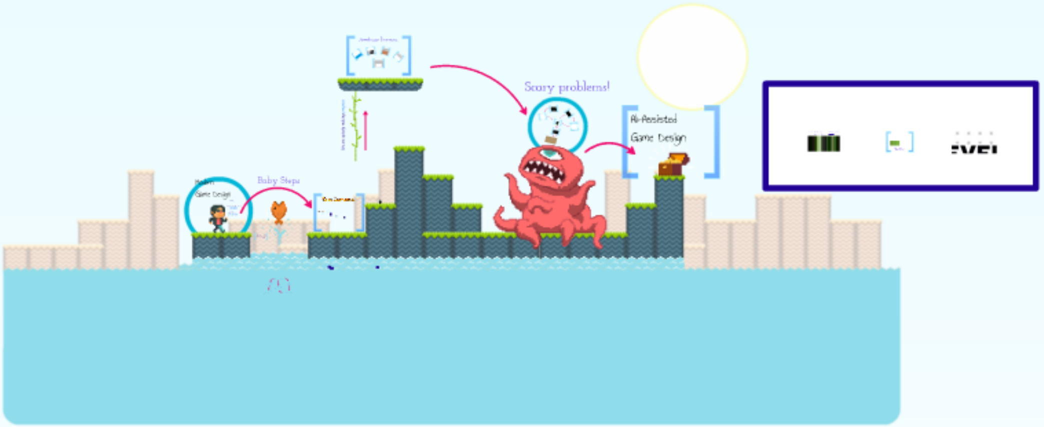
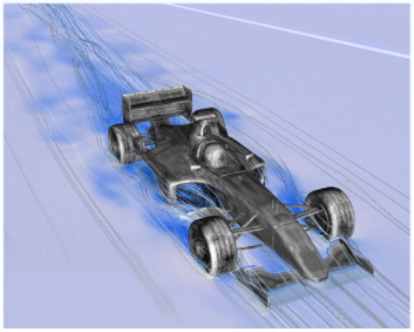
What would it take to make Shigi a reality?

I'm trying to sell you on a way of thinking about design.

I'm not trying to sell you a tool.



Virtual Wind Tunnel for Game Design



From the Behavior Up: When the AI Is the Design

Paul Tozour
Intelligence Engine Design Systems

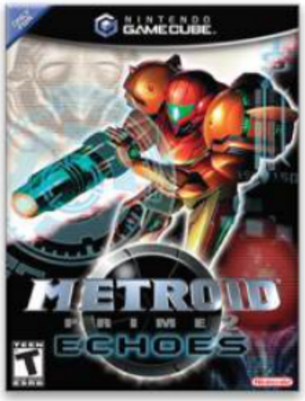
Damian Isla
Christian Baekkelund
Moonshot Games

AI ARTIFICIAL INTELLIGENCE SUMMIT

GAME DEVELOPERS CONFERENCE®
SAN FRANCISCO, CA
MARCH 25-29, 2013
EXPO DATES: MARCH 27-29
2013

Intelligence Engine

DESIGN SYSTEMS



paultozour.prosite.com
GDC Play kiosk 50

"Evolver" Coevolutionary Optimizer: What, How, and WHY

Shigi

Science Fiction!

AI-Assisted Game Design

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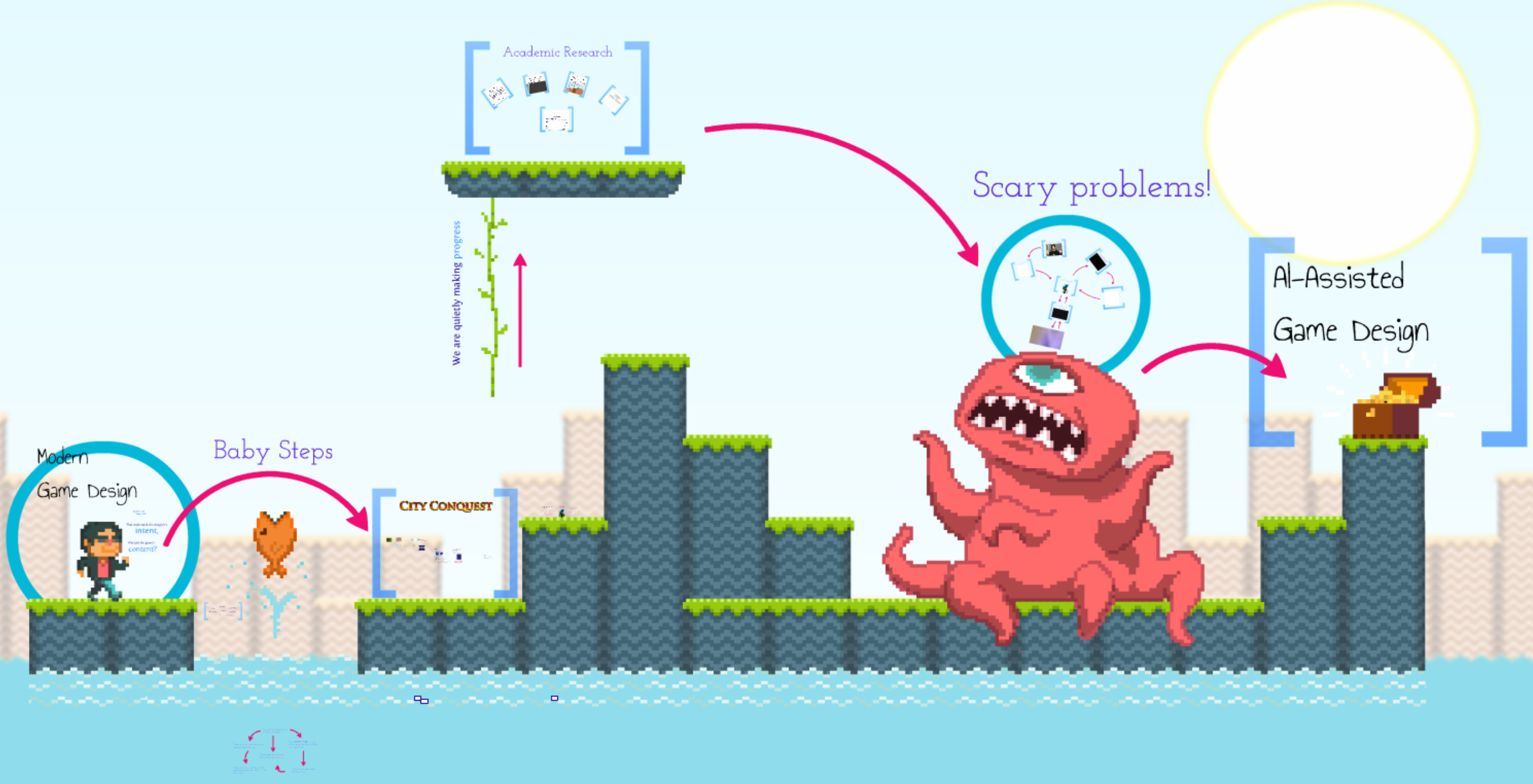

Prezi

I’m not trying to sell you a tool.

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way of thinking about design.

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way of thinking about design.

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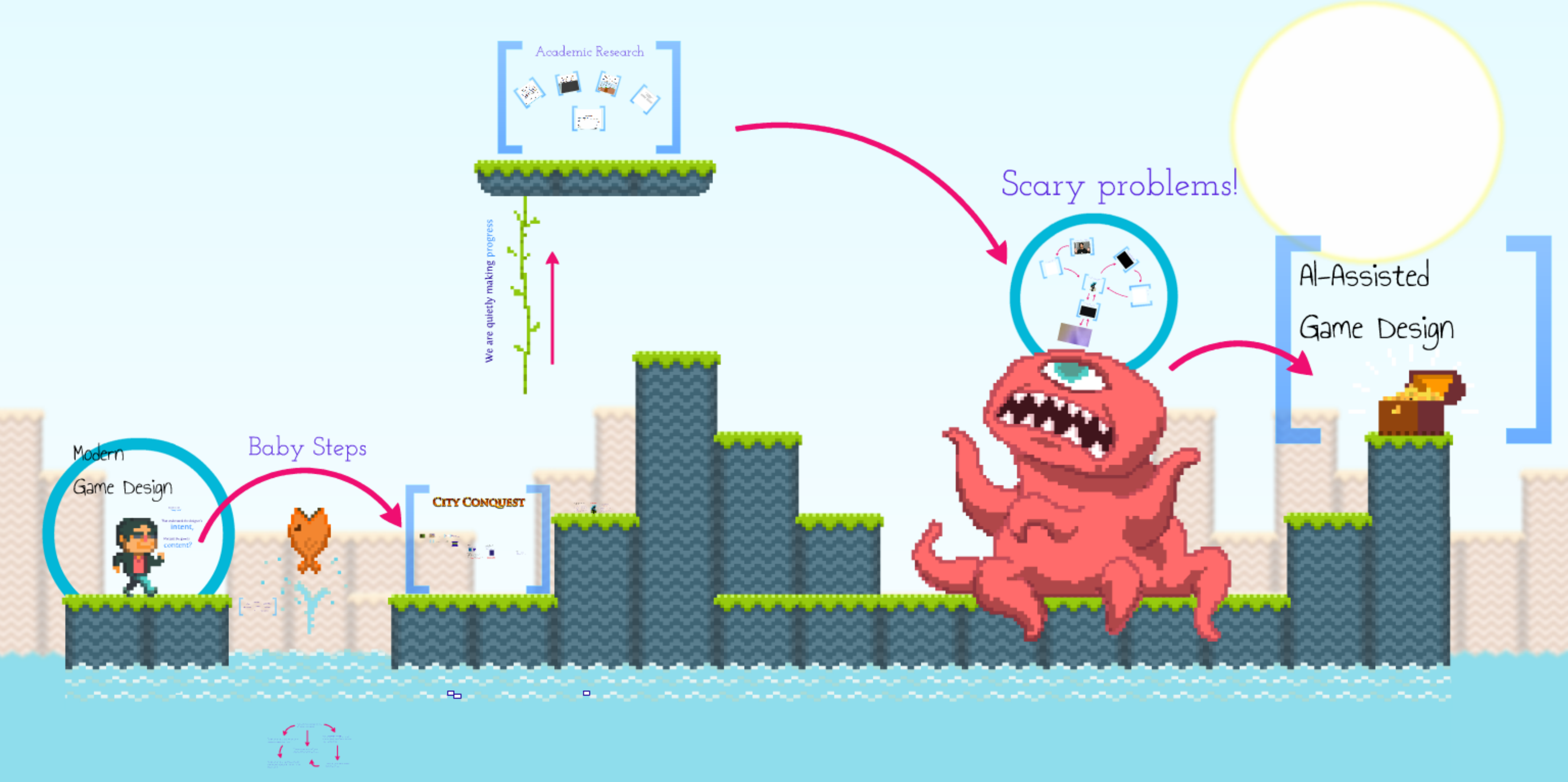


Modern Game Design

Bo

What could we do with "deep tools"

That understand the designer's **intent,**

Not just the game's **content?**

[

Lighting
Animation
Partic
Dialogue Editing
Scripting
Lev
AI
Sound Des

"We are still alchemists of our trade, mixing two parts impure story with one part polluted gameplay with three parts market voodoo.

As an industry, we need to move beyond the mystical hand waving that defines modern game design."

-- Daniel Cook, Spry Fox

"Our design process is a giant Katmari ball,

picking up every idea it rolls over."
- Anonymous producer

Modern game design = "iteration"
"Iteration" = trial and error

Exploring the darkness.

No disciplined way to explore the possible design decisions and their ramifications without actually implementing them.

An Edisonian Process

Risky. Expensive. Time-consuming. Error-prone.

Prototyping is faster & cheaper but STILL very expensive & time-consuming.

We take for granted that this is the ONLY way to design!

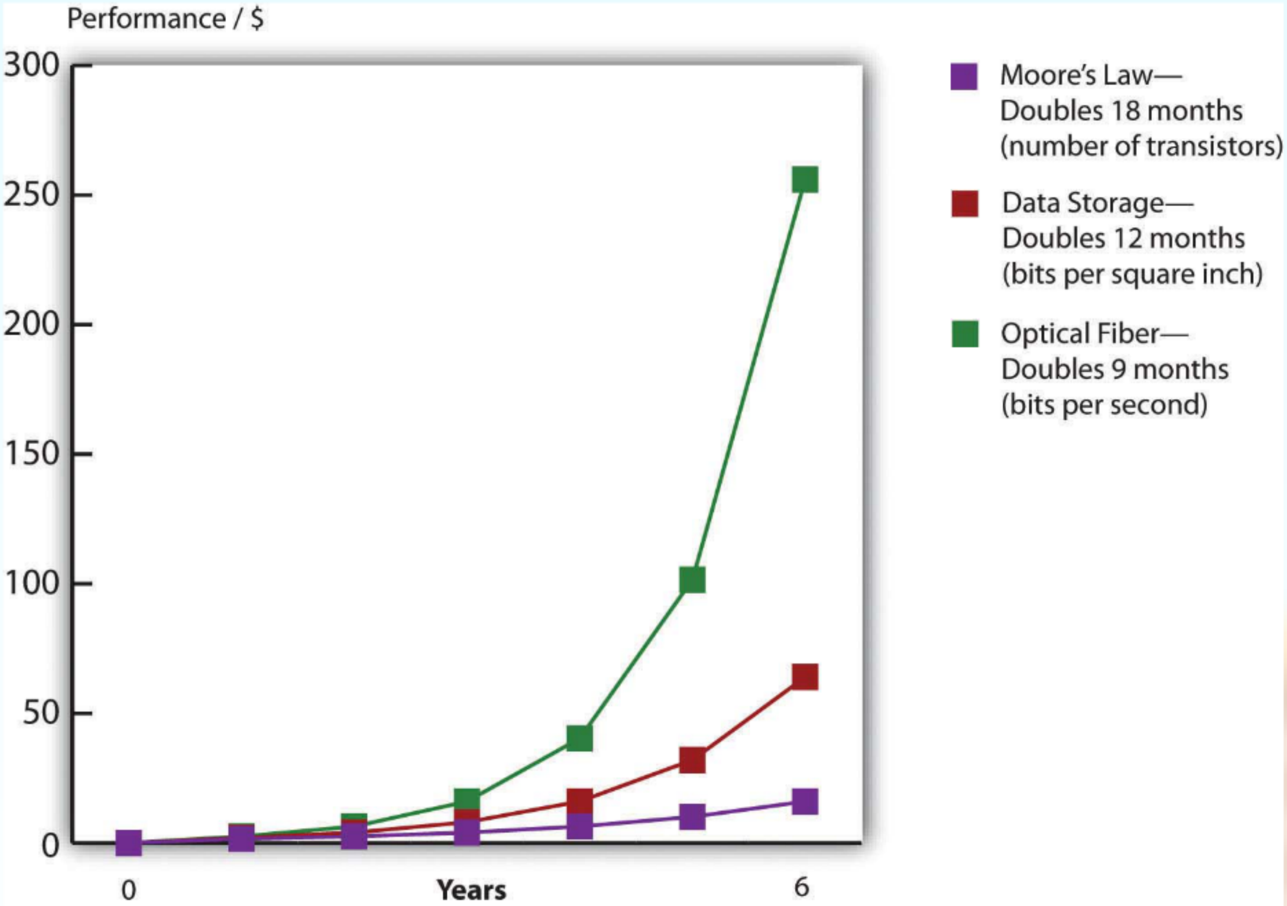
ch
Strategi
A S S O
VS

HEAT MAP

These are not design tools.

- Not interactive
- Pre-release user testing with focus groups & beta testers is expensive -- costs scale linearly
- Post-release user testing is too late

Moore's Law


Performance / $
300
250
200
150
100
50
0
0
Years
6
🟪 Moore's Law—Doubles 18 months (number of transistors)
🟥 Data Storage—Doubles 12 months (bits per square inch)
🟩 Optical Fiber—Doubles 9 months (bits per second)

What could we do with

"deep tools"

What could we do with

"deep tools"

That understand the designer's

intent,

Not just the game's

content?

Animation

Lighting

Particle Effects

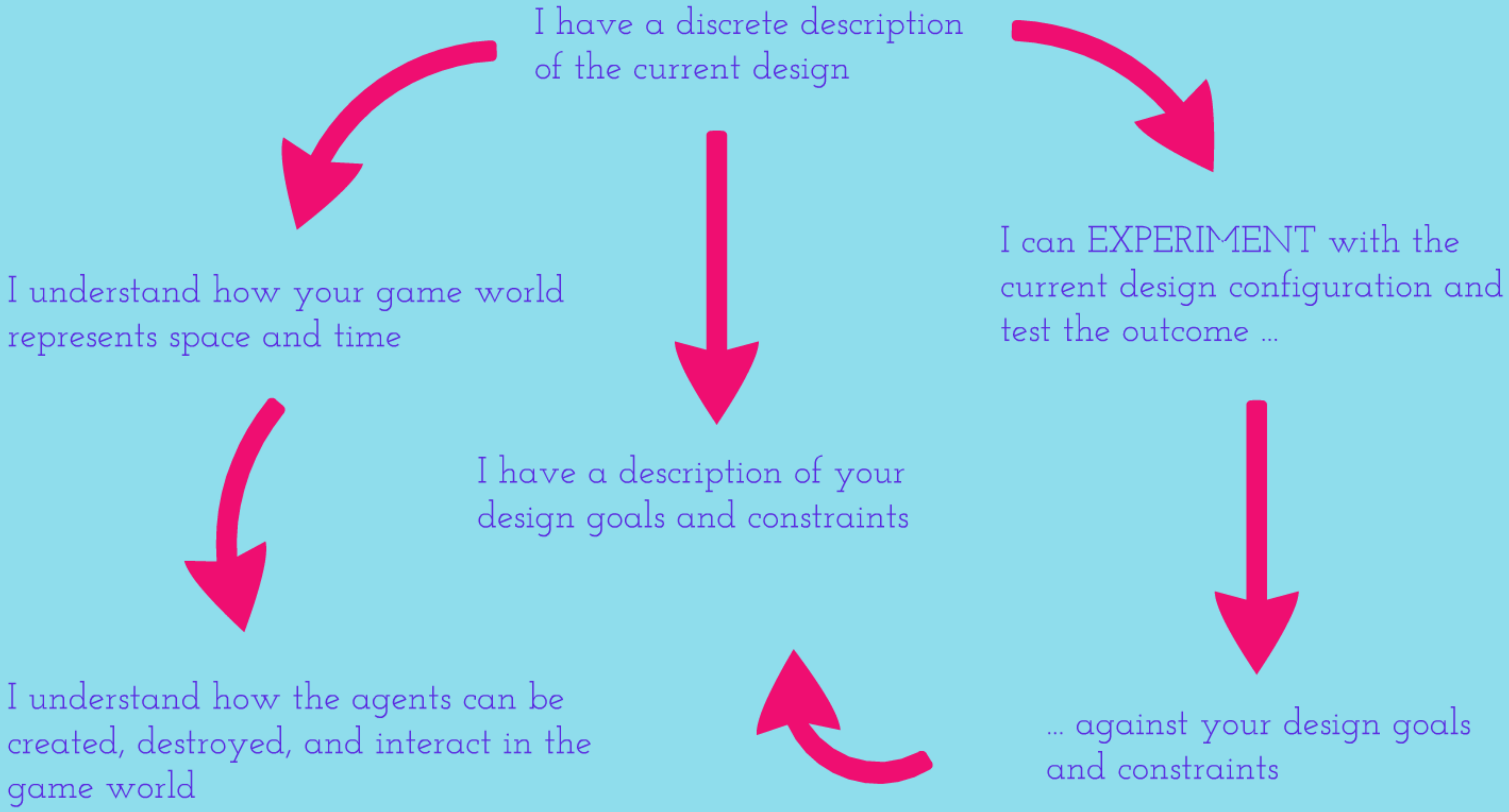
Scripting

Dialogue Editing

Level Design

AI

Sound Design



I have a discrete description of the current design

I understand how your game world represents space and time

I understand how the agents can be created, destroyed, and interact in the game world

