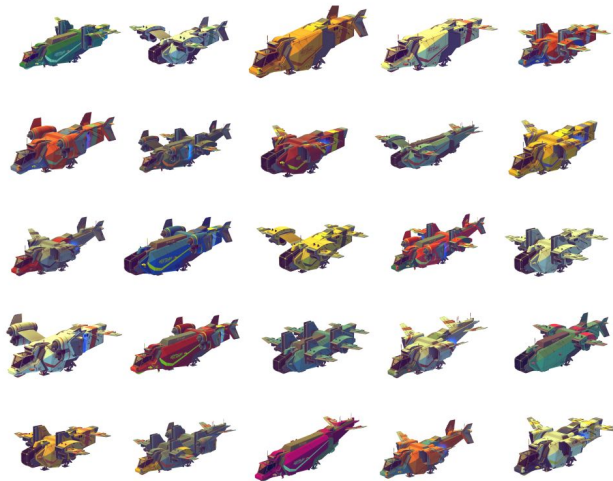
Test with Intention

Automate as much as you can

Recognise what you can't

ALWAYS test for breadth and variety

Establish min and max situations





Games Don't Just Ship Once

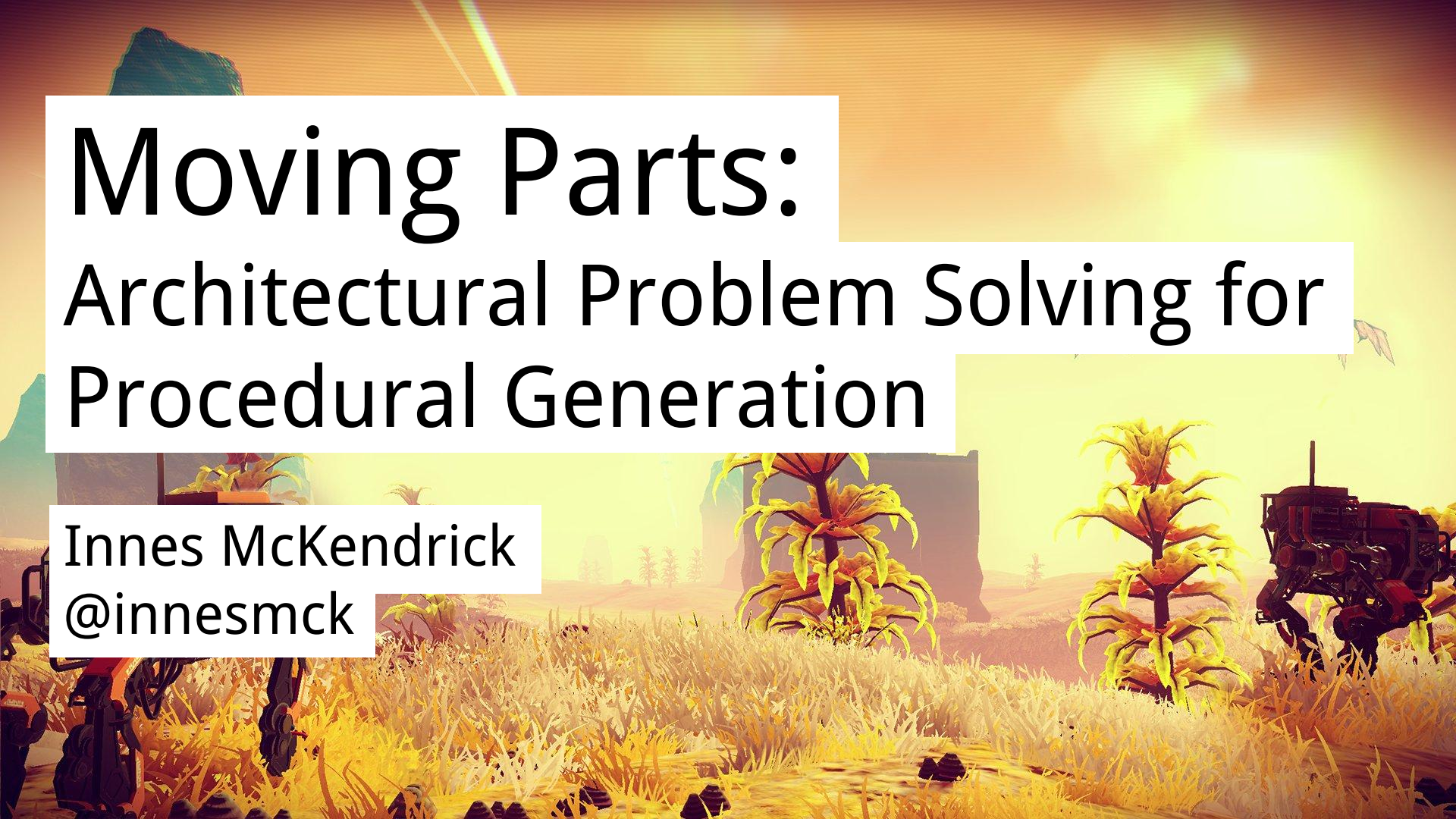
Build For Growth

Design for Iteration

Support with Adaptable Gameplay

Embrace Change





Moving Parts:

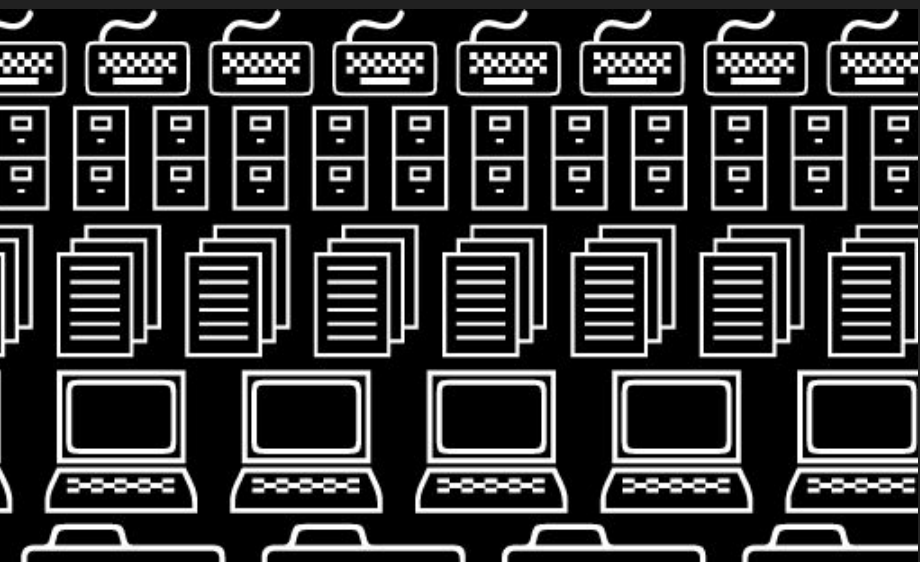
Architectural Problem Solving for Procedural Generation