I have a description of your design goals and constraints

I can EXPERIMENT with the current design configuration and test the outcome …

… against your design goals and constraints

I have a discrete description of the current design

T

he World

I have a description of your design goals and constraints of the

I understand how your game world represents space and time

I have a

design go

I have a de
design goal

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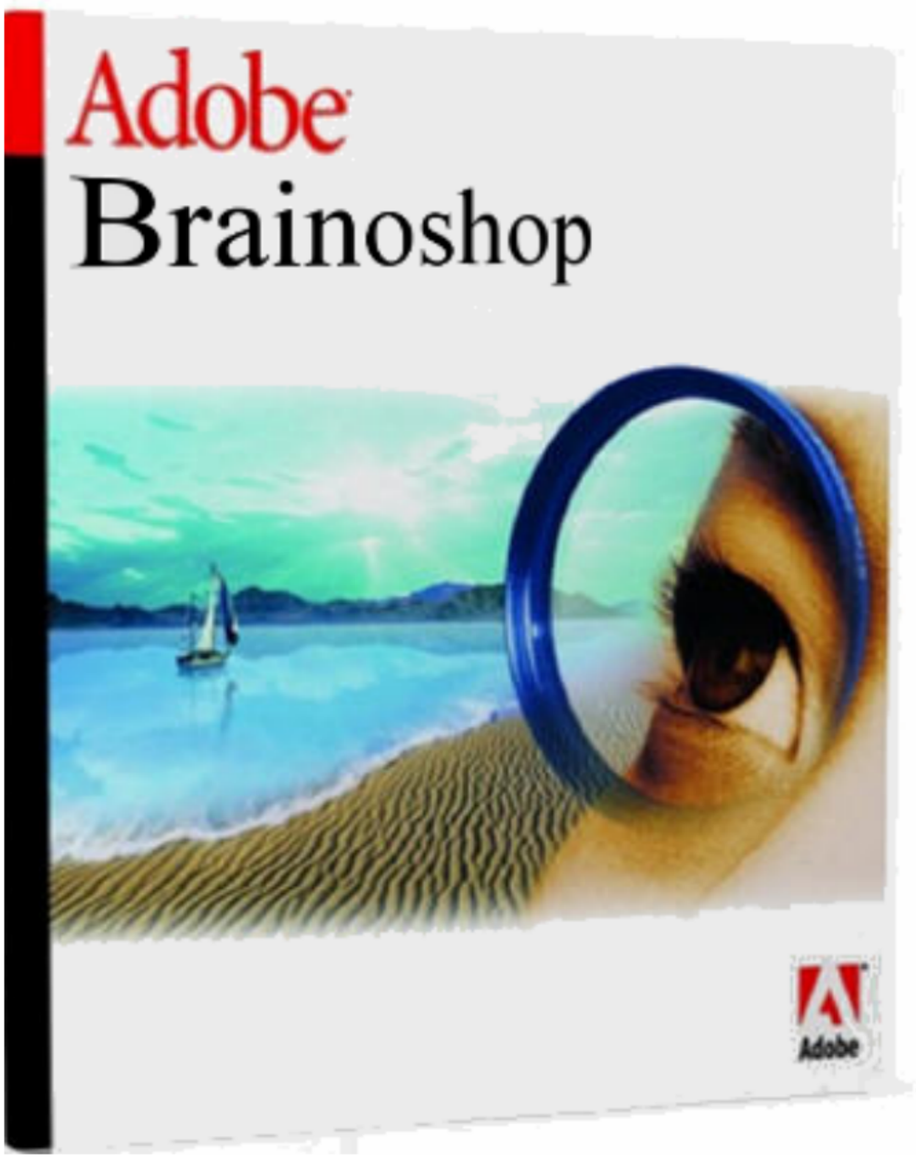
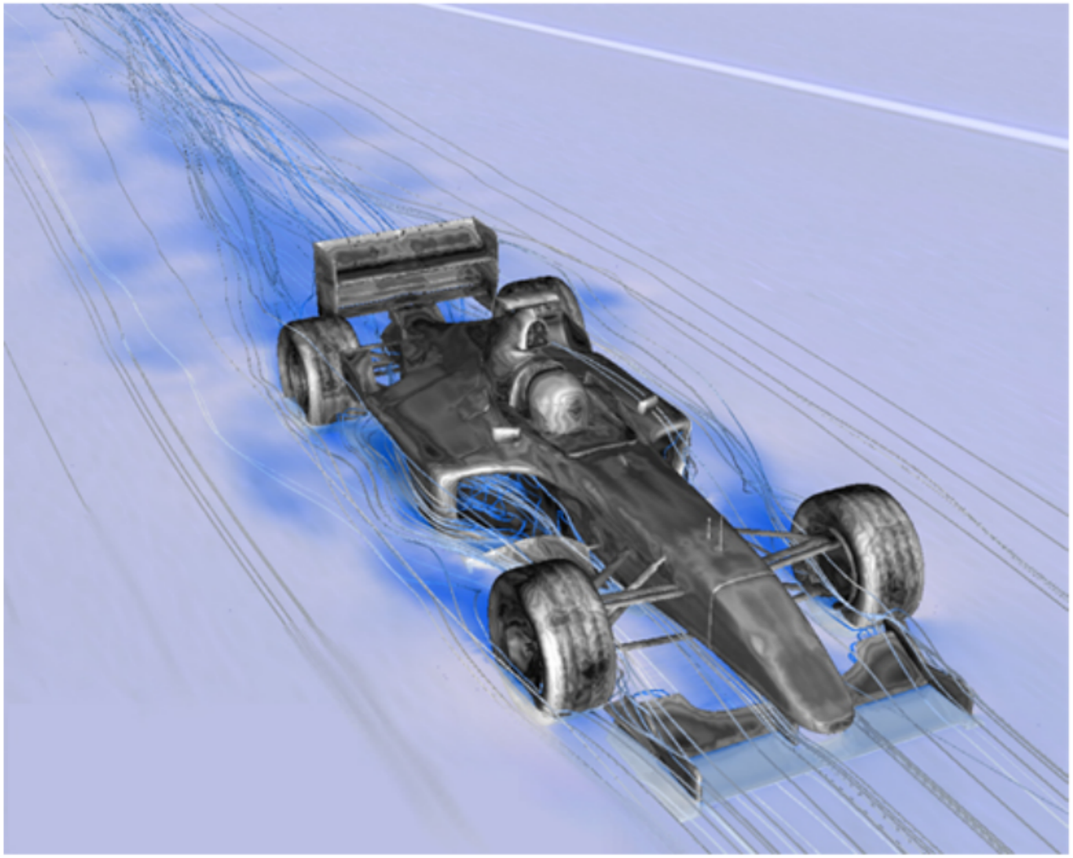
The "Photoshop of AI" Debate



The "Virtual Wind Tunnel for Game Design" Debate



Design is the
process of

Artificial intelligence
is the study &
implementation of

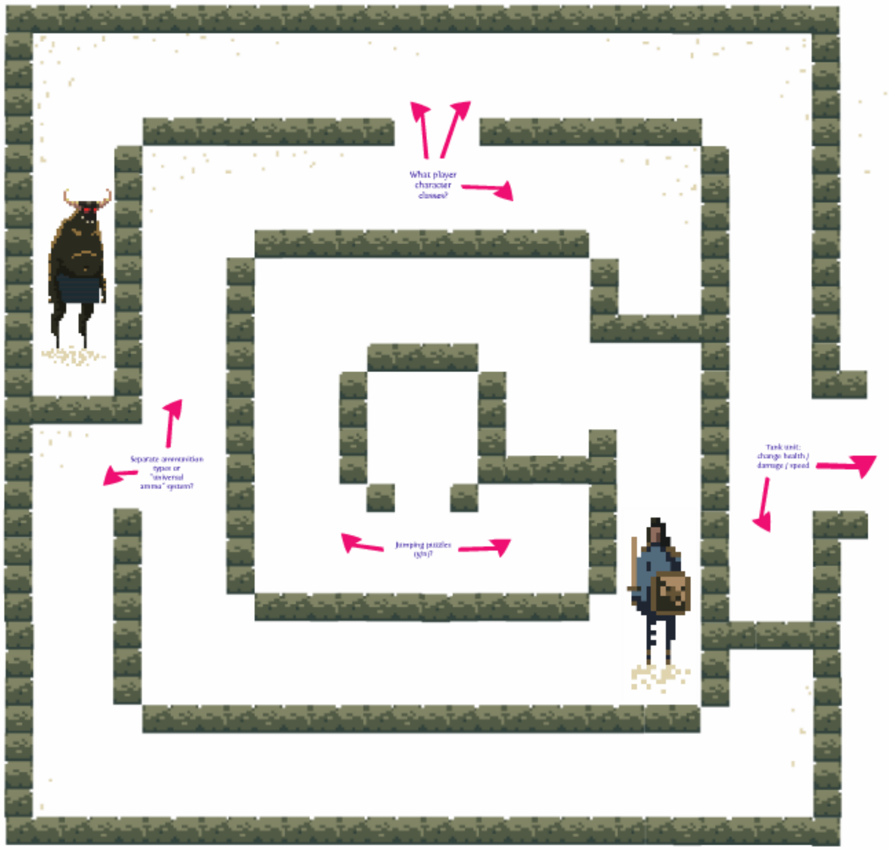
Search.

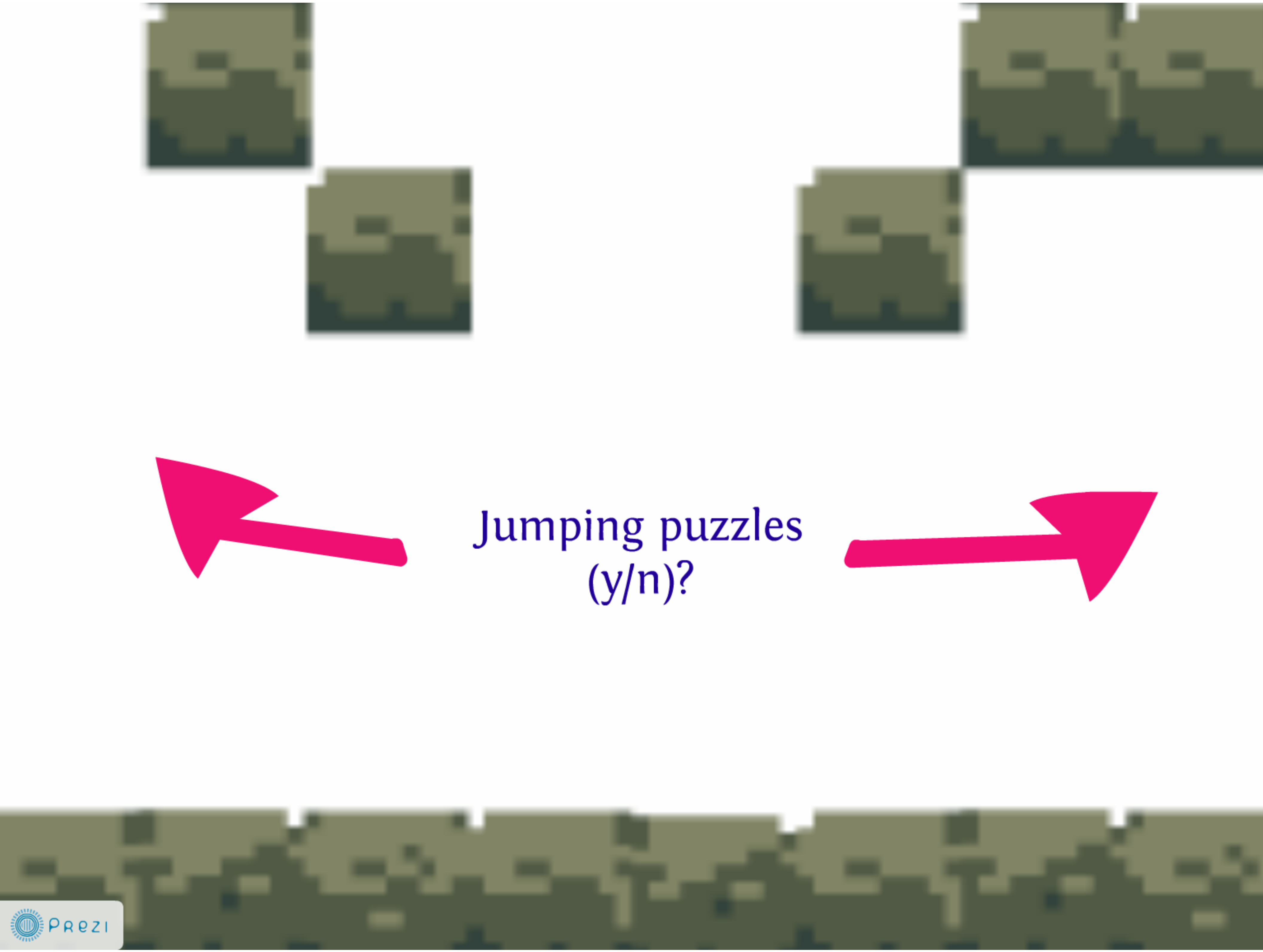
for optimal design
configurations in the
space of possible
design decisions

to make decisions
more quickly and
more optimally than
humans can do alone.

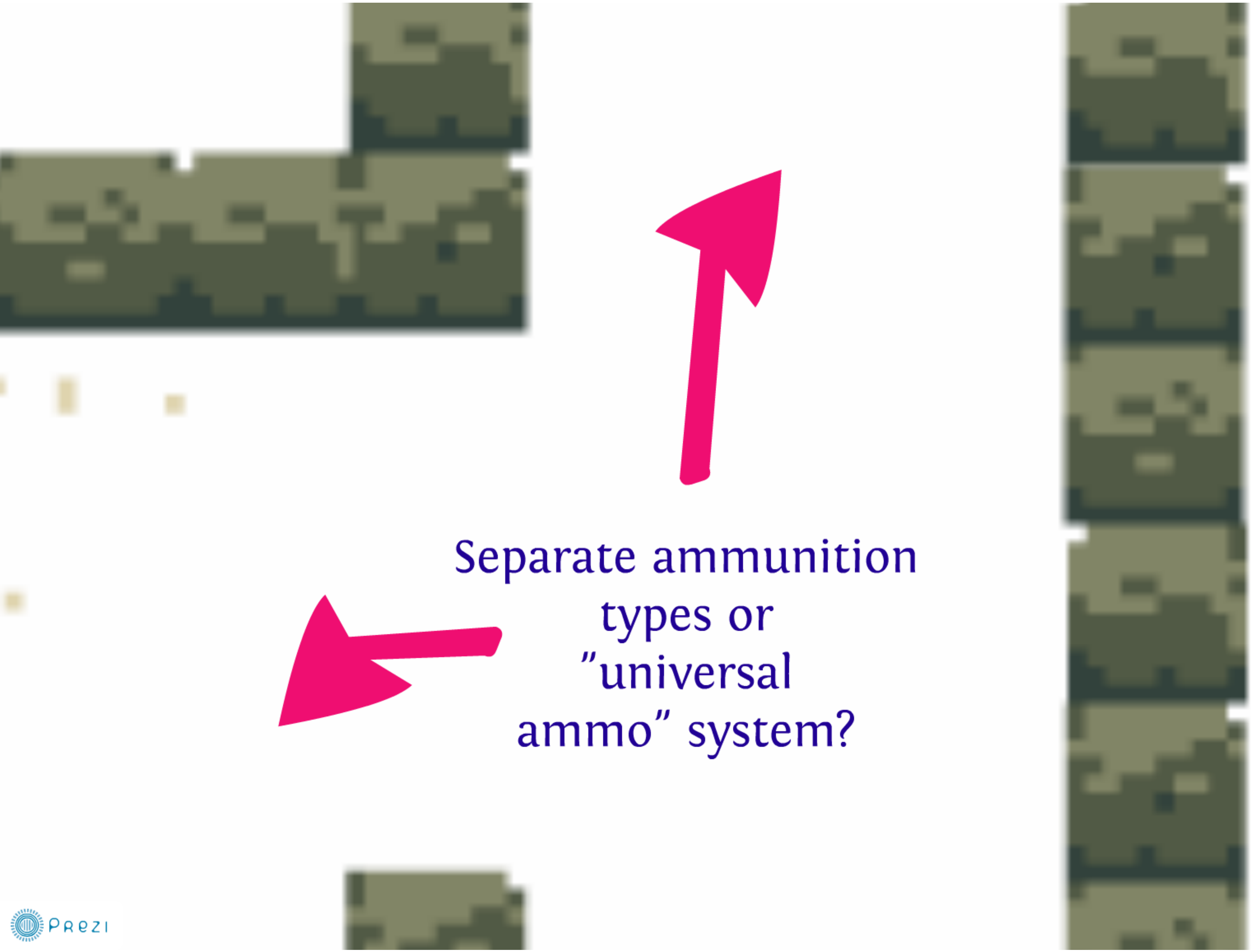
Design is search.

The process of design is a sequence of decisions through the search space of design possibilities.


What player character classes?
Separate ammunition types or "universal ammo" system?
Jumping puzzles (y/n)?
Tank unit: change health / damage / speed

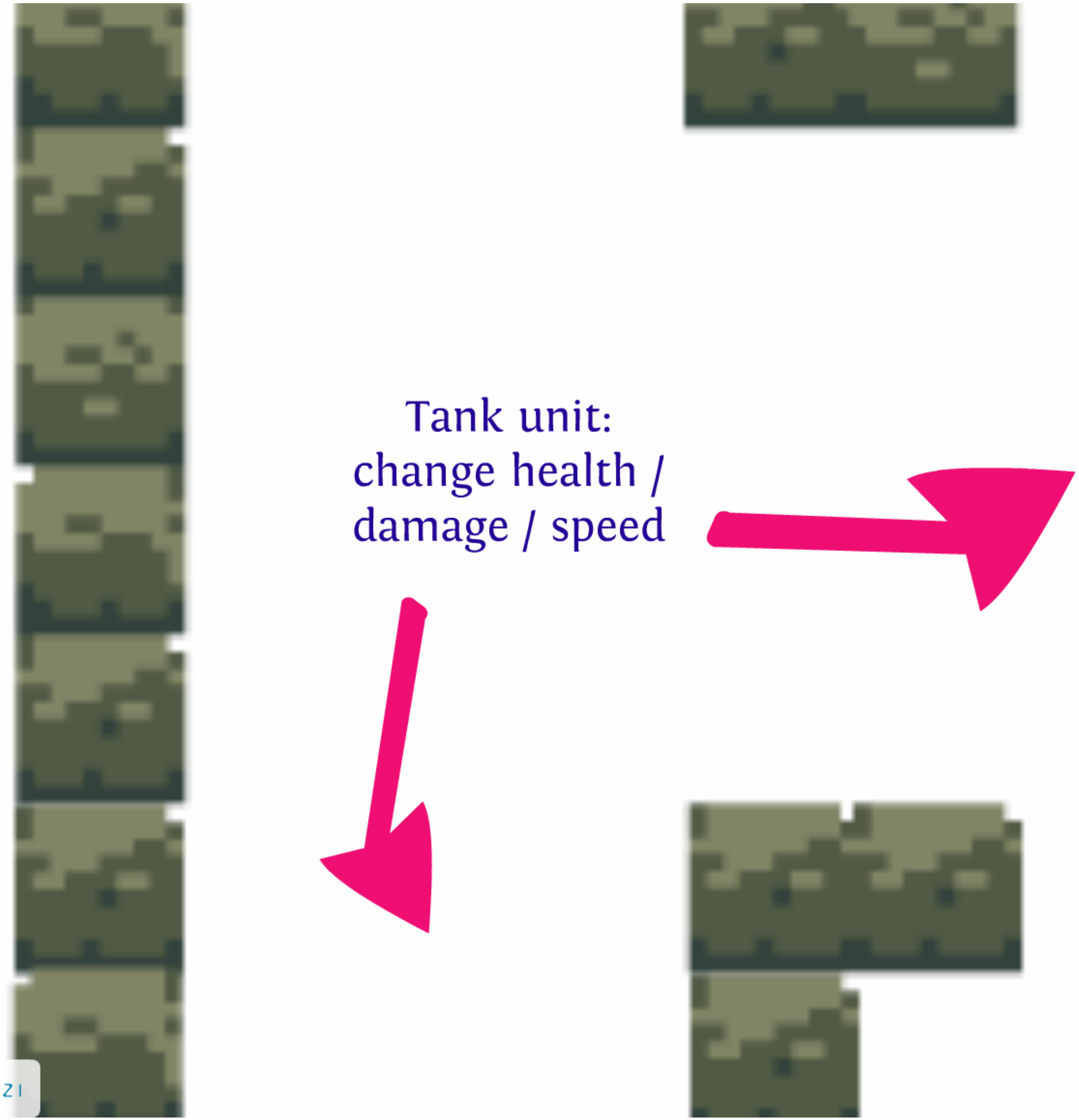


Jumping puzzles (y/n)?



Separate ammunition types or "universal ammo" system?

What player character classes?



Tank unit:
change health /
damage / speed

Design is search.

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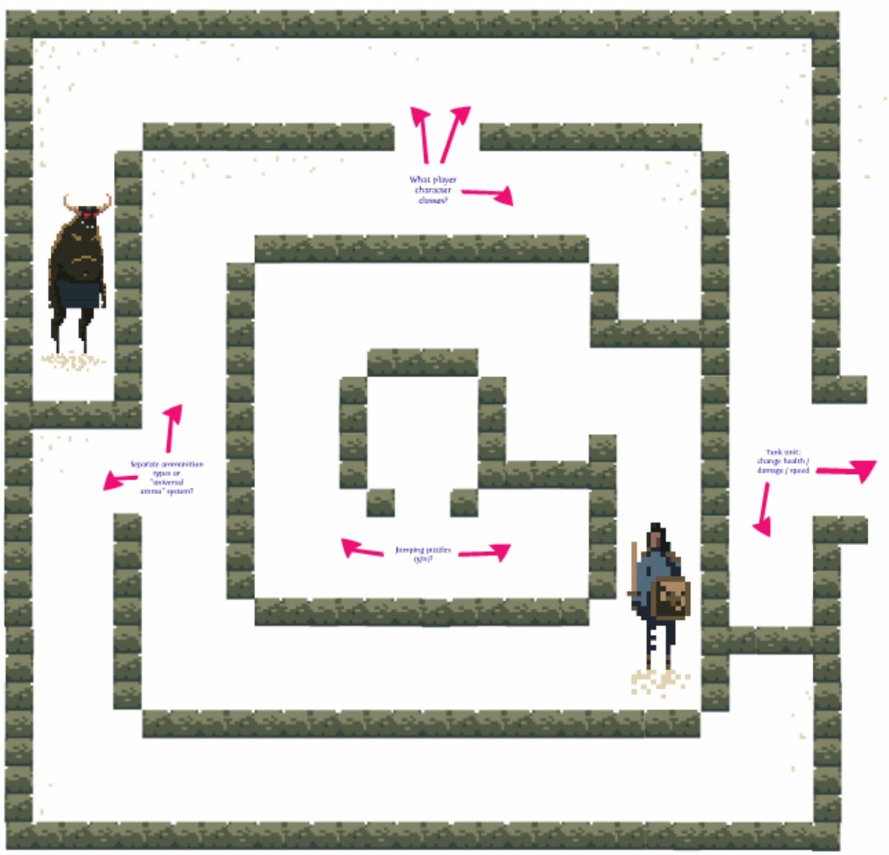
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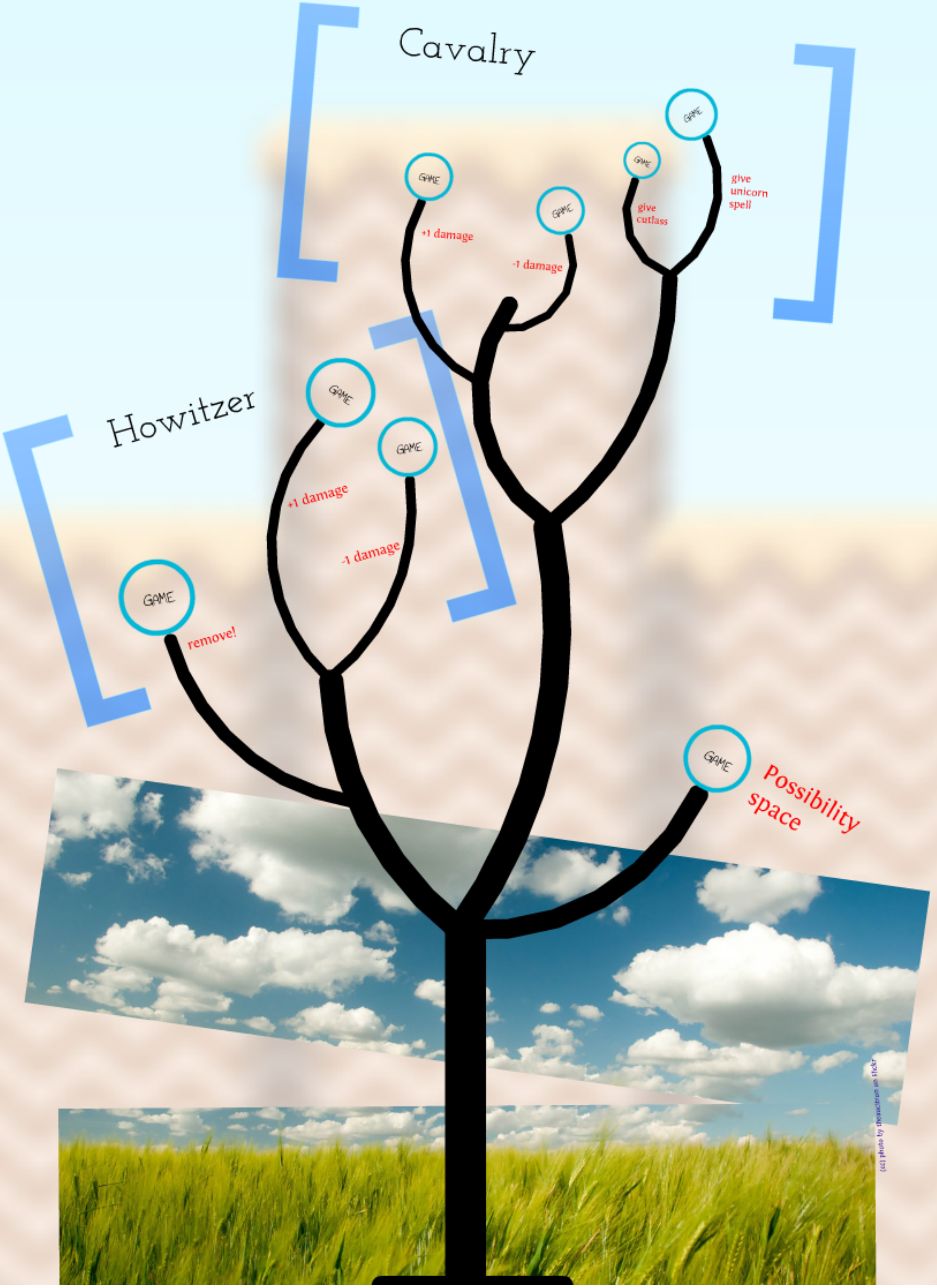


Cavalry

+1 damage

-1 damage

give cutlass

give unicorn spell

Howitzer

+1 damage

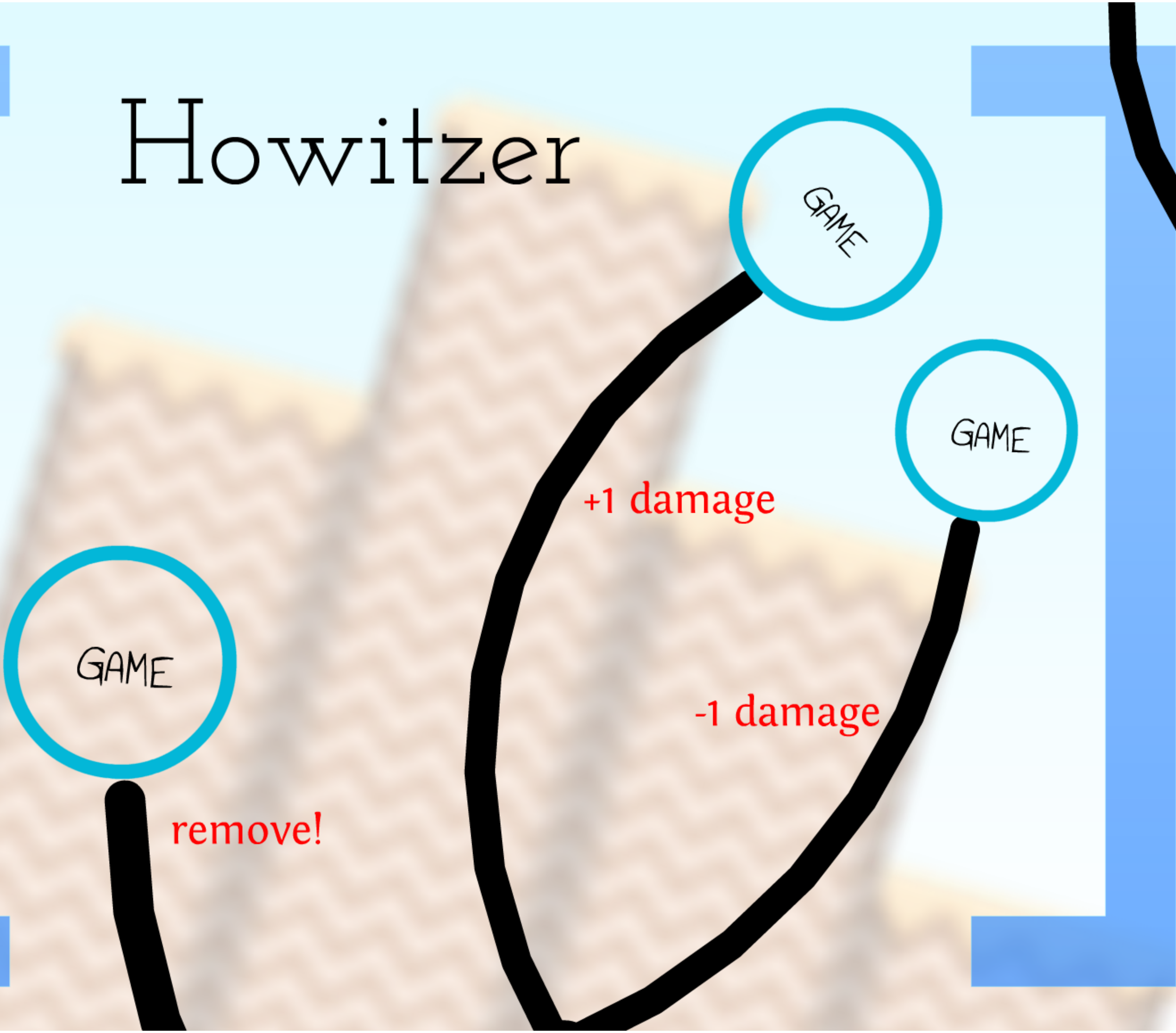
-1 damage

remove!

Possibility space

(cc) photo by theaucitron on flickr

Howitzer

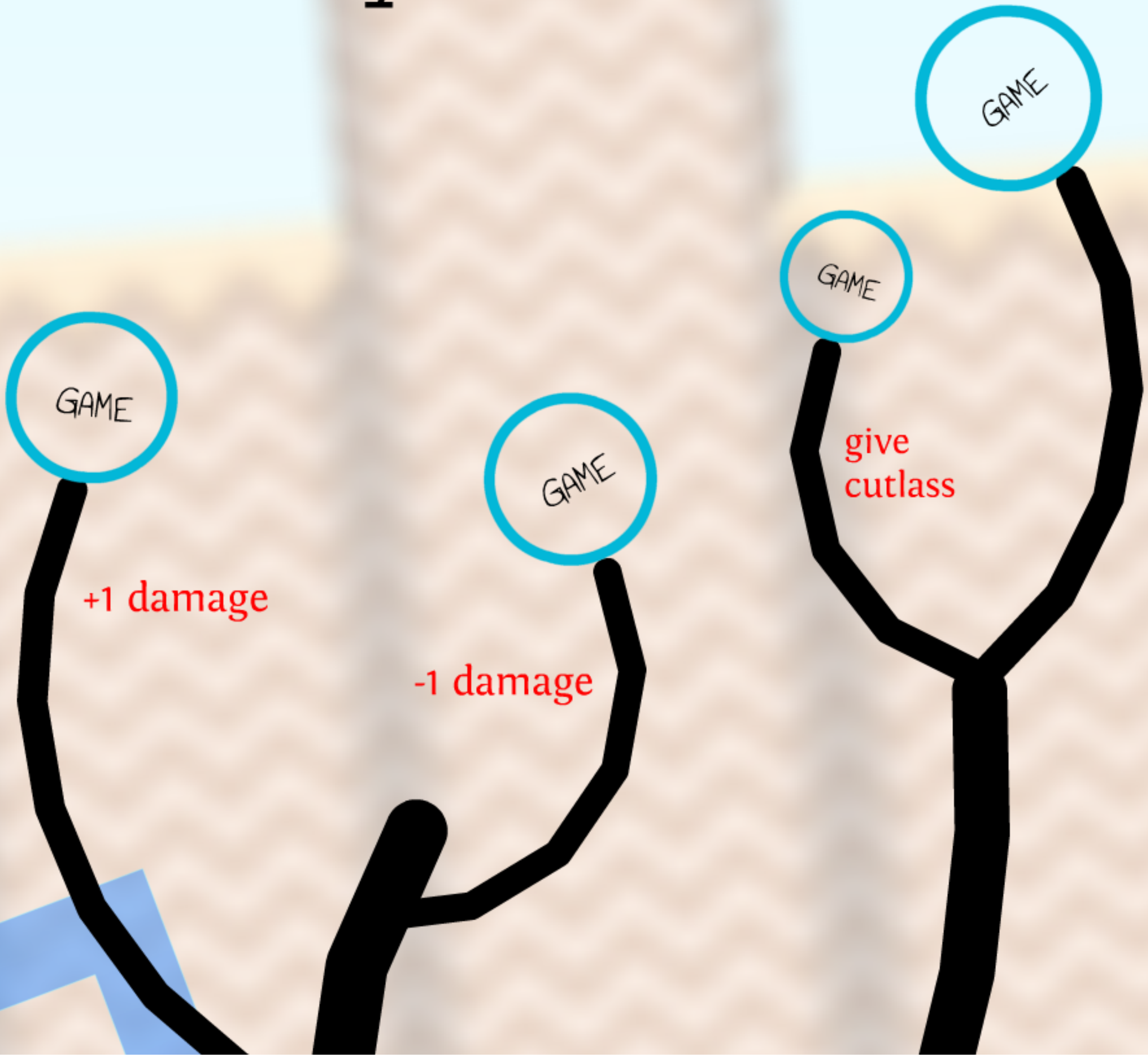


+1 damage

-1 damage

remove!

Cavalry



+1 damage

-1 damage

give cutlass

give unicorn spell

Possibility space

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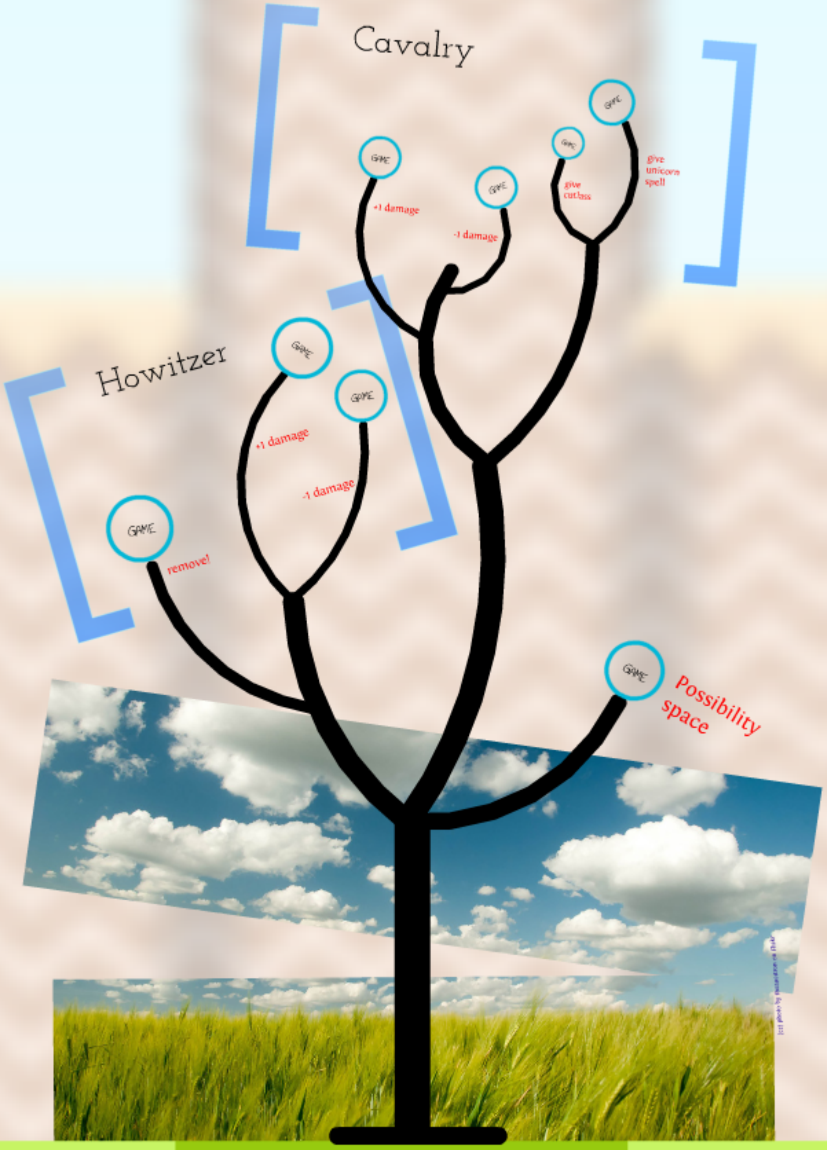
Design Space



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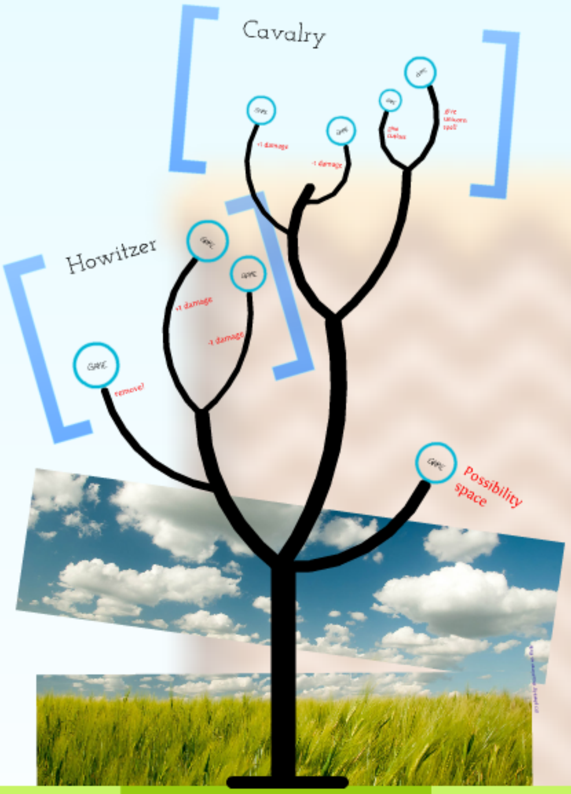
Design Space



- In theory, you could search this tree to automatically (re)design a game if you could accurately determine how to branch and how to evaluate each branch.

- Challenge #1: how to enumerate the possible design changes

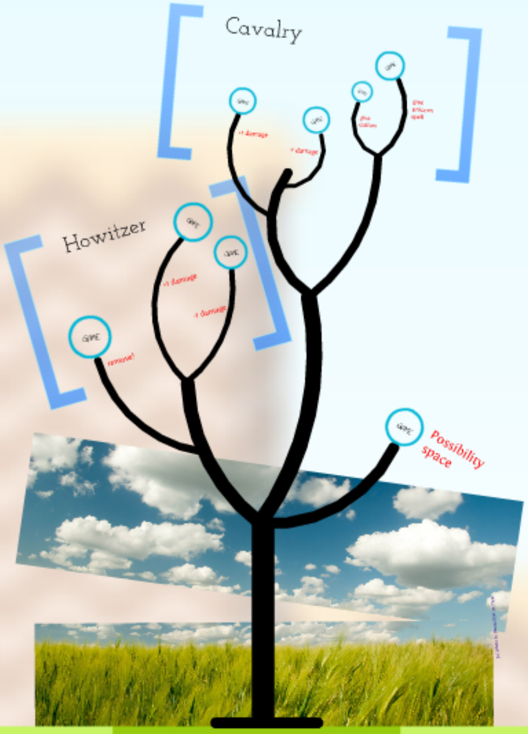
- Challenge #2: how to characterize and quantify the possibility space of the resulting game configuration

Maybe Not Quite as Hard as it Looks ...

No need to fully explore each possibility space! We only care about how it is different from its parent -- how (or whether) it alters the gameplay.

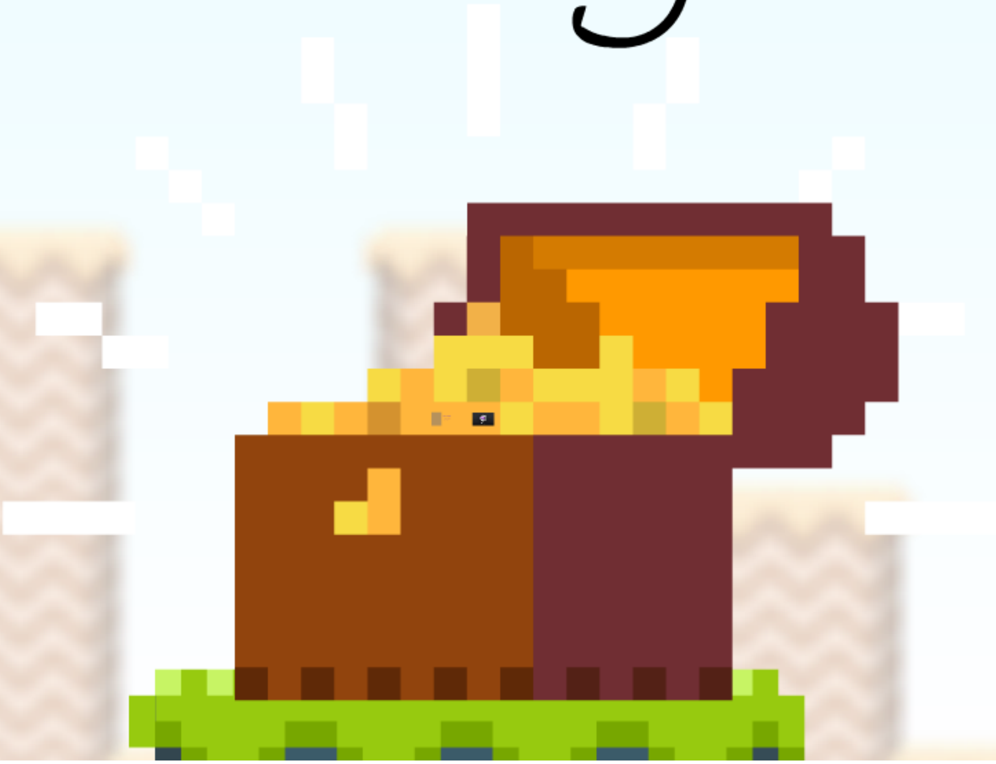
Don't necessarily need to narrow down to ONE optimal configuration Search itself can be useful if it reduces the scope of the problem to something designers can solve manually.

Design Space



What would it take to make Shigi a reality?