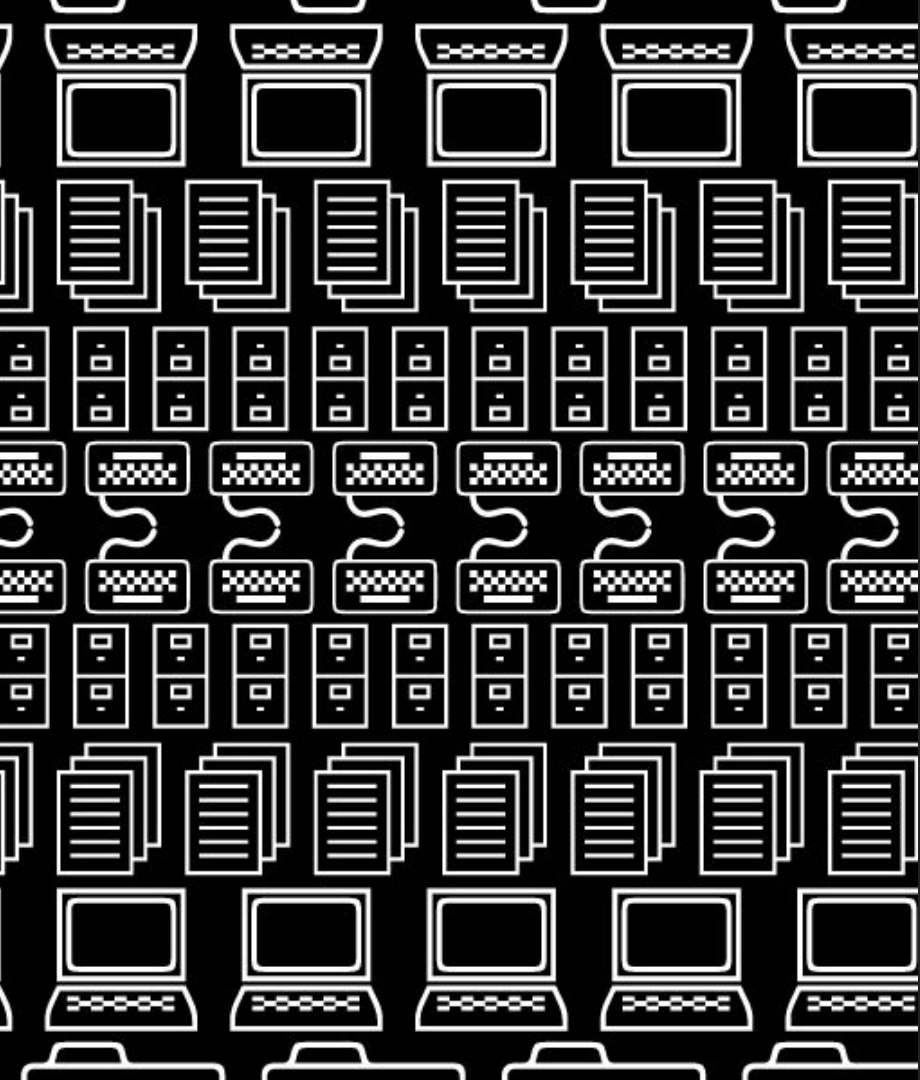
Innes McKendrick
@innesmck

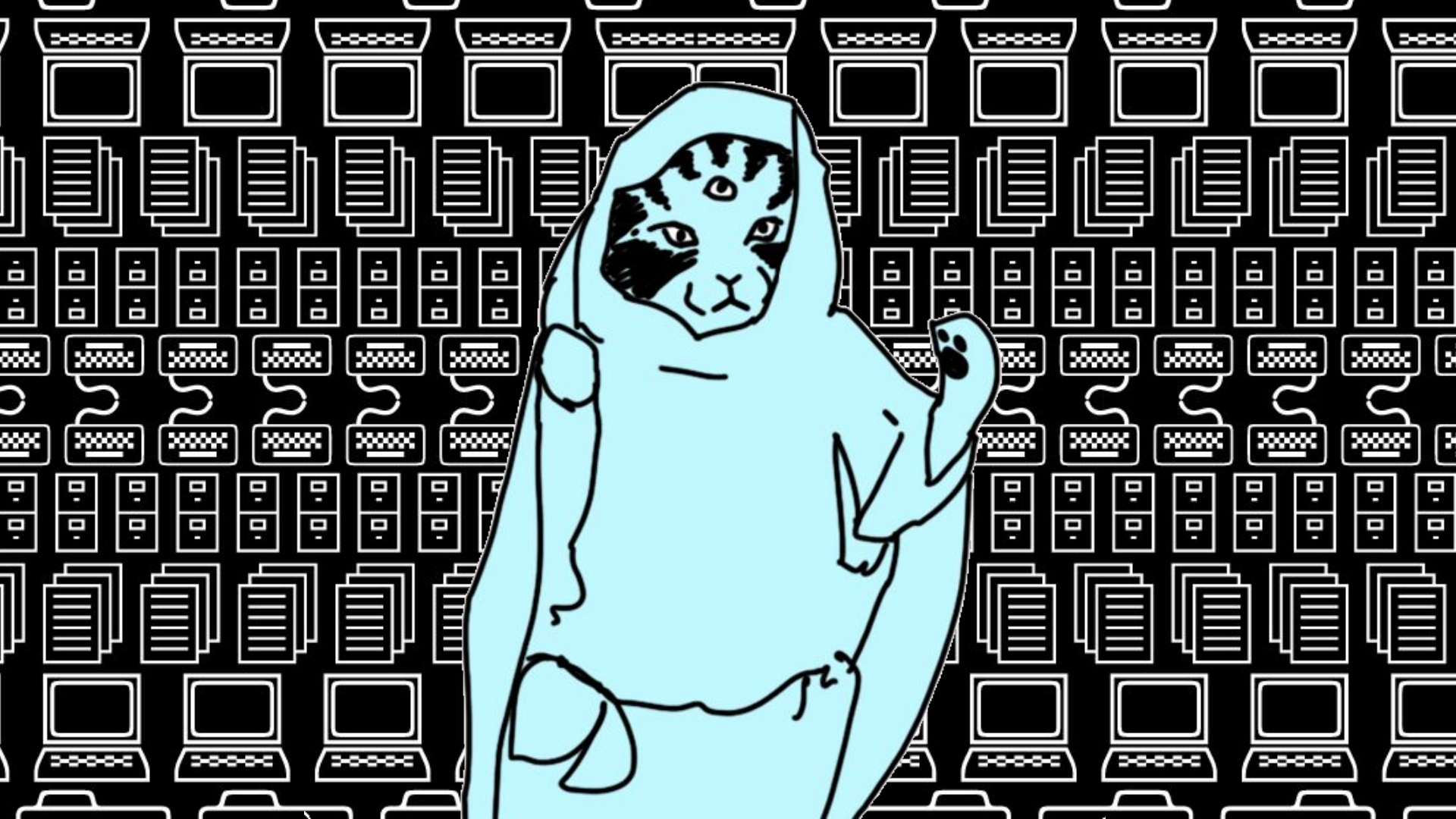
Serialism & Sonification

in Mini Metro

Serialism

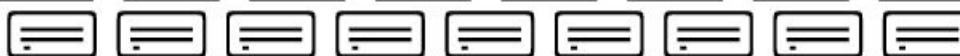






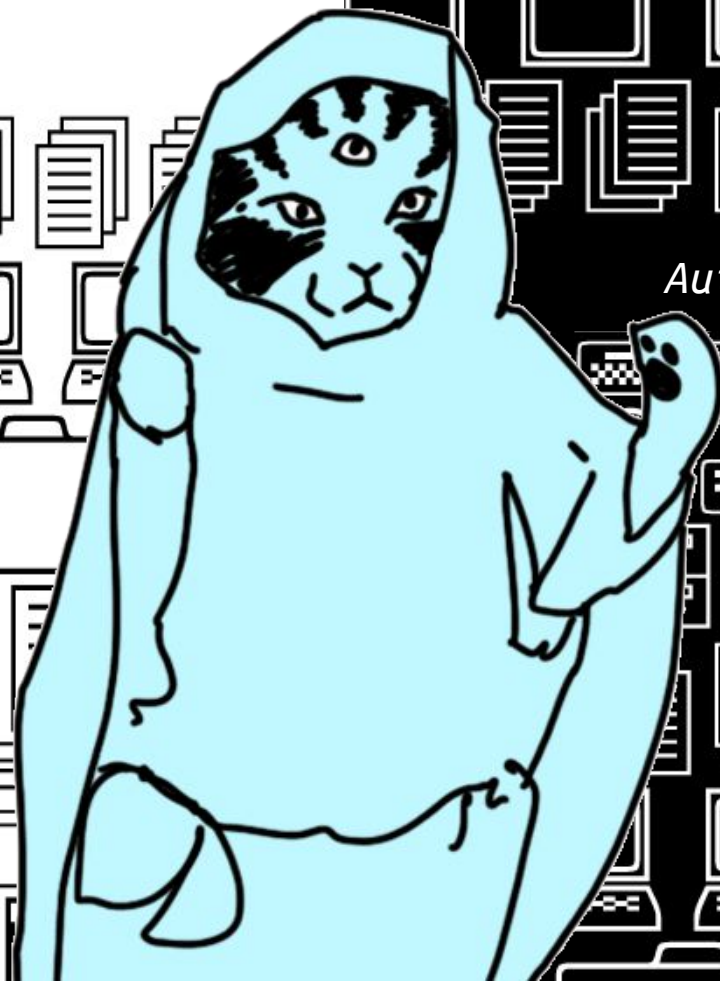


Game Data



Game Data