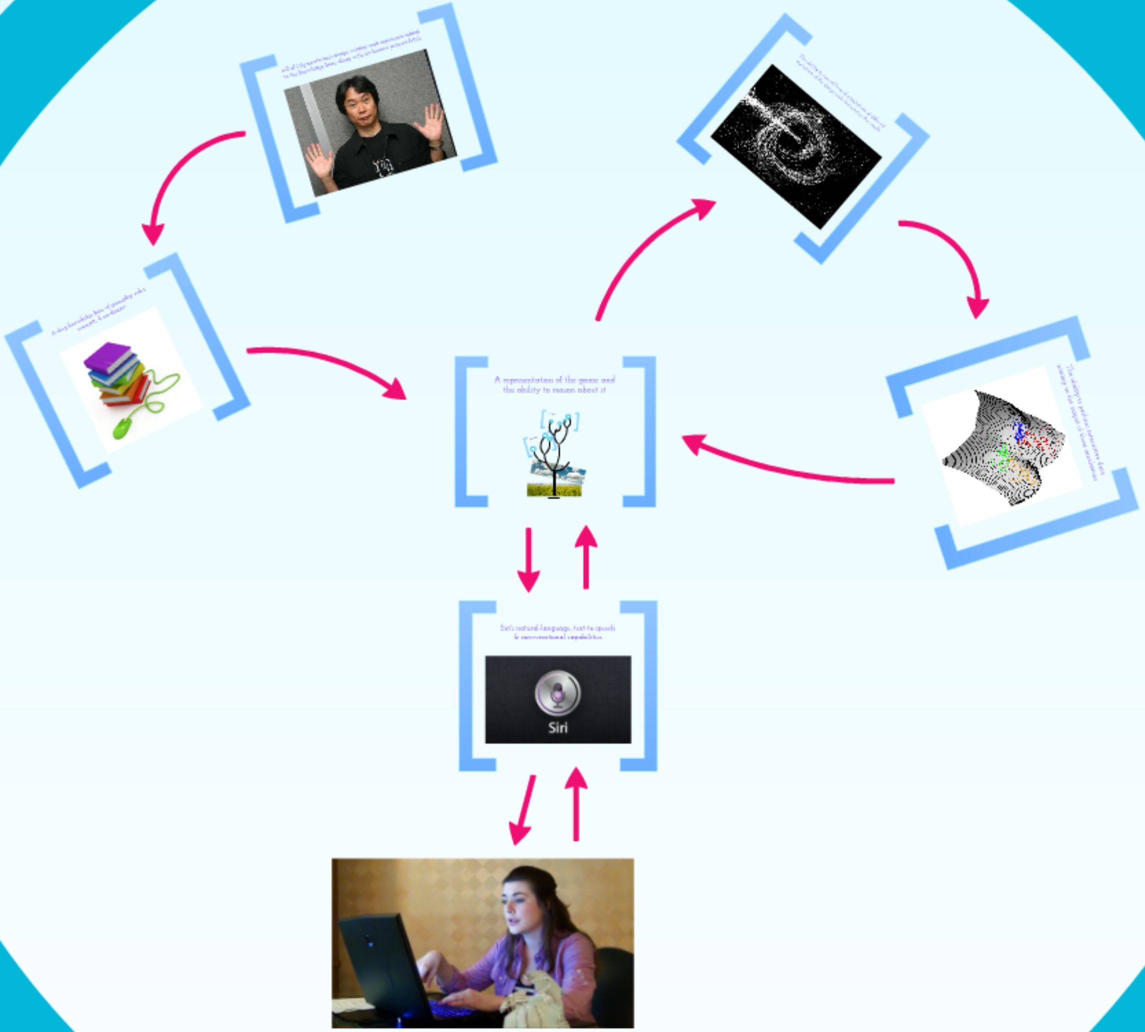
AI-Assisted Game Design



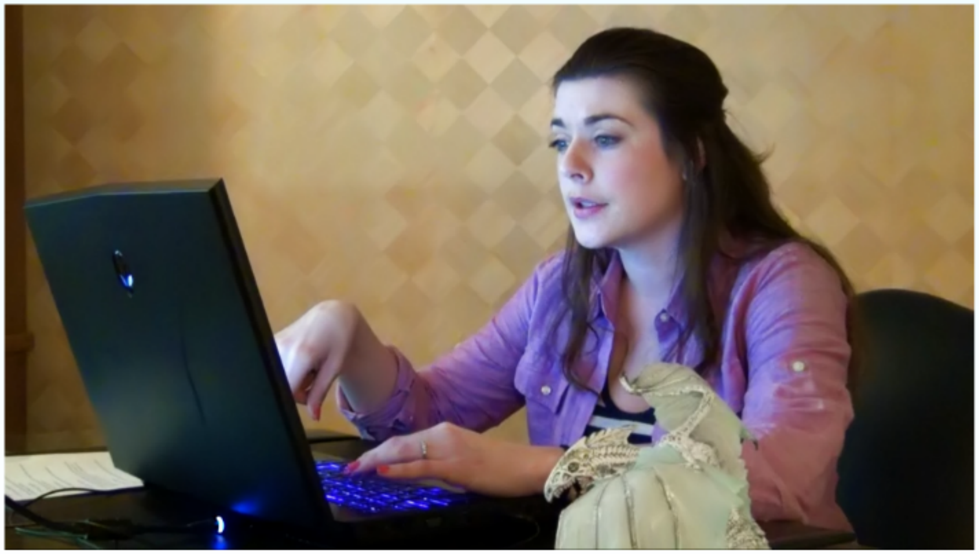
Scary problems!

AI-Assisted

Game Desig


[illegible]
[illegible]
[illegible]
[illegible]
A representation of the game and the ability to reason about it
Siri: natural-language, text-to-speech & conversational capabilities
Siri

Siri's natural-language, text-to-speech & conversational capabilities



Siri's natural-language, text-to-speech & conversational capabilities

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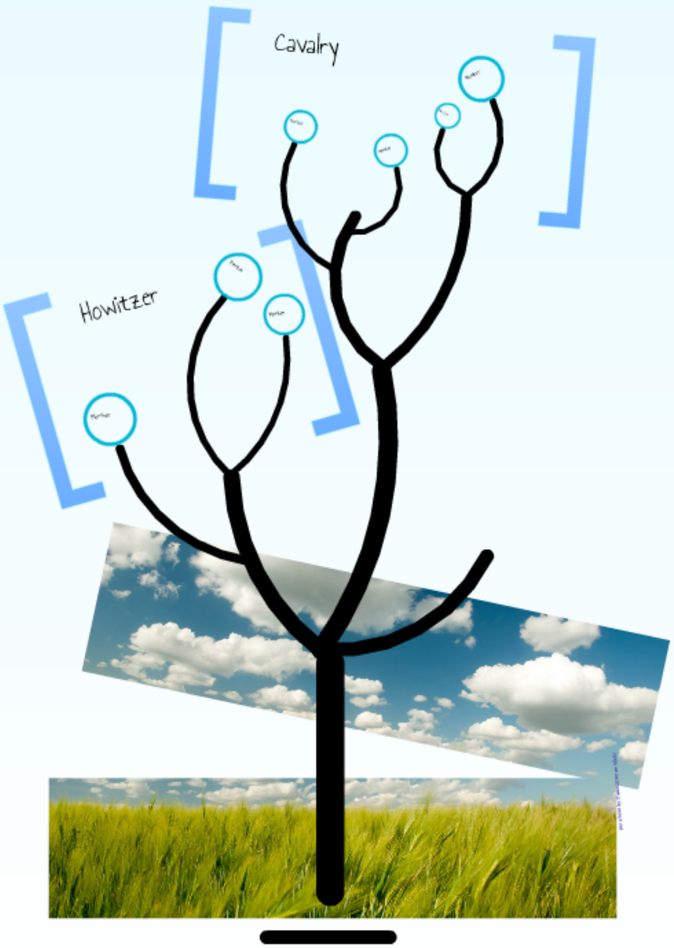
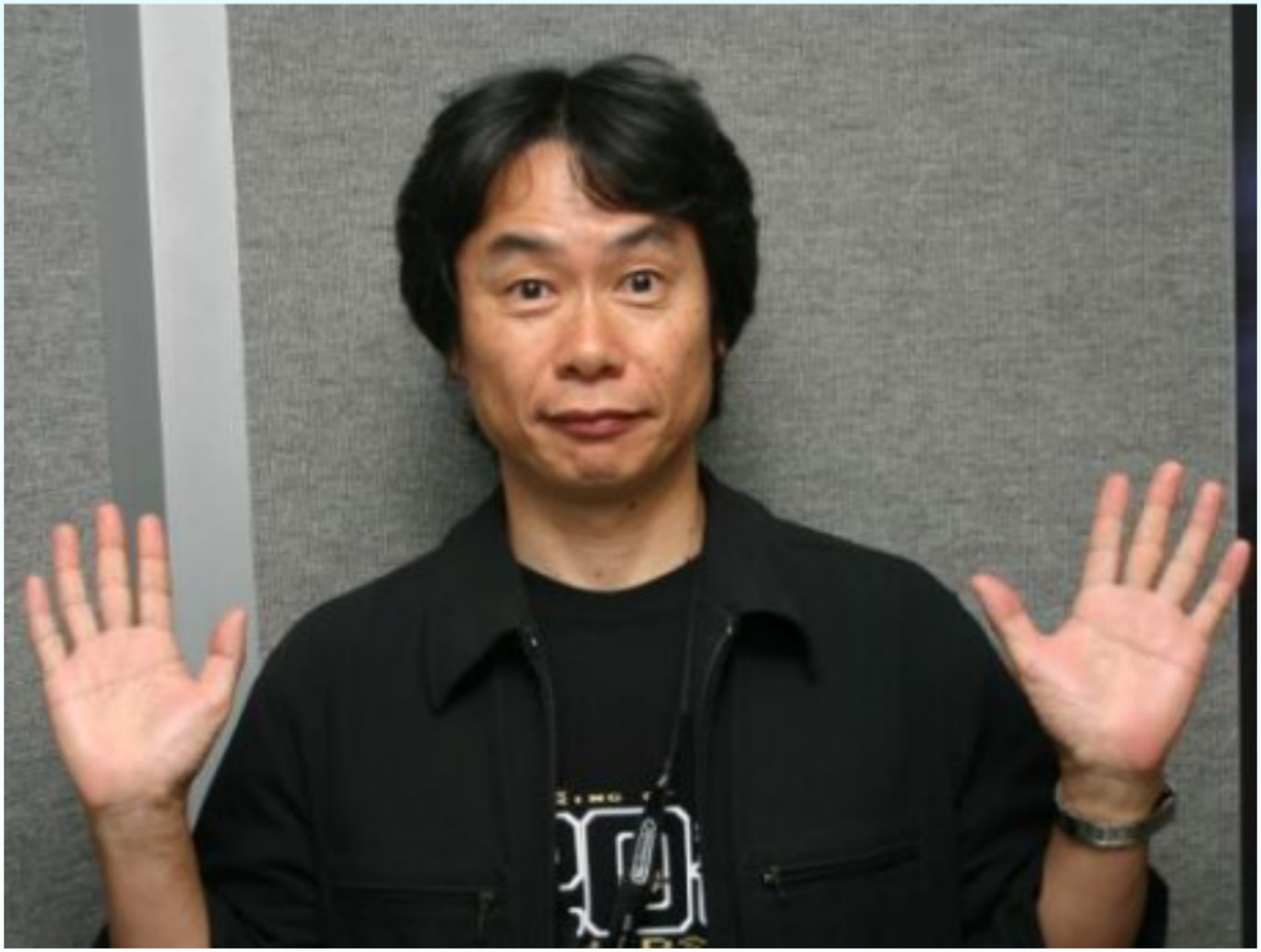
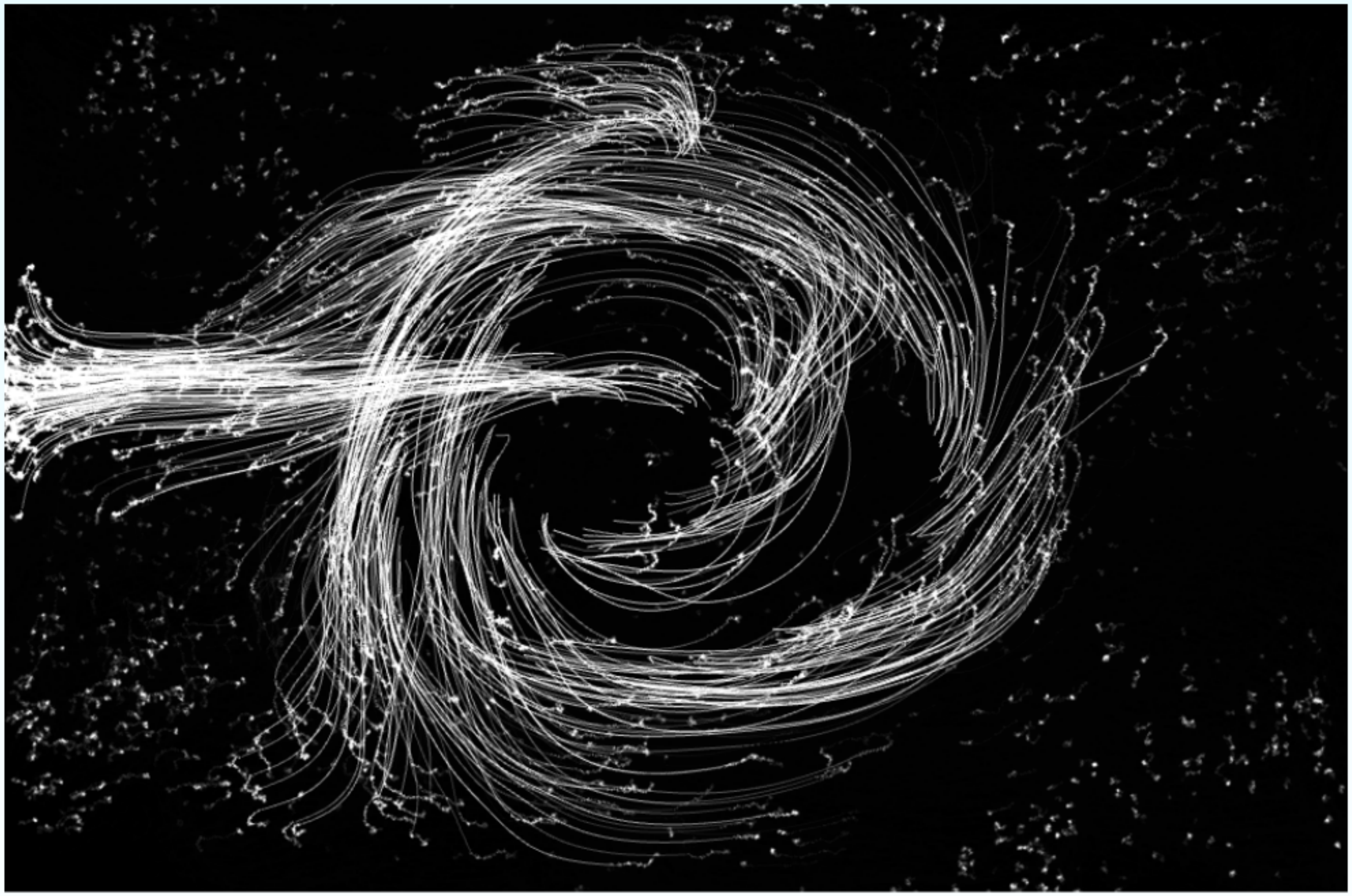


A deep knowledge base of gameplay rules, concepts, & mechanics

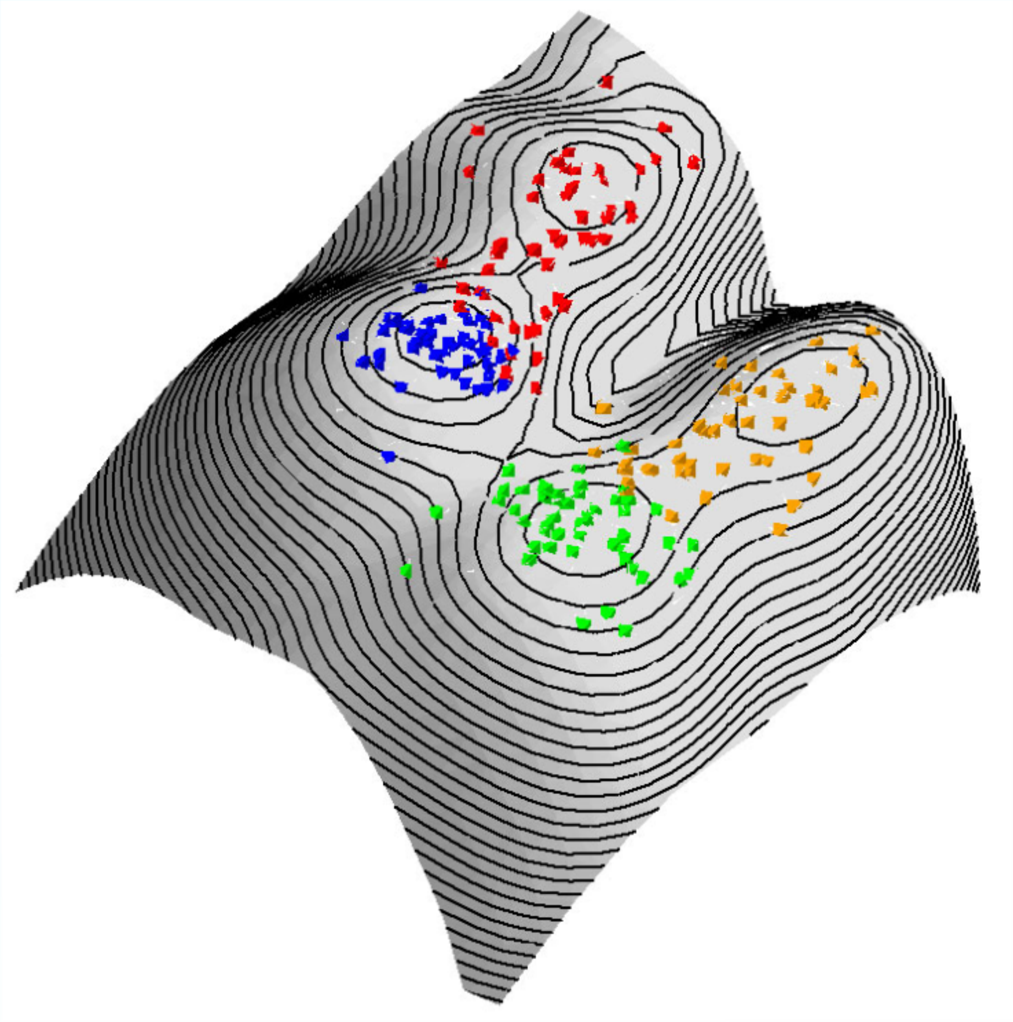
All of Miyamoto-san's design wisdom and experience added to the knowledge base, along with his bizarre princess fetish

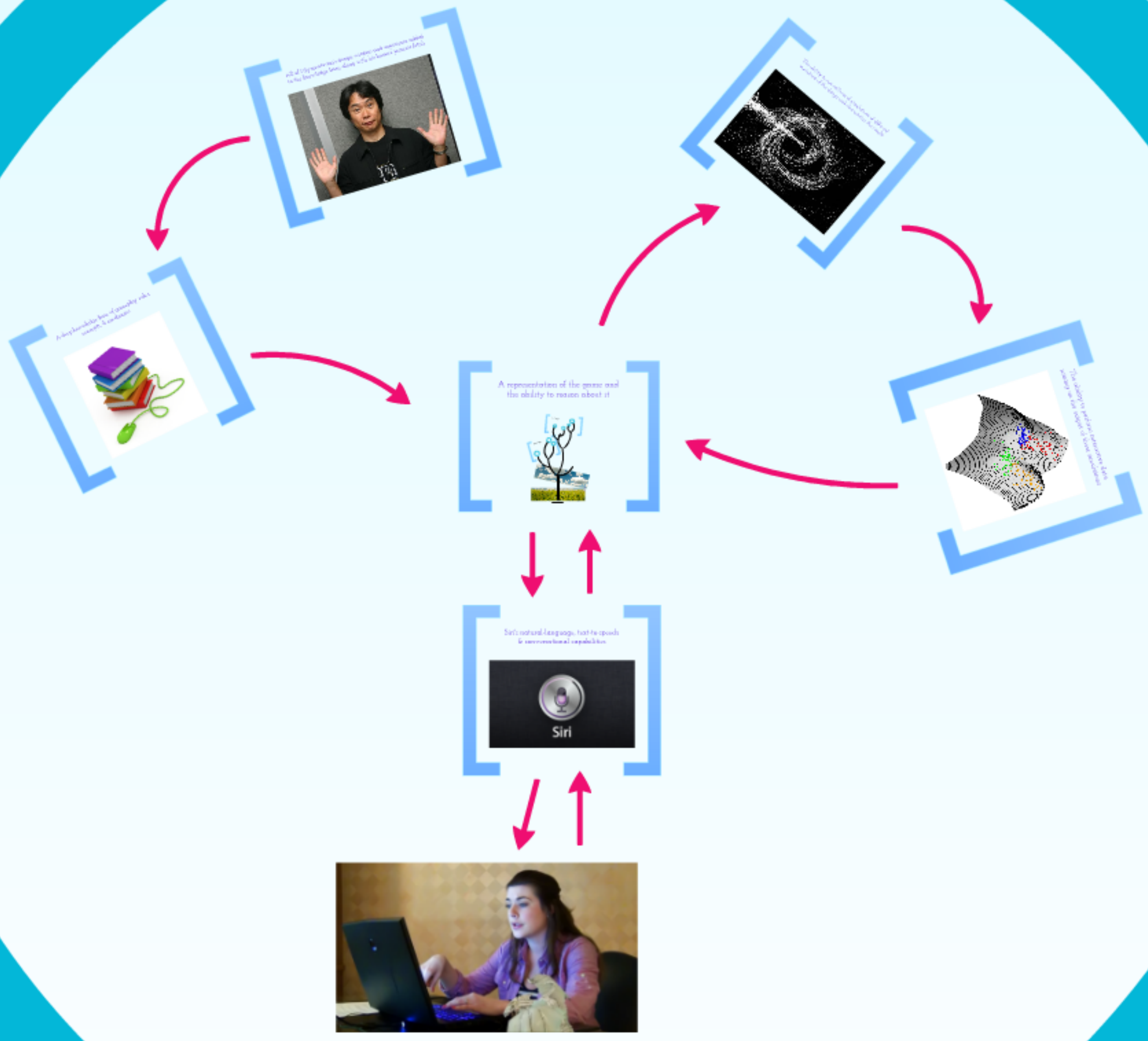


The ability to run millions of simulations of different variations of the design and characterize the results



The ability to perform interactive data mining on the output of those simulations





[illegible]

A [illegible]

[illegible]

The ability to [illegible]

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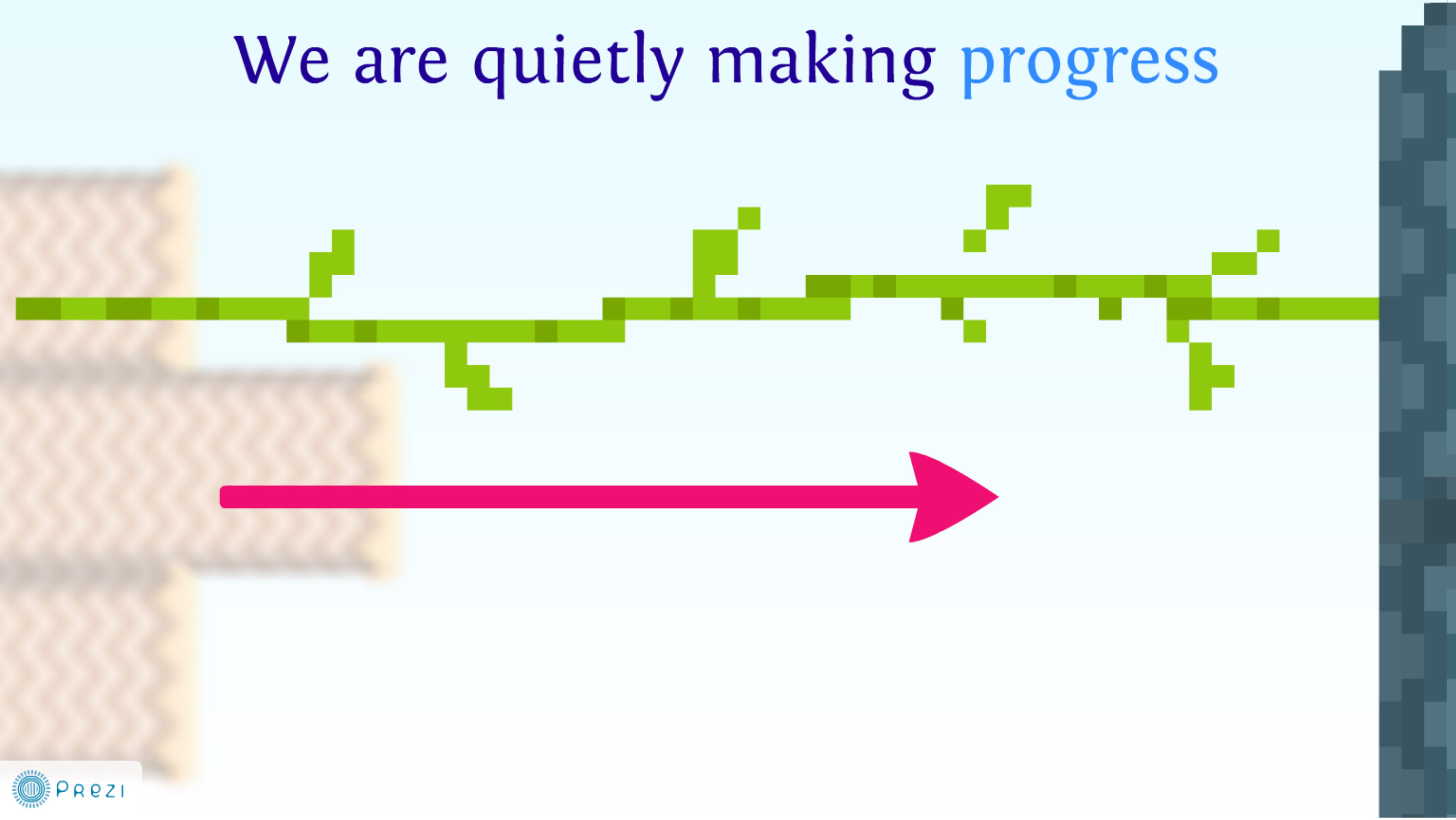
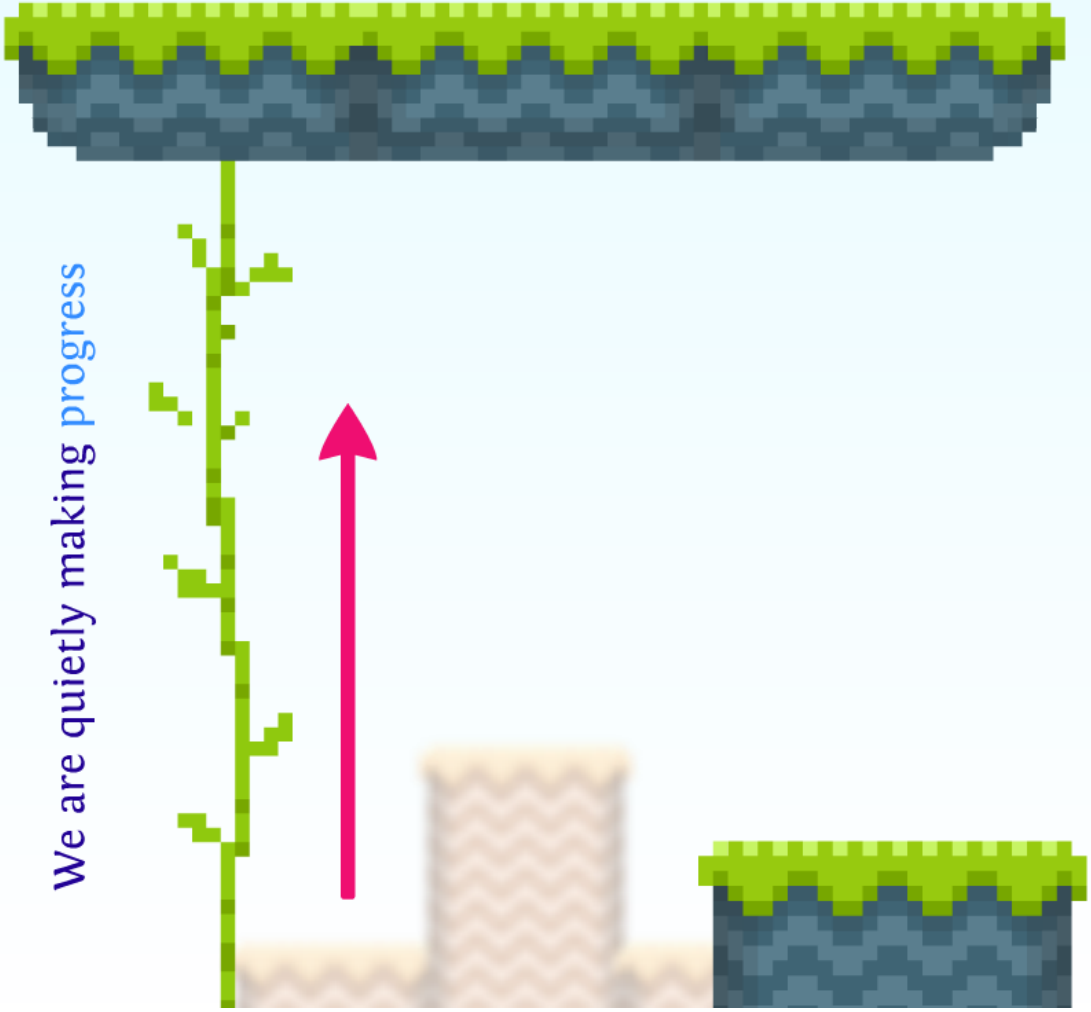
Siri: natural-language, text-to-speech & conversational capabilities

We are quietly making progress

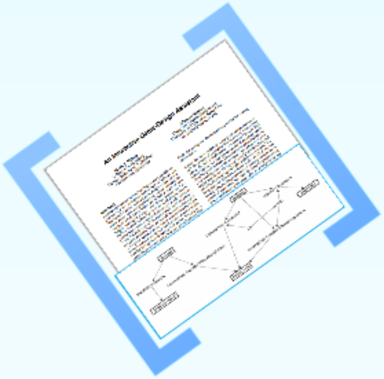


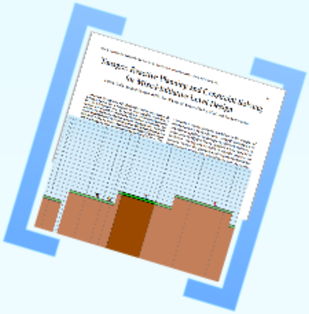
Academic Research



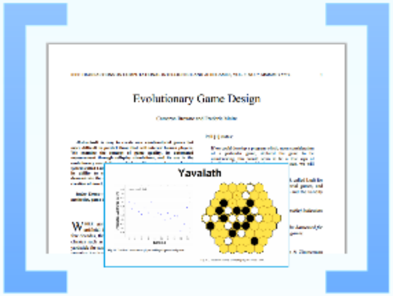
We are quietly making progress

Academic Research

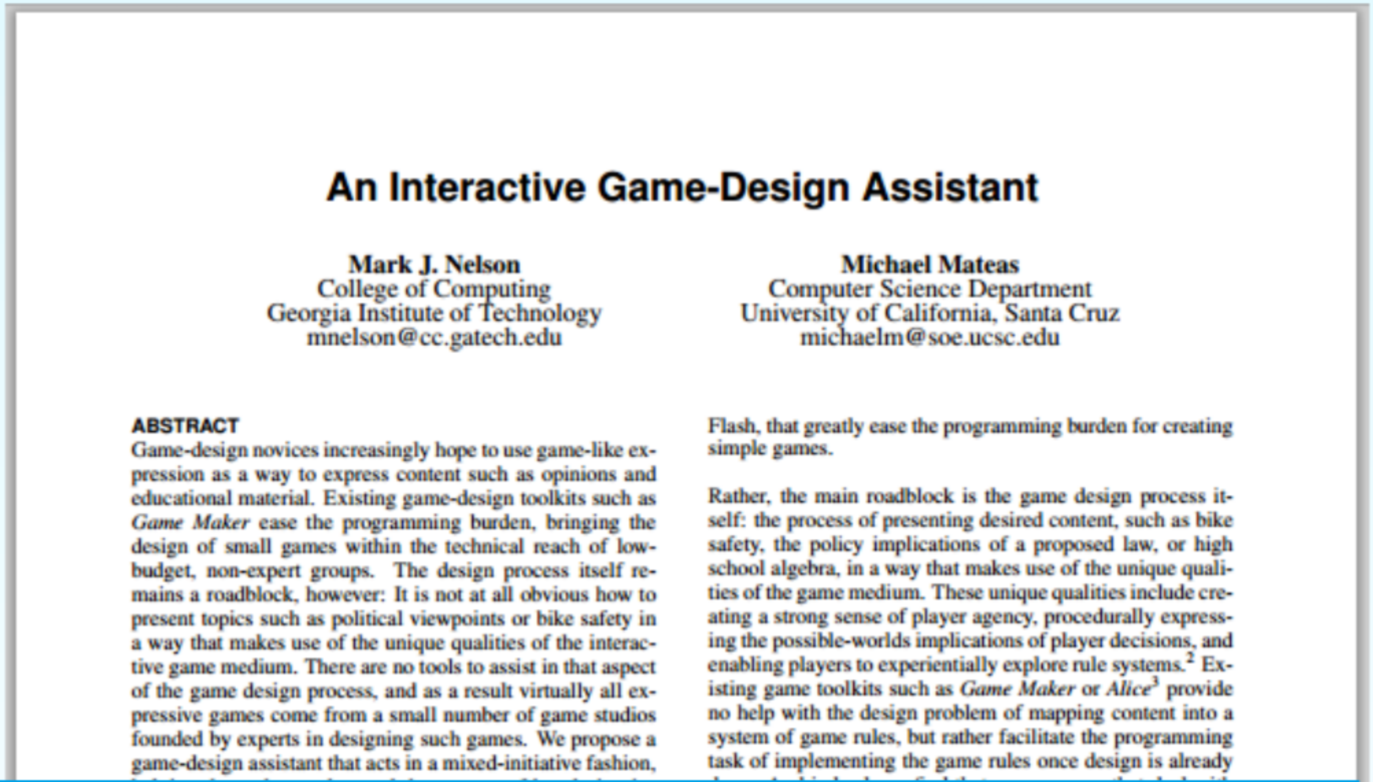




Tanagra: Reactive Planning and Constraint Solving for Mixed-Initiative Level Design



Evolutionary Game Design



An Interactive Game-Design Assistant

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Georgia Institute of Technology
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Michael Mateas
Computer Science Department
University of California, Santa Cruz
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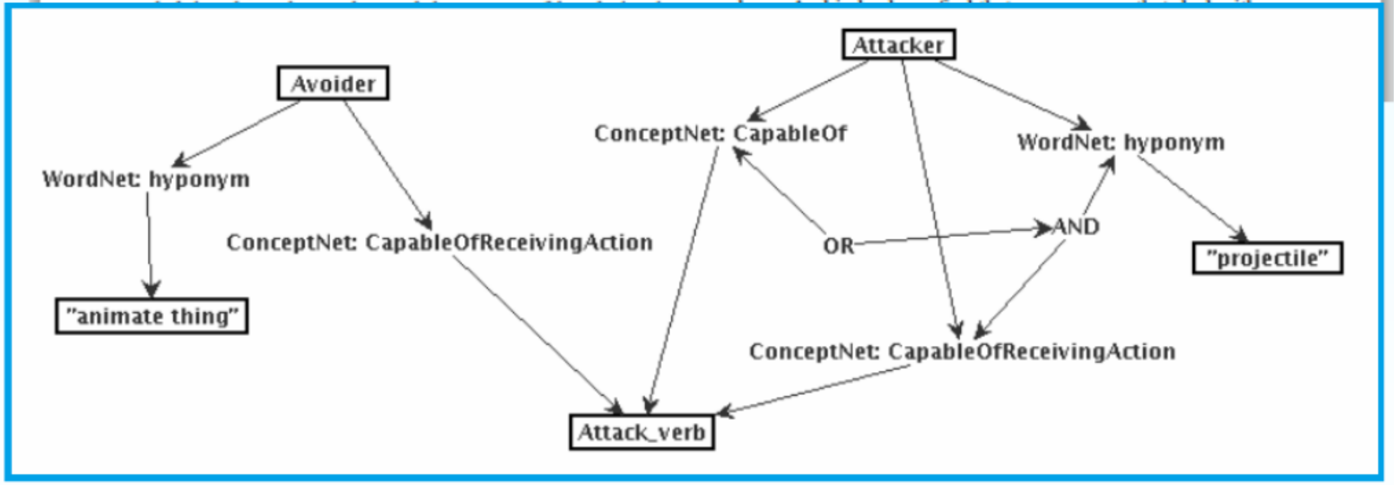
ABSTRACT

Game-design novices increasingly hope to use game-like expression as a way to express content such as opinions and educational material. Existing game-design toolkits such as *Game Maker* ease the programming burden, bringing the design of small games within the technical reach of low-budget, non-expert groups. The design process itself remains a roadblock, however: It is not at all obvious how to present topics such as political viewpoints or bike safety in a way that makes use of the unique qualities of the interactive game medium. There are no tools to assist in that aspect of the game design process, and as a result virtually all expressive games come from a small number of game studios founded by experts in designing such games. We propose a game-design assistant that acts in a mixed-initiative fashion,

Flash, that greatly ease the programming burden for creating simple games.

Rather, the main roadblock is the game design process itself: the process of presenting desired content, such as bike safety, the policy implications of a proposed law, or high school algebra, in a way that makes use of the unique qualities of the game medium. These unique qualities include creating a strong sense of player agency, procedurally expressing the possible-worlds implications of player decisions, and enabling players to experientially explore rule systems.[2] Existing game toolkits such as *Game Maker* or *Alice*[3] provide no help with the design problem of mapping content into a system of game rules, but rather facilitate the programming task of implementing the game rules once design is already



Computational Intelligence and Tower Defence Games

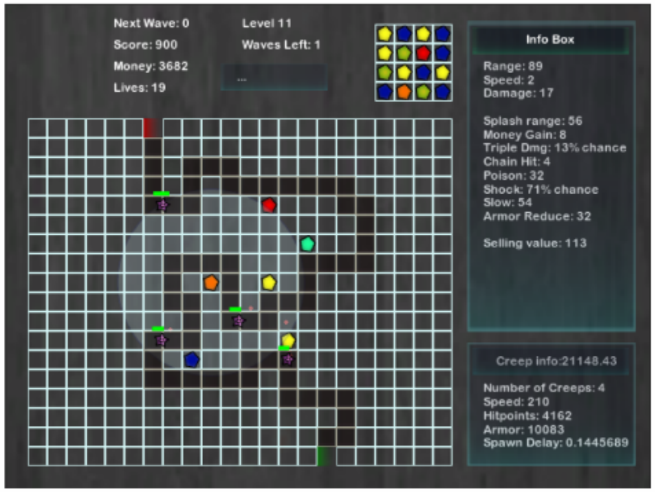
Phillipa Avery
Department of Computer Science and Engineering
University of Nevada, Reno, USA
Email: pippa@cse.unr.edu

Julian Togelius, Elvis Alistar,
and Robert Pieter van Leeuwen
Center for Computer Games Research
IT University of Copenhagen, Denmark
Email: {juto, elal, rpvl}@itu.dk

***Abstract*— The aim of this paper is to introduce the use of Tower Defence (TD) games in Computational Intelligence (CI) research. We show how TD games can provide an important**

possibilities to improve the gameplay of TD games using CI methods.

TD games can be real-time or turn-based in nature, and the



Next Wave: 0
Score: 900
Money: 3682
Lives: 19

Level 11
Waves Left: 1

Info Box
Range: 89
Speed: 2
Damage: 17

Splash range: 56
Money Gain: 8
Triple Dmg: 13% chance
Chain Hit: 4
Poison: 32
Shock: 71% chance
Slow: 54
Armor Reduce: 32

Selling value: 113

Creep info:21148.43

Number of Creeps: 4
Speed: 210
Hitpoints: 4162
Armor: 10083
Spawn Delay: 0.1445689

Fig. 4. The Infinite TD game during play of another level, in the middle of a creep wave. The purple stars inside the dark path are creeps, moving from the dark green path entrance towards the red path exit. Above each critter is a small green bar signifying its current health. The brightly coloured pentagons outside of the path are towers. One of the towers is currently selected, meaning that a dimly illuminated circle around the tower shows its range, and the info box to the right of the screen displays its statistics (range, speed, splash range etc).

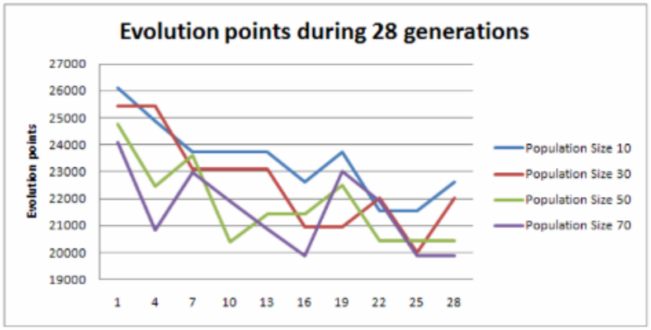


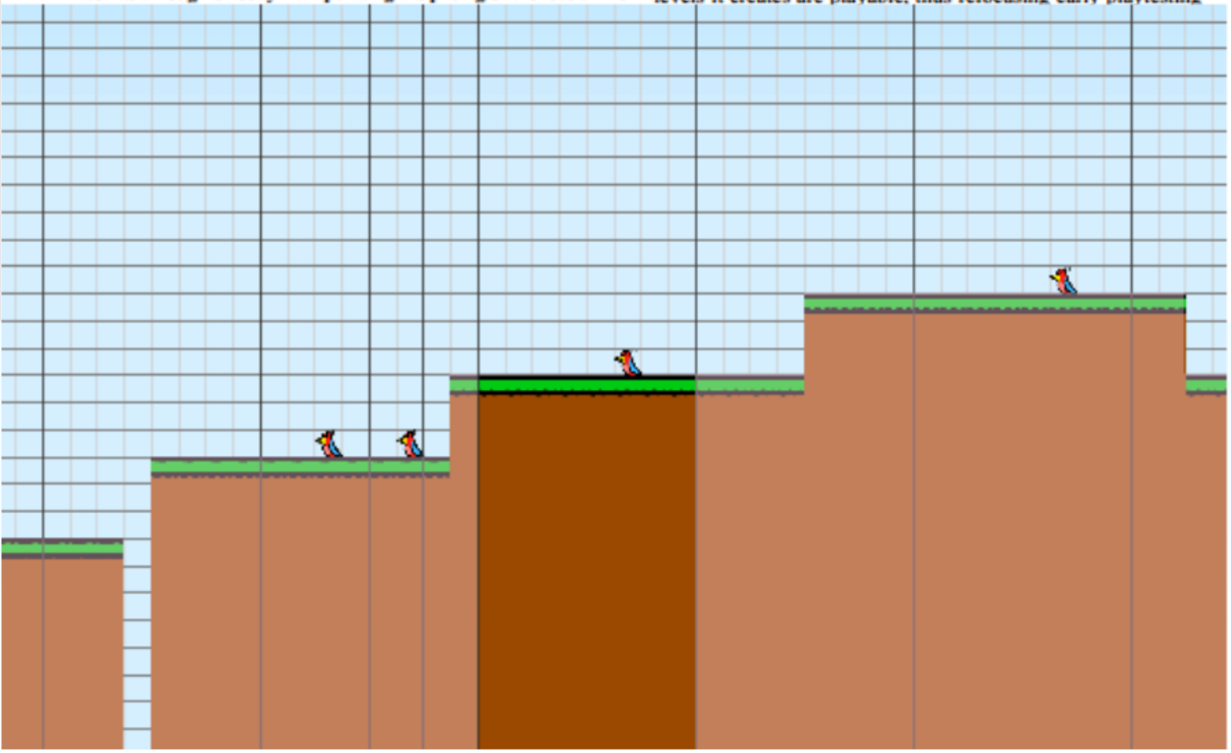
Fig. 5. Creep evolution. The "evolution points" value refers to the number of points that need to be spent before attaining a fitness of at least 1, meaning that at least one creep breaks through the player's defences and reaches the end of the path. In this game, the creeps are tested against a complicated map with 30 towers.