Authored Data





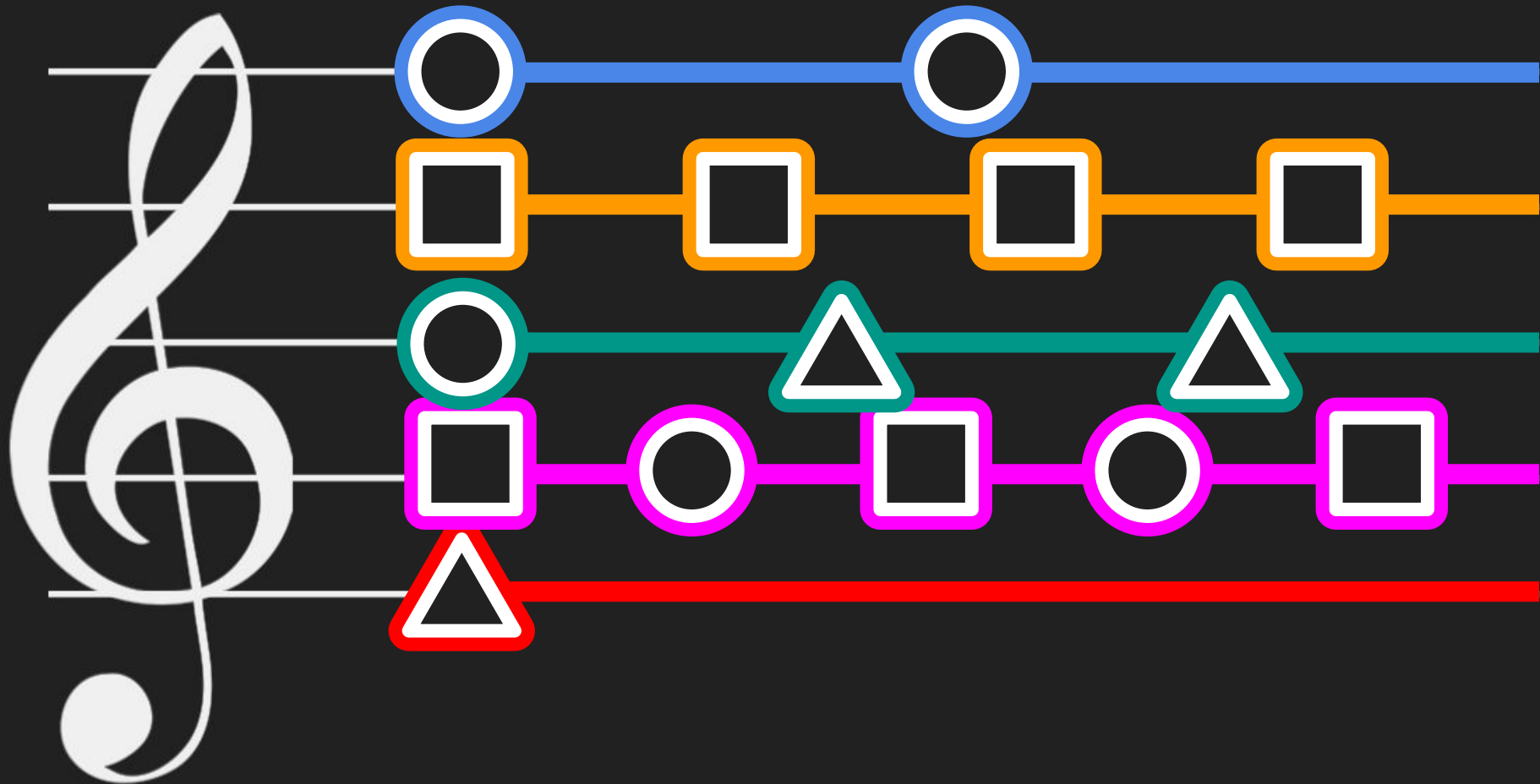
1 In-Game Hour

= 0.8 secs

= 1 beat @ 72 bpm

= our master pulse



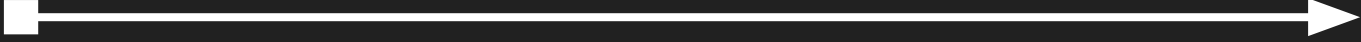


[1, 2, 3, 4, 6]

[1, 2, 3, 4, 6]



master pulse (0.8s)

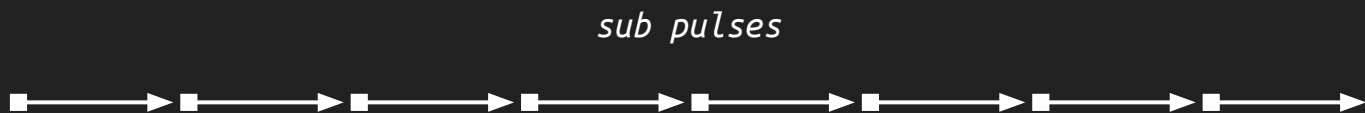