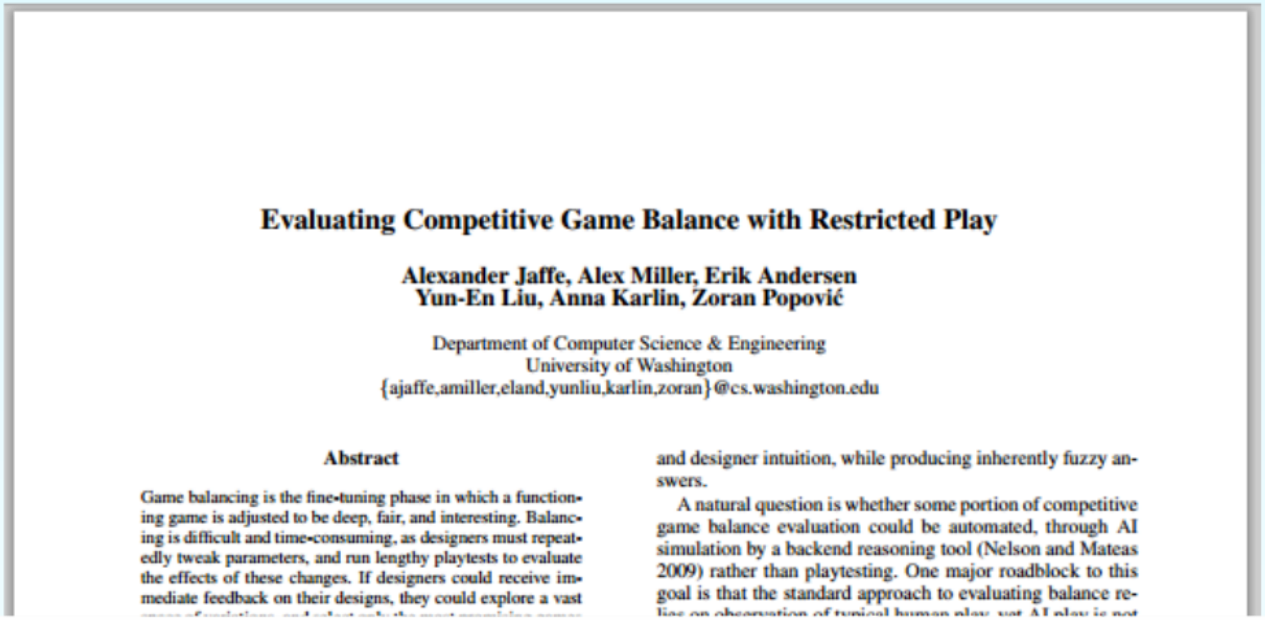
Tanagra: Reactive Planning and Constraint Solving for Mixed-Initiative Level Design

Gillian Smith, *Student Member, IEEE*, Jim Whitehead, *Senior Member, IEEE*, and Michael Mateas

***Abstract*—Tanagra is a mixed-initiative tool for level design, allowing a human and a computer to work together to produce a level for a 2-D platformer. An underlying, reactive level generator ensures that all levels created in the environment are playable, and provides the ability for a human designer to rapidly view many different levels that meet their specifications. The human designer can iteratively refine the level by placing and moving level geometry, as well as through directly manipulating the pacing of the level. This**

a procedural content generator, capitalizes on the strengths of both human and computer designers. Tanagra's underlying level generator is capable of producing many different variations on a level more rapidly than human designers, whose strengths instead lie in creativity and the ability to judge the quality of the generated content. The generator is able to guarantee that all the levels it creates are playable, thus refocusing early playtesting





Evaluating Competitive Game Balance with Restricted Play

Alexander Jaffe, Alex Miller, Erik Andersen
Yun-En Liu, Anna Karlin, Zoran Popović

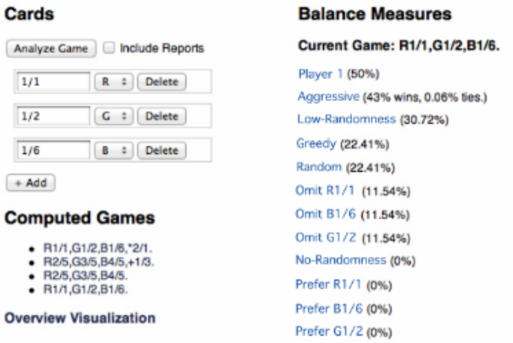
Department of Computer Science & Engineering
University of Washington
{ajaffe,amiller,eland,yunliu,karlin,zoran}@cs.washington.edu

Abstract

Game balancing is the fine-tuning phase in which a functioning game is adjusted to be deep, fair, and interesting. Balancing is difficult and time-consuming, as designers must repeatedly tweak parameters, and run lengthy playtests to evaluate the effects of these changes. If designers could receive immediate feedback on their designs, they could explore a vast

and designer intuition, while producing inherently fuzzy answers.

A natural question is whether some portion of competitive game balance evaluation could be automated, through AI simulation by a backend reasoning tool (Nelson and Mateas 2009) rather than playtesting. One major roadblock to this goal is that the standard approach to evaluating balance re-



Cards

1/1	R	Delete
1/2	G	Delete
1/6	B	Delete

Computed Games

- R1/1,G1/2,B1/6,*2/1.
- R2/5,G3/5,B4/5,+1/3.
- R2/5,G3/5,B4/5.
- R1/1,G1/2,B1/6.

Overview Visualization

Balance Measures

Current Game: R1/1,G1/2,B1/6.

Player 1 (50%)
Aggressive (43% wins, 0.06% ties.)
Low-Randomness (30.72%)
Greedy (22.41%)
Random (22.41%)
Omit R1/1 (11.54%)
Omit B1/6 (11.54%)
Omit G1/2 (11.54%)
No-Randomness (0%)
Prefer R1/1 (0%)
Prefer B1/6 (0%)
Prefer G1/2 (0%)

Fig. 1: A basic analysis using our tool. The results show the performance of varieties of restricted play against a restriction-exploiting player. Players who never play Red 1/1, for example, win 11.54% of the time.

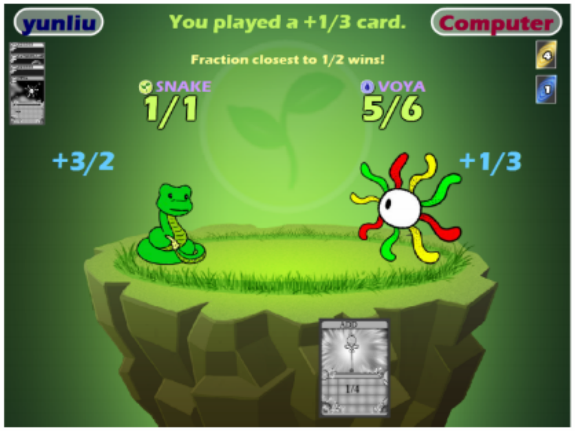
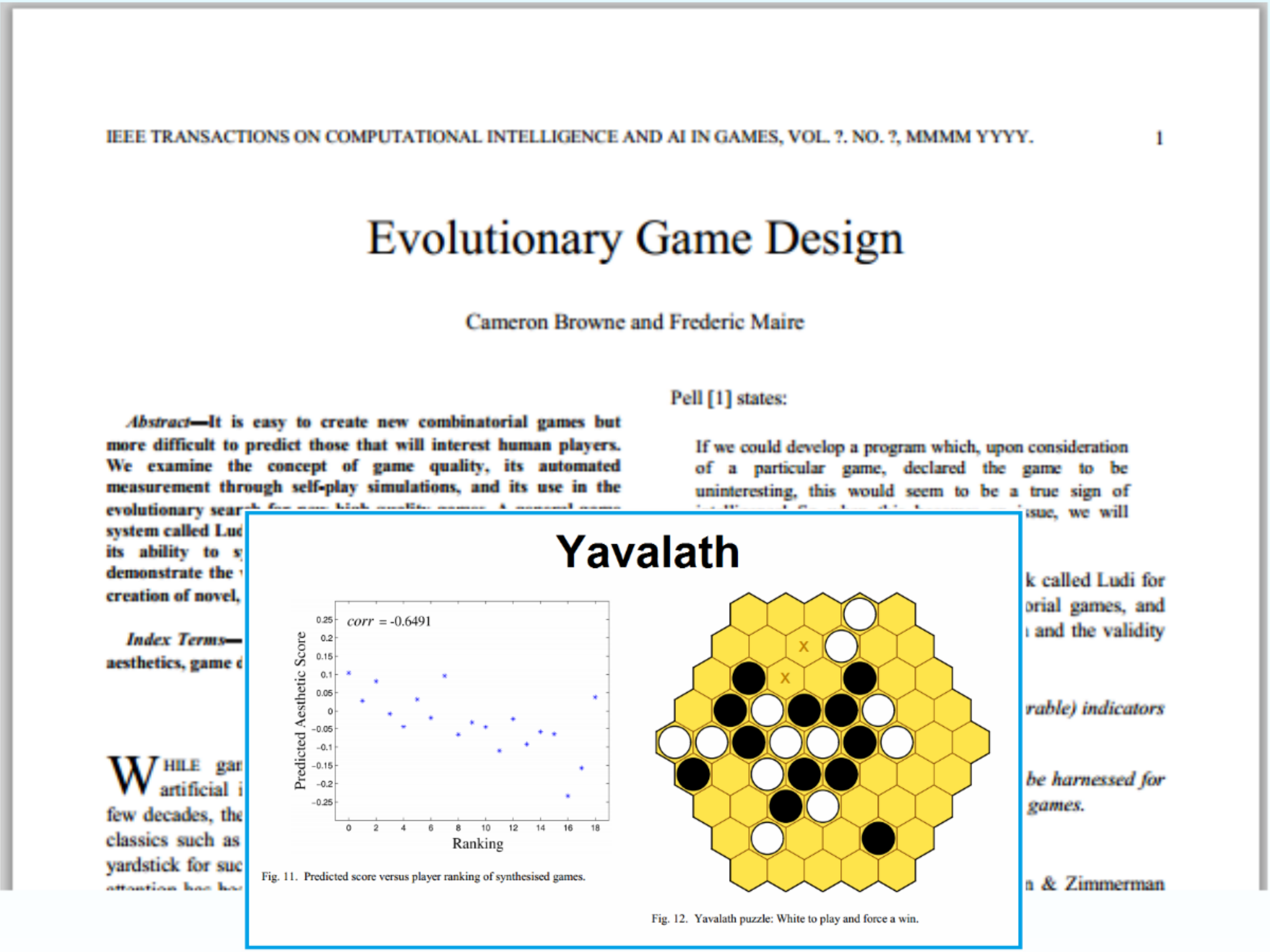


Fig. 2: *Monsters Divided.* $G1/1$ and $B5/6$ are played, with $+3/2$ and $+1/3$ power cards applied to them, respectively. G's rule is in play: closest to 1/2 wins. $5/6 + 1/3$ beats $1/1 + 3/2$, so P2 wins a B trophy.



IEEE TRANSACTIONS ON COMPUTATIONAL INTELLIGENCE AND AI IN GAMES, VOL. ?. NO. ?, MMMM YYYY. 1

Evolutionary Game Design

Cameron Browne and Frederic Maire

Abstract—It is easy to create new combinatorial games but more difficult to predict those that will interest human players. We examine the concept of game quality, its automated measurement through self-play simulations, and its use in the evolutionary sear

system called Lud

its ability to s

demonstrate the

creation of novel,

Index Terms—

aesthetics, game c

WHILE gar

artificial i

few decades, the

classics such as

yardstick for suc

Pell [1] states:

> If we could develop a program which, upon consideration of a particular game, declared the game to be uninteresting, this would seem to be a true sign of

issue, we will

k called Ludi for

orial games, and

and the validity

rable) indicators

be harnessed for

games.

n & Zimmerman

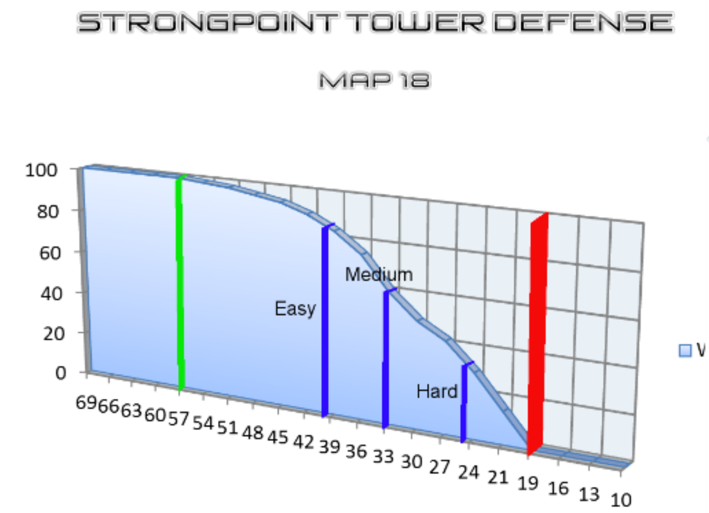
Yavalath

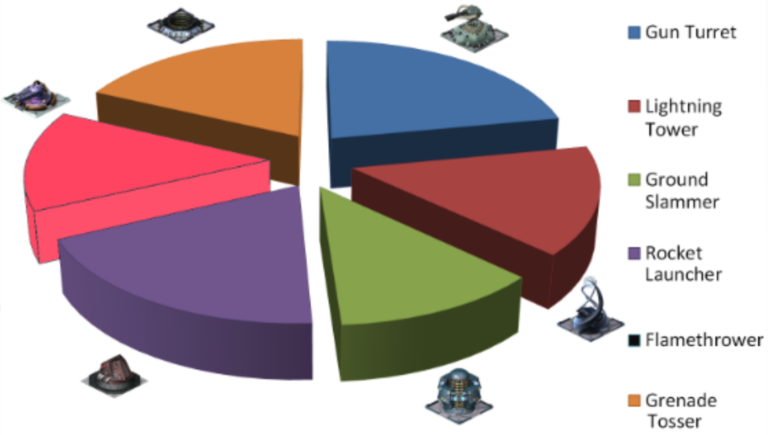
Fig. 11. Predicted score versus player ranking of synthesised games.

Fig. 12. Yavalath puzzle: White to play and force a win.