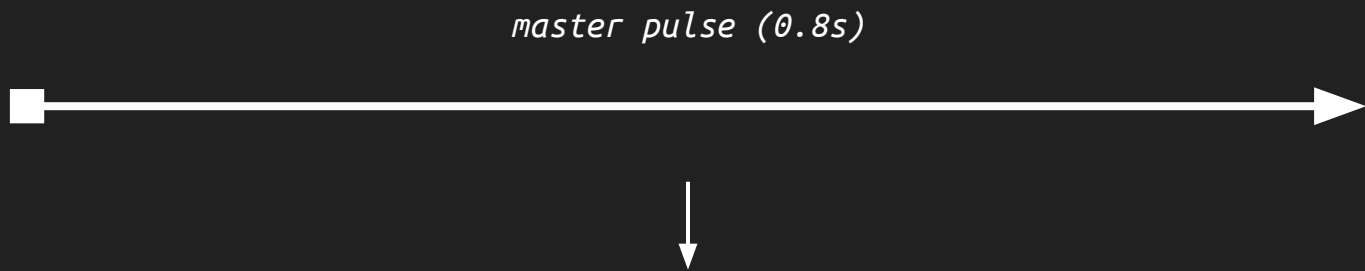


master pulse (0.8s)



sub pulses





[1, 2, 3, 4, 6]

master pulse (0.8s)



sub pulses



[1, 2, 3, 4, 6]

master pulse (0.8s)



sub pulses



[1, 2, 3, 4, 6]

master pulse (0.8s)



sub pulses



[1, 2, 3, 4, 6]

master pulse (0.8s)



sub pulses



[1, 2, 3, 4, 6]

master pulse (0.8s)



sub pulses



[1, 2, 3, 4, 6]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

APPLAUSE

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Stations

Passengers



Station: [Circle, Square, Triangle, Circle]