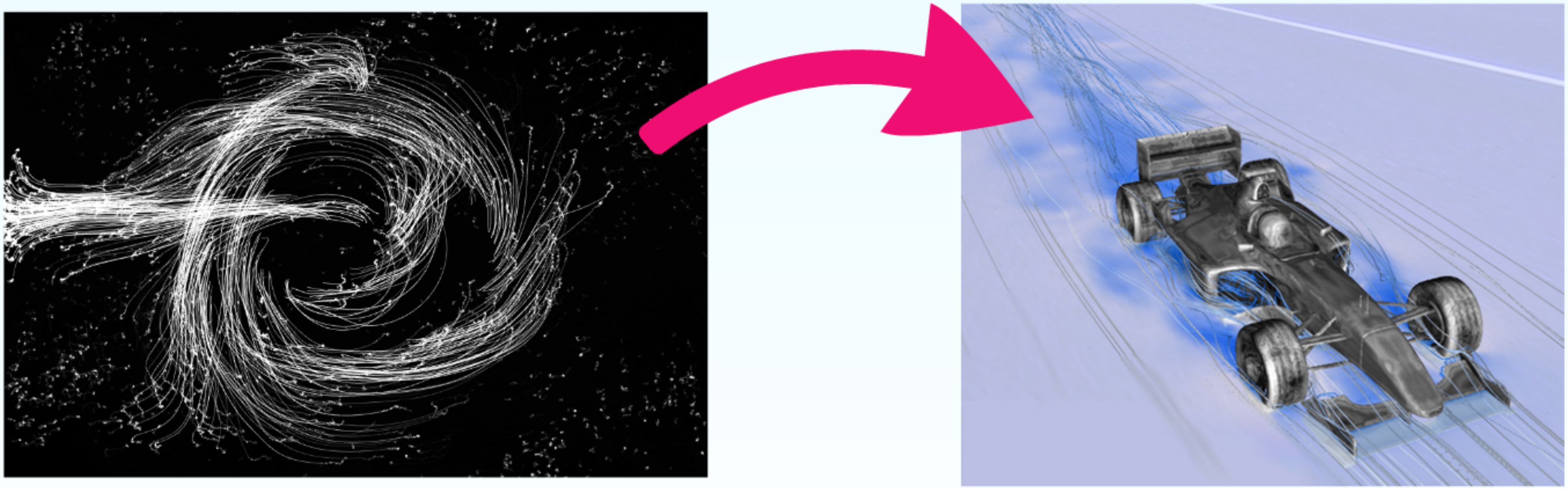
Shigi

Tower Defense Map Balancing

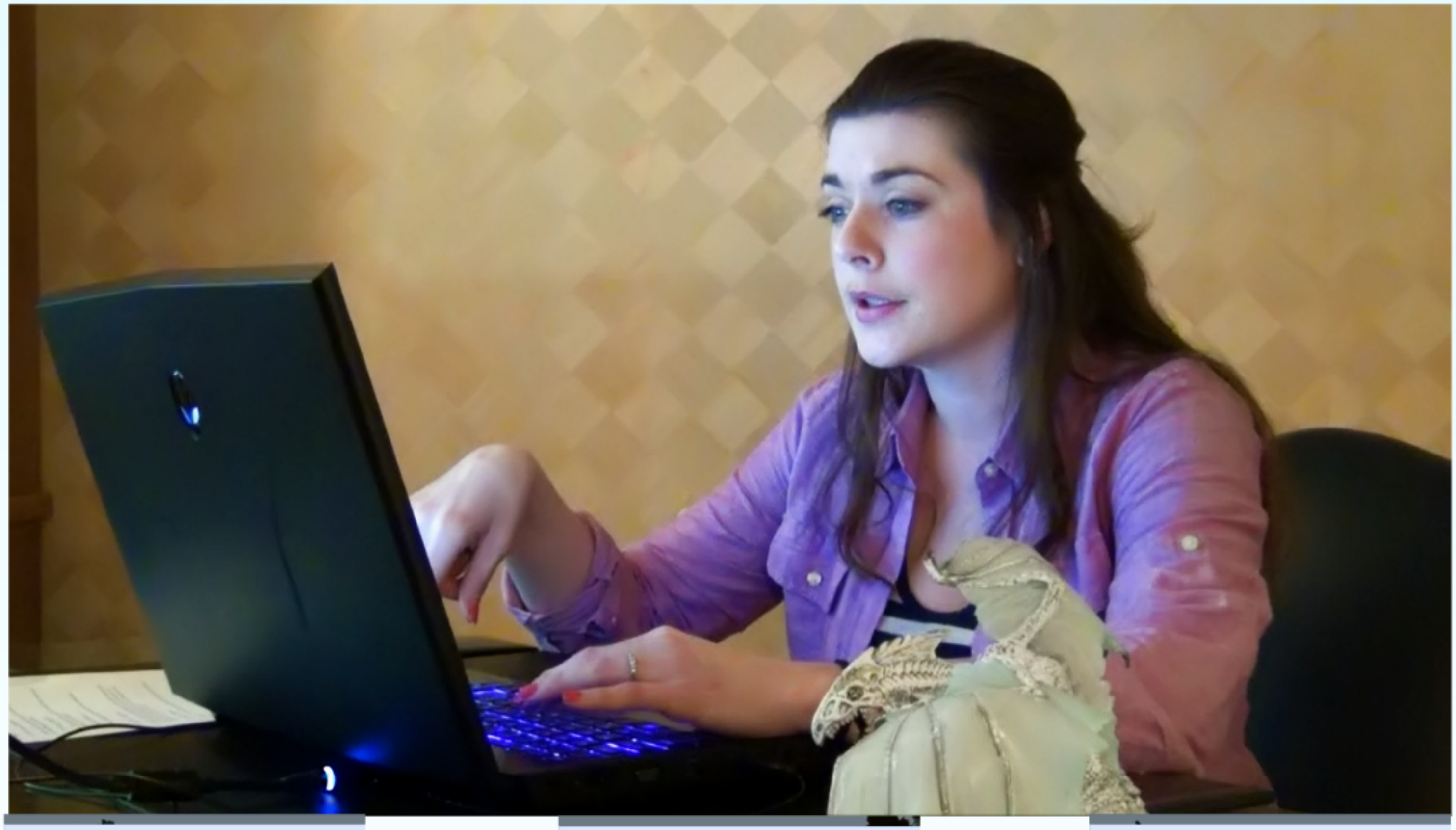


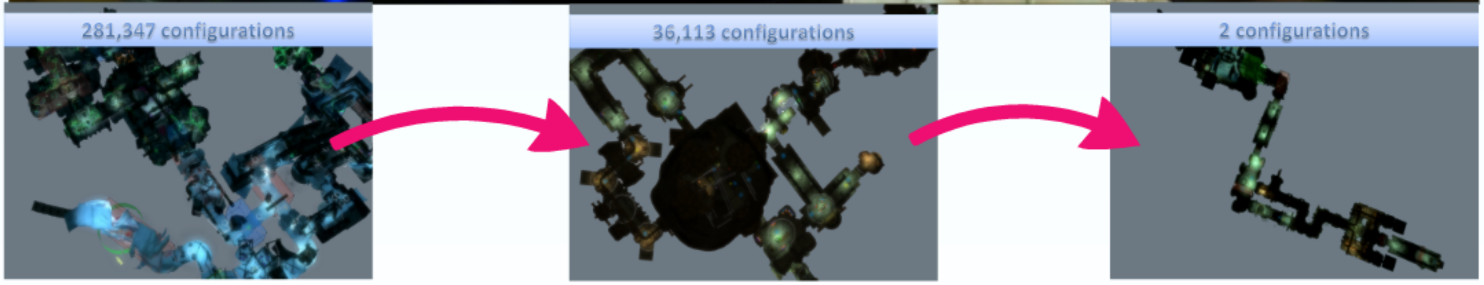


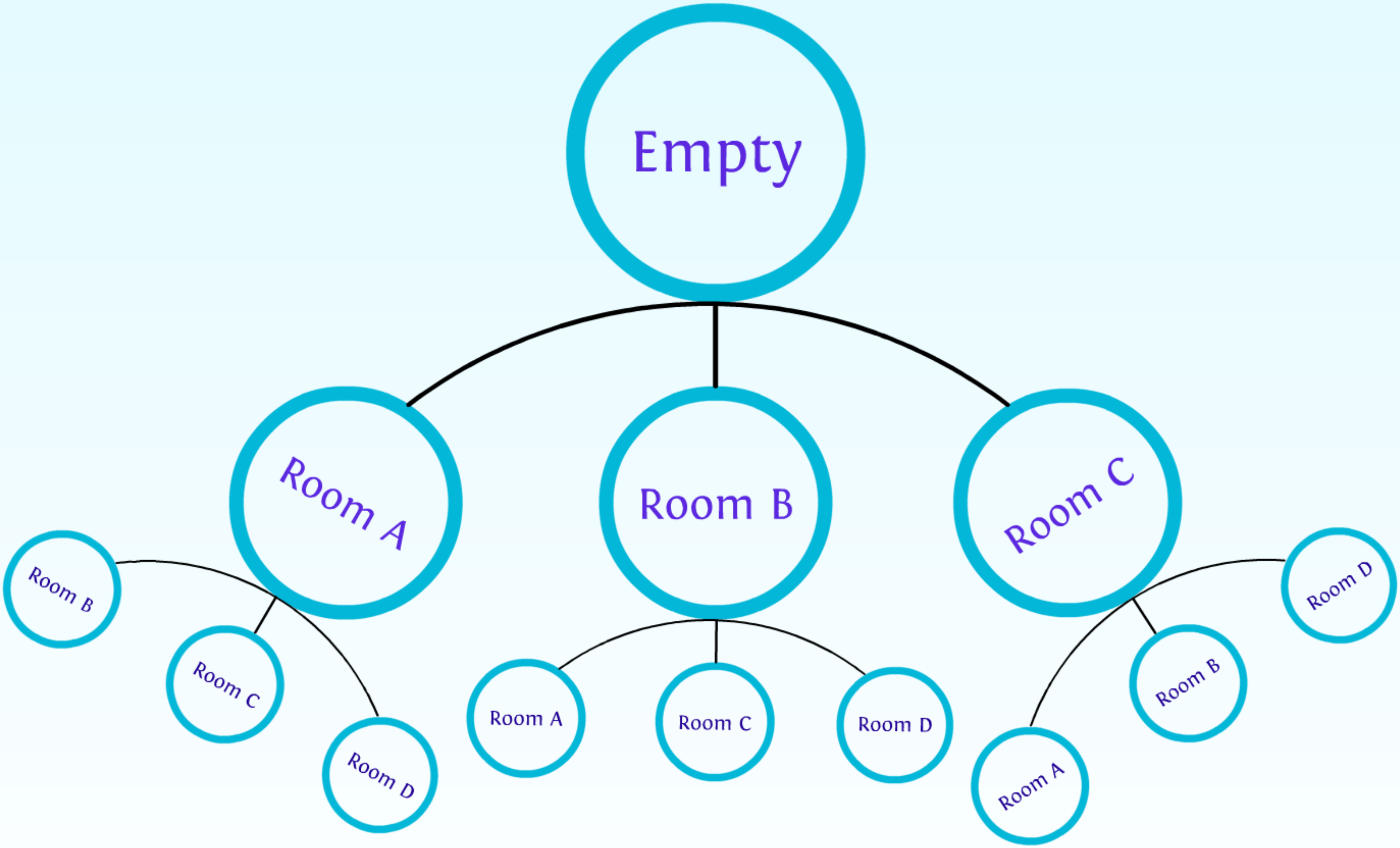
Using Simulation to Determine Airflow of Virtual Wind Tunnel



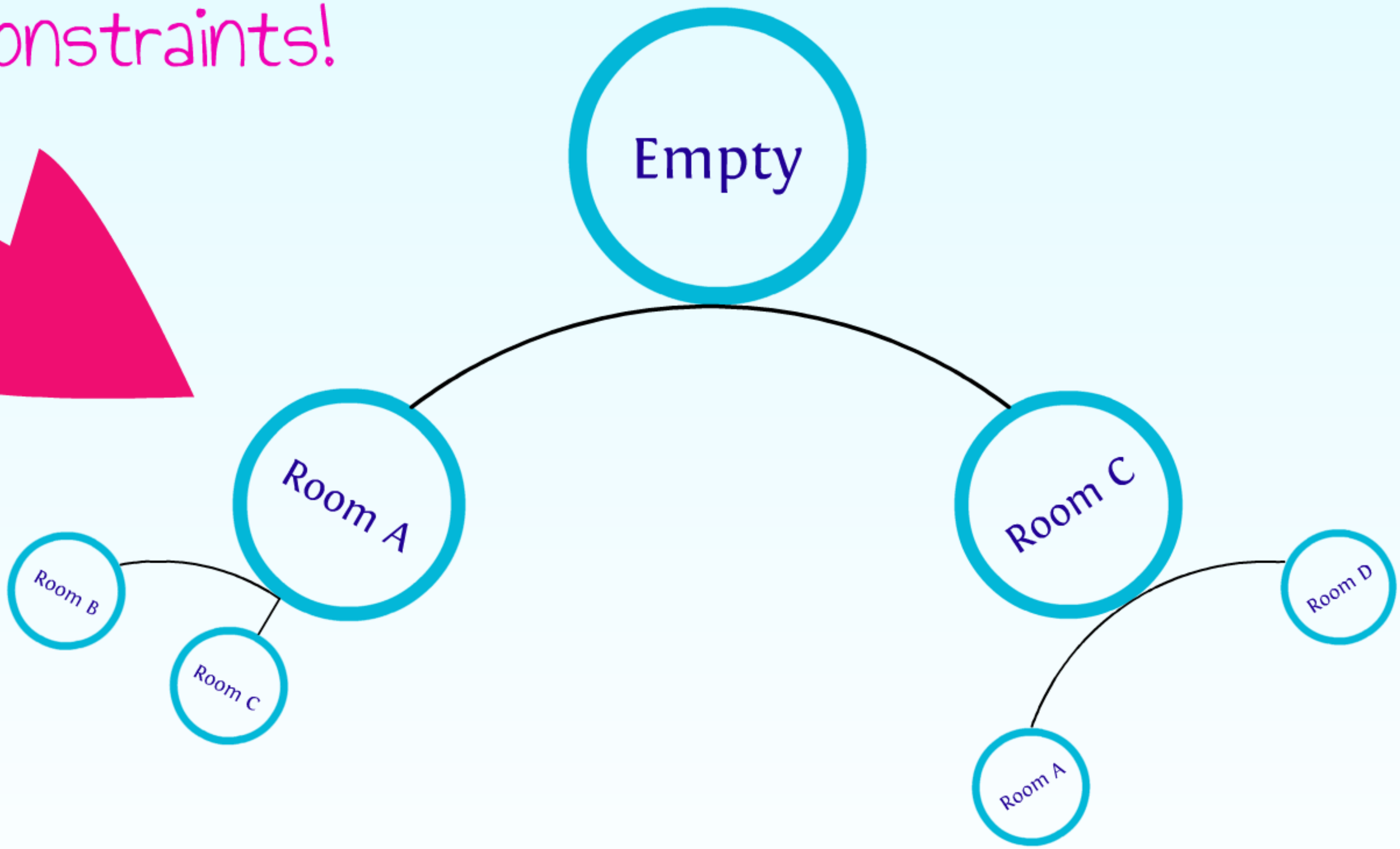
AI-Assisted Reconfiguration of a Game World





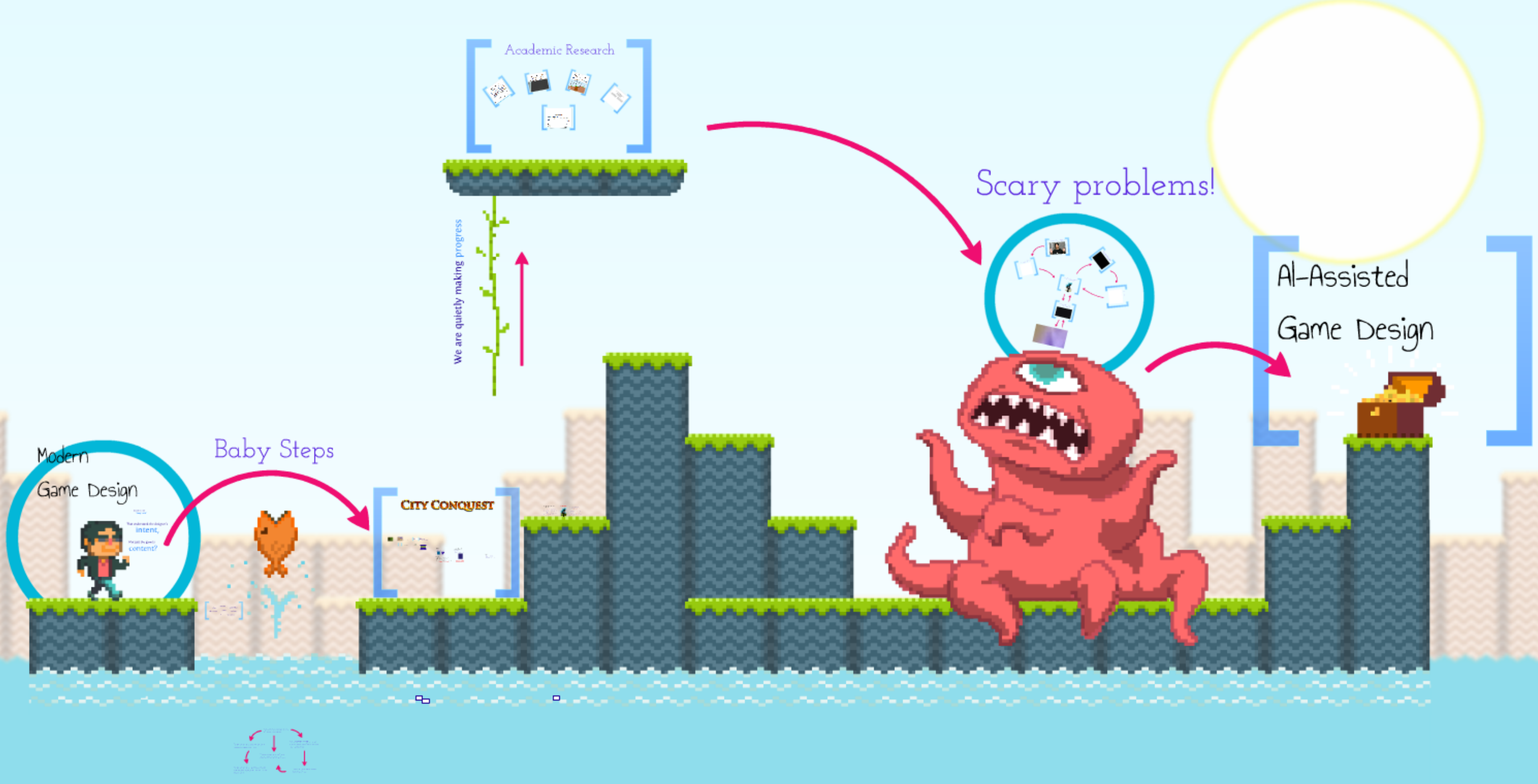

Empty
Room A
Room B
Room C
Room B
Room C
Room D
Room A
Room C
Room D
Room D
Room B
Room A

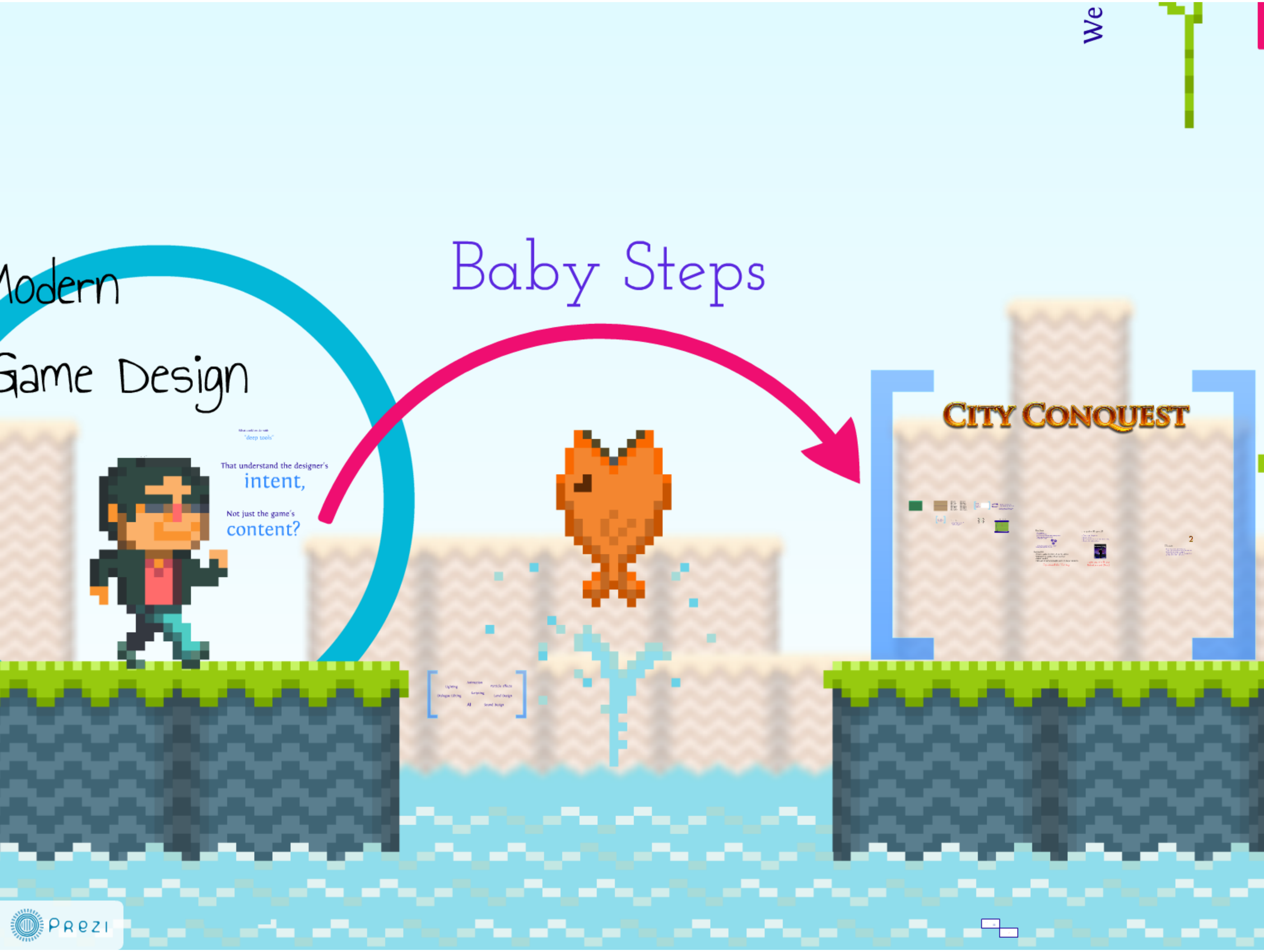
+constraints!



I'm trying to sell you on a
way of thinking about design.

I'm not trying to sell you a tool.





We

Modern

Game Design

What could we do with

"deep tools"

That understand the designer's

intent,

Not just the game's

content?

Baby Steps

Lighting

Animation

Particle effects

Dialogue Editing

Scripting

Level Design

AI

Sound Design

City Conquest

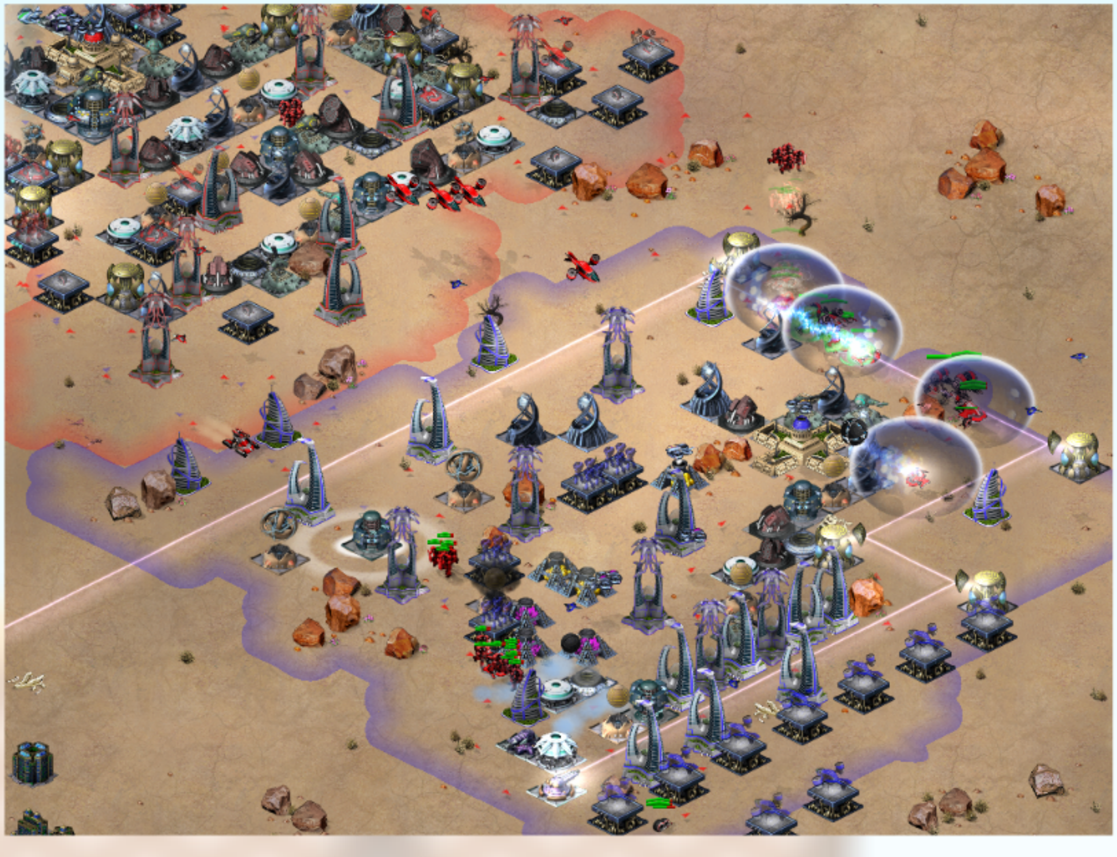
3

CITY CONQUEST

Design goals

- No globally dominant strategies
- Every tower/unit has a unique tactical role
- Every tower/unit's resource cost (gold or crystals) is proportional to its average utility
- Every tower/unit is useful when considering its unique role and its cost

(... + many more not listed here)



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Build=0,11,48,Mine,16
Build=0,11,47,Skyc,24
Build=0,14,42,Turr,28
Build=0,14,40,Turr,171184
Build=0,9,47,Mine,52
Build=0,9,49,Mine,60
Build=0,15,45,GrSl,100808
Build=0,10,49,Drop,100812
Build=0,13,45,RktL,100816
Build=0,17,44,RktL,100820
Build=0,10,45,Skyc,100824
Upgrade=0,13,45,RktL,100816
Build=0,17,49,Drop,100832
...
```