X Position %: [45%, 54%, 68%, 84%]

Passengers: [4, 6, 9, 1]

Red Line

Rhythms: [1, 2, 3, 4, 6]

Pitches: [C3, E3, F3]

Bassline: [C, G, E, A]

Stations

Passengers



File Set: [Circle, Square, Triangle, Circle]

Pan: [10%L, 8%R, 36%R, 68%R]

Volume: [40%, 60%, 90%, 10%]

Game Data

Line Lengths

Line ID

Station Type

Station Occupancy

Station Line

Position

Object ID

Locations

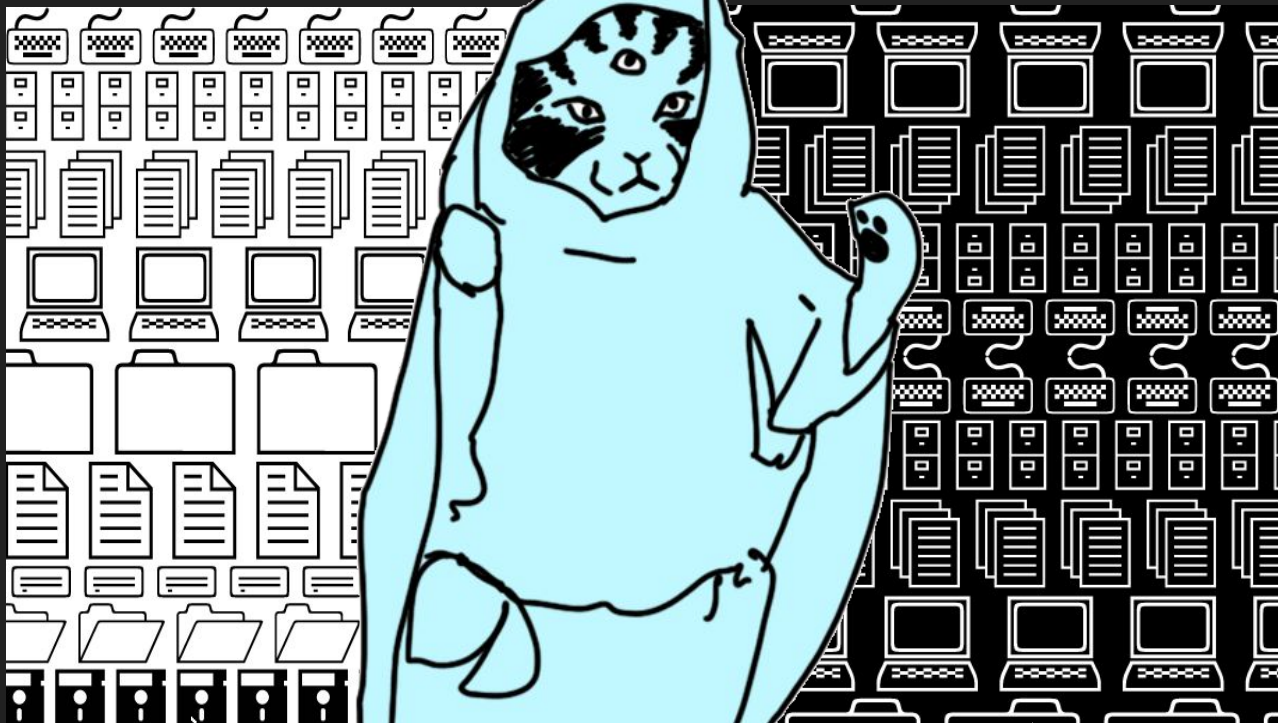
Passenger Types

Time Increments

Game State

Game Speed

etc...



Authored Data

Per Line
Assignments

Pitches

Basslines

Tempos/Subtempos

Rhythms

Transpositions

Menu Chords

Timbres

Note Fade Times

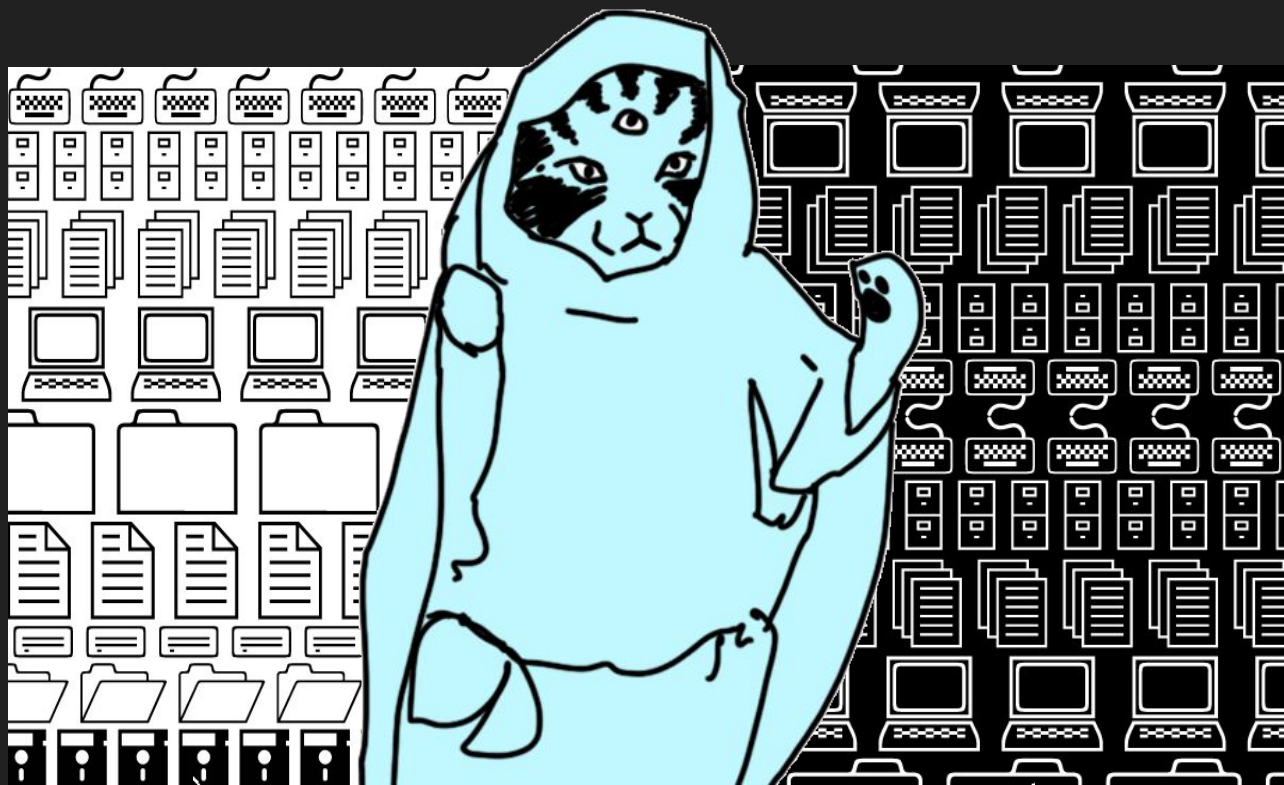
Passenger

Spawn Rhythms

Per City

Assignments

etc...





Why?

Immediacy & Embodiment

Immediacy





15 

THU 





Embodiment



Thanks!

Rich Vreeland
Disasterpeace.com

Beyond Procedural Horizons

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