```
Build=0,11,46,Mine,8
Build=0,11,48,Mine,16
Build=0,11,47,Skyc,24
Build=0,14,42,Turr,28
Build=0,14,40,Turr,171184
Build=0,9,47,Mine,52
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Build=0,17,49,Drop,100832
...
```

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Build=1,11,48,Mine,16
Build=1,11,47,Skyc,24
Build=1,14,42,Turr,28
Build=1,15,45,GrSl,100808
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Build=1,17,44,RktL,100820
Build=1,10,45,Skyc,100824
Upgrade=1,17,44,RktL,100820
...
```
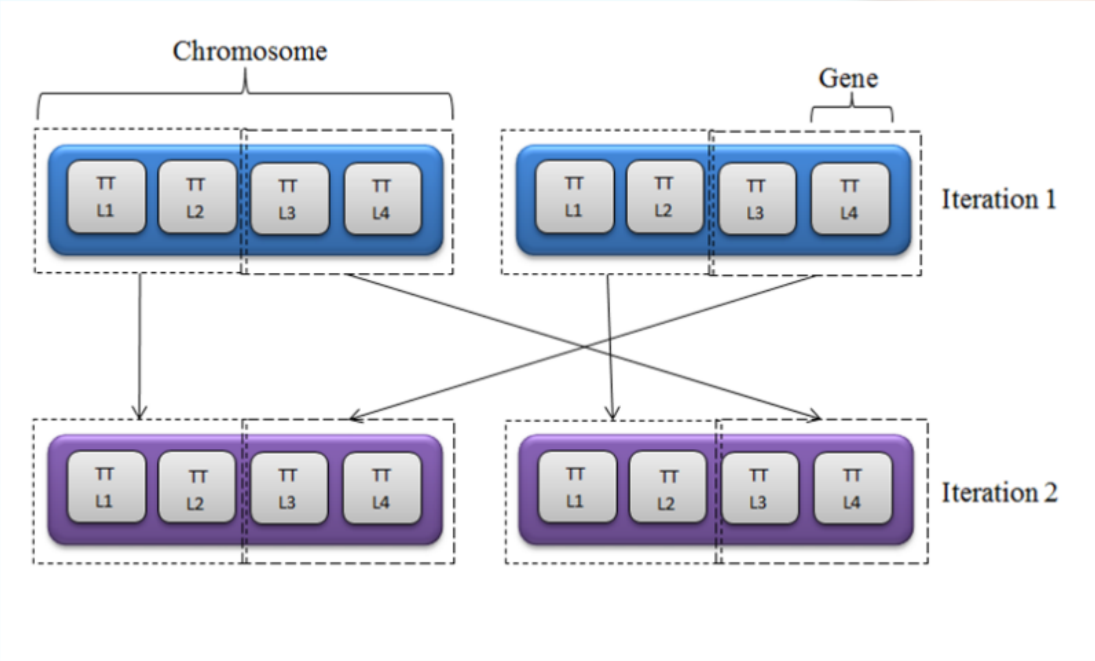
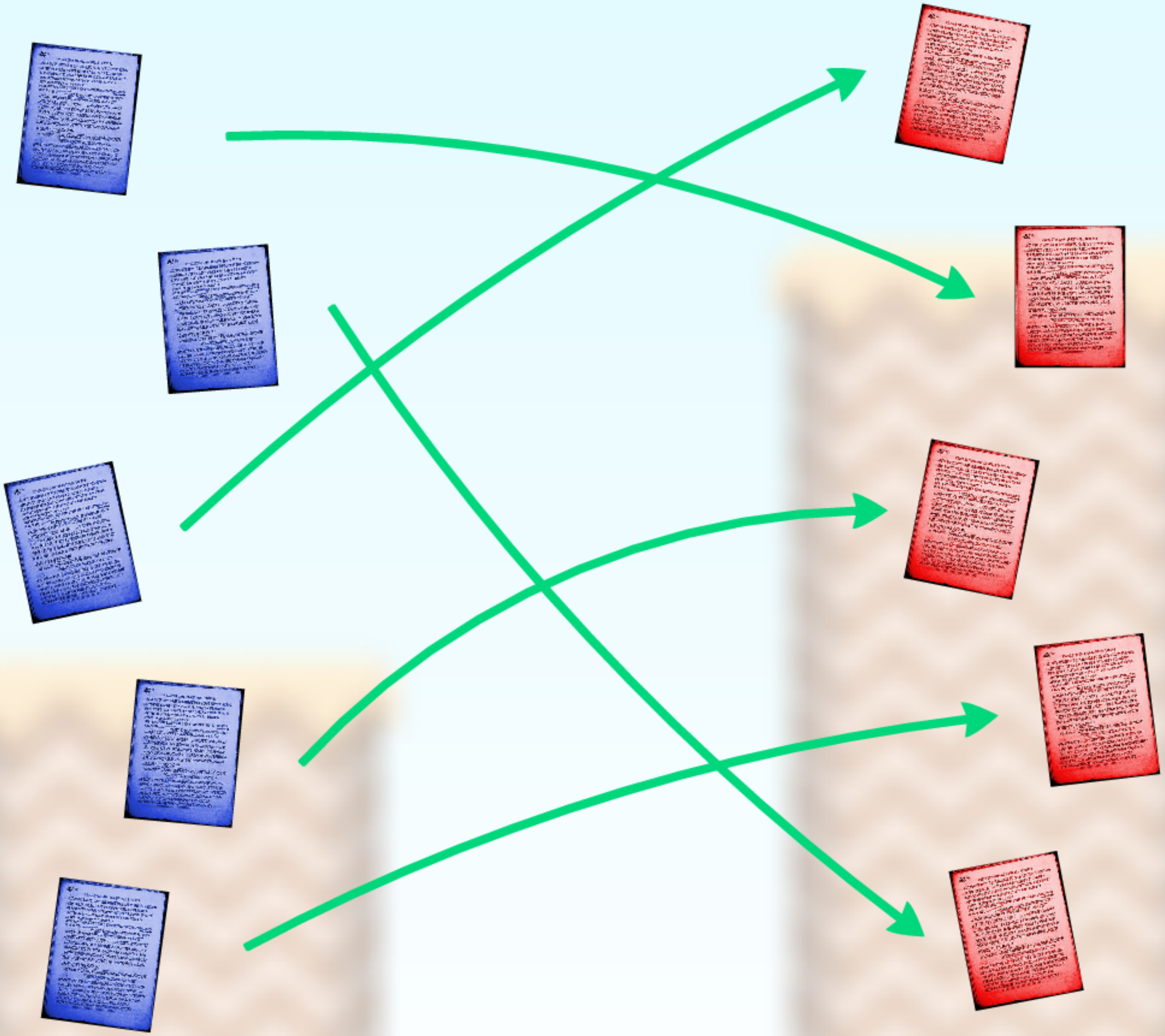

Mutation

Crossover

Replacement

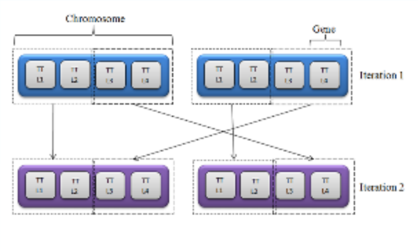




Mutation

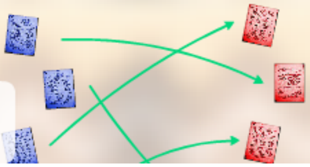
Crossover

Replacement



- Manual re-balancing
- Excel Solver optimization

Aesthetic aspects of balancing are difficult/impossible to quantify



Fitness Function

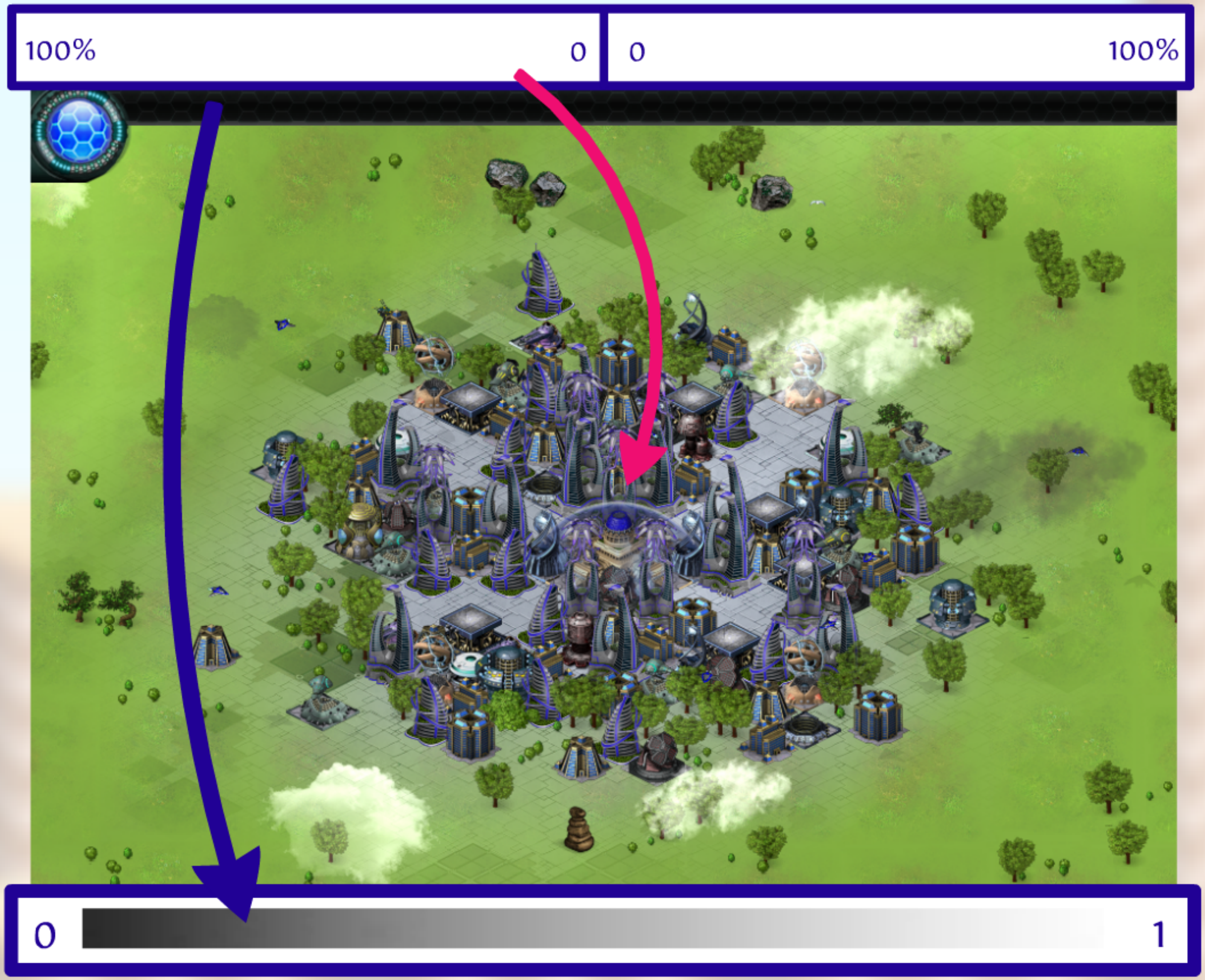
Player A's Capitol's health

Player B's Capitol's health

Fitness Function

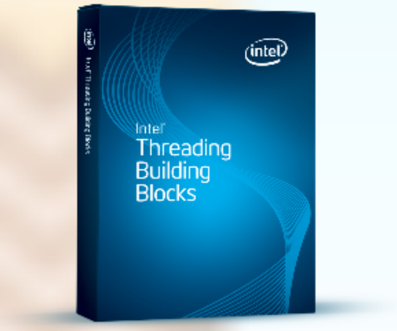
Player A's Capitol's health

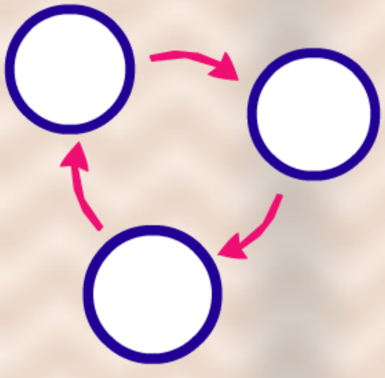
Player B's Capitol's health



Evolver

- Skip rendering
- Optimize game logic
- Parallelize with Intel Threading Building Blocks
- Fitness function customizations
- Island genetic model





~1 million simulated games in 12-14 hours (running overnight on a spare PC)

Evolver

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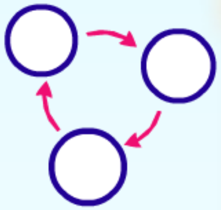

~1 million simulated games in 12-14 hours
(running overnight on a spare PC)

Positive ROI

- Total 2 weeks of coding & tuning effort
- Replaced 3-5 weeks of hand-tuning!
- Better results!
- Allowed incremental exploration of design decisions

Optimized for Victory

Evolver

- Skip rendering
- Optimize game logic
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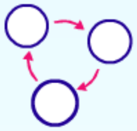

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- Total 2 weeks of coding & tuning effort
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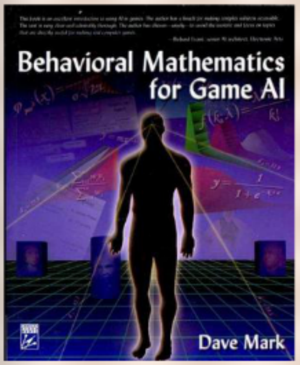
- Allowed incremental exploration of design decisions

Optimized for Victory

Computer Player AI

- Traditional AI system
- Behavior tree
- Script-guided building placement hints
- Behavioral mathematics



Optimized for Player Entertainment (Fun!)

City Conquest 2

Goals

- GA for mission tuning & balancing
- Fitness function customizable for each mission
- GA-based AI vs computer player AI
- Integrate with external data mining system to get more useful data from results

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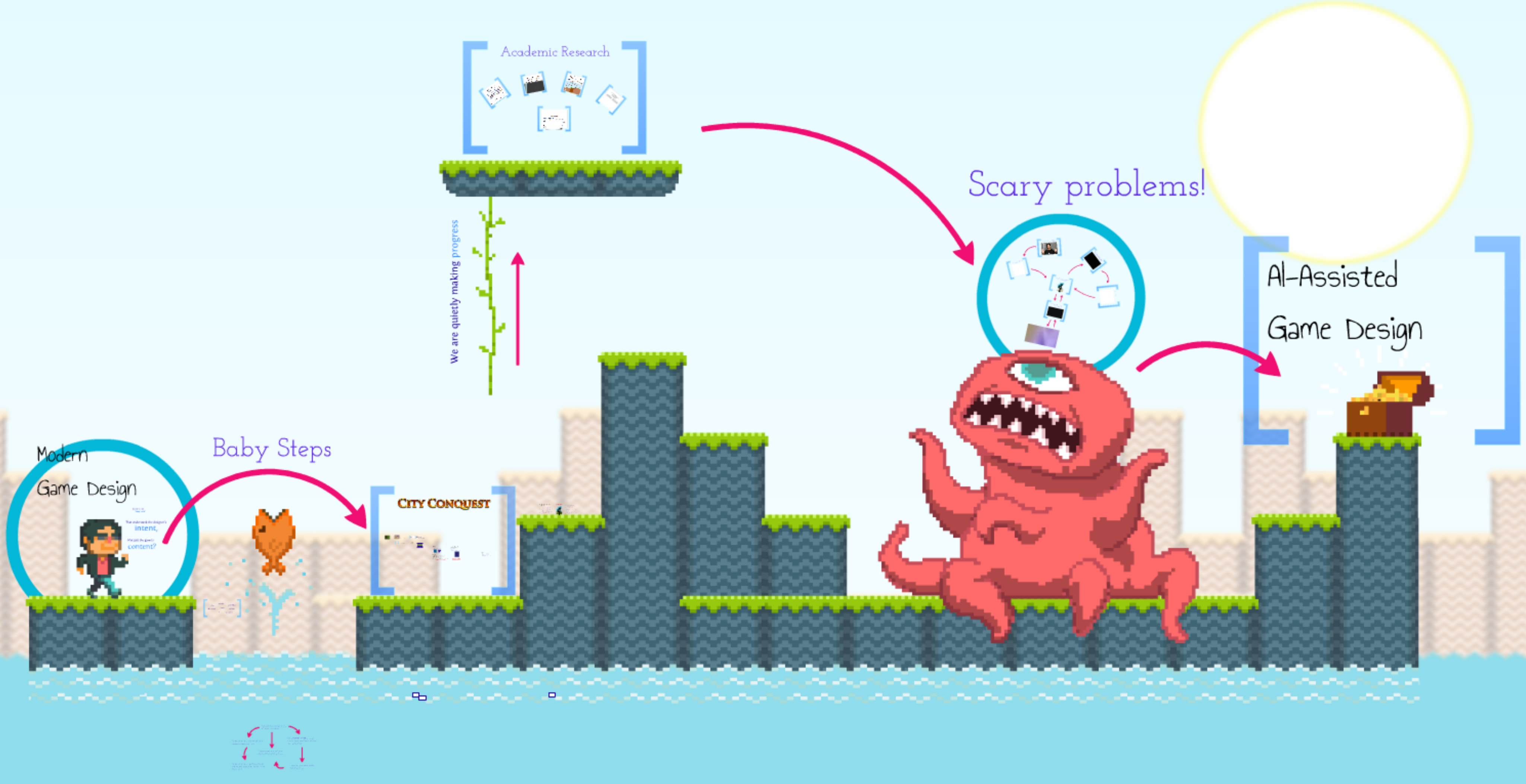
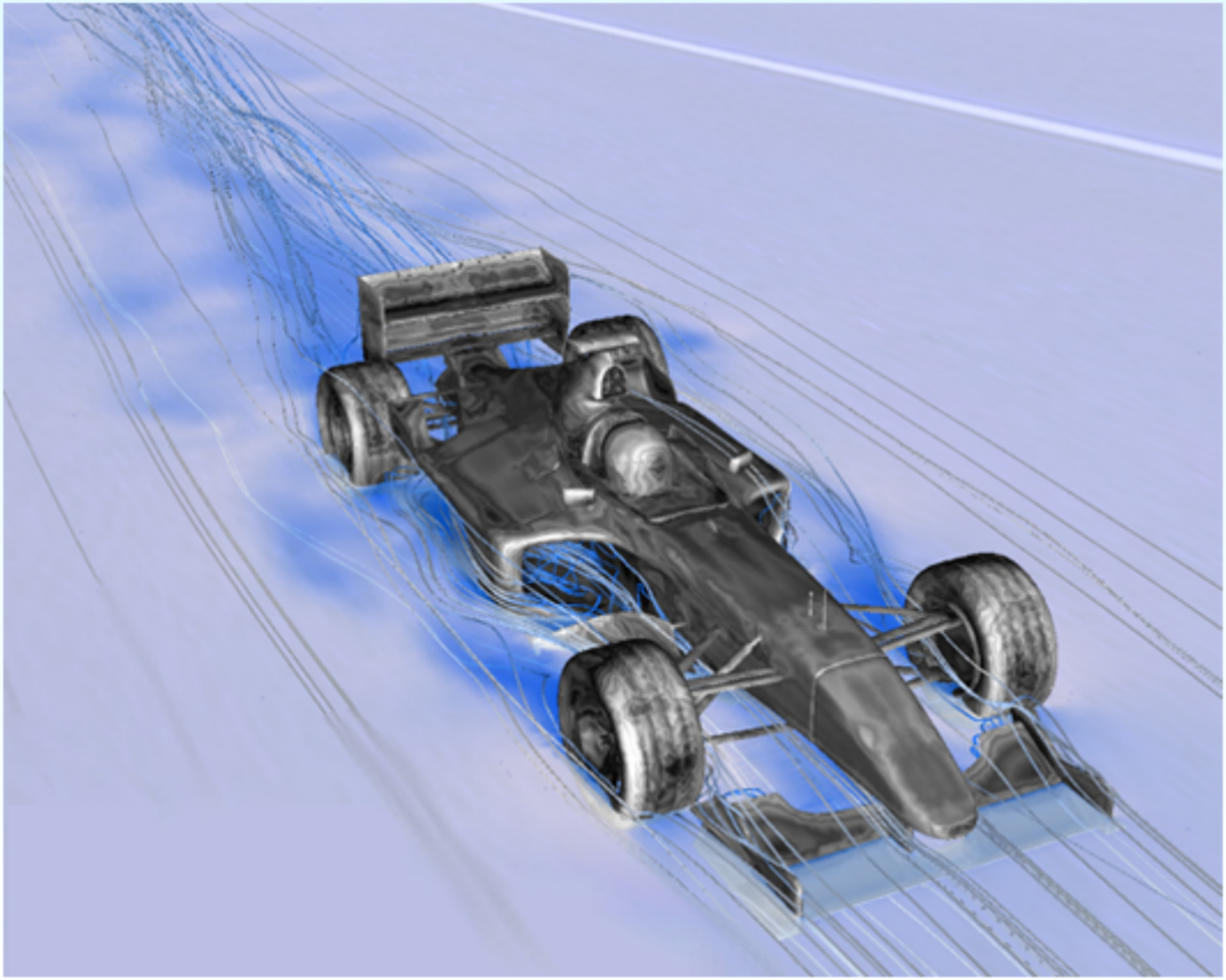


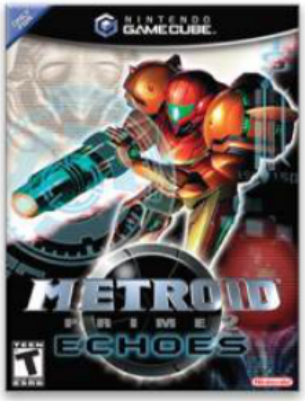
Virtual Wind Tunnel for Game Design



AI-Assisted Game Design

Intelligence Engine

DESIGN SYSTEMS



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GDC Play kiosk 50

From the Behavior Up: When the AI Is the Design

Paul Tozour
Intelligence Engine Design Systems

Damian Isla
Christian Baekkelund
Moonshot Games

AI ARTIFICIAL INTELLIGENCE SUMMIT

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