

Orchestrating Game Generation

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Orchestrating game generation

- Game development requires a **multitude of creative skillsets** (in both humans and AI)
- How should the different creative domains influence each other so that the final outcome achieves a **harmonized and fruitful communication** across domains?
- Similar to musical orchestration: by a **composer, a maestro, or through jamming?**



Creativity in Games

(originating from humans or computers)



Games are multi-faceted



audio

visuals

narrative

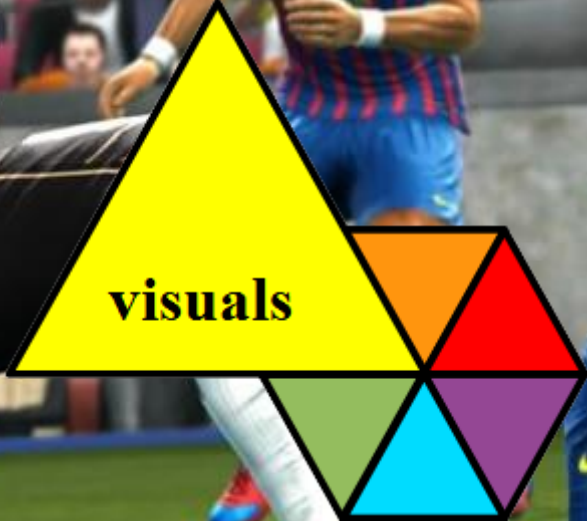
level
design

gameplay

game
design

Nameless One - "Why have I lost my memory?"
Lothar - "It is a side effect of losing your mortality."
Nameless One - "I have lost my mortality? What do you mean?"
Lothar - "Your mortality - your soul, if you will, that which allows you to live and die - is gone from you. It was stripped from you by magic means, by the night hag Ravel Puzzlewell. Your mortality is the key to your existence - when you find it, you will find your answers."
Nameless One - "Tell me about this Ravel."
Lothar - "Ravel Puzzlewell is an enigma, even among the night hags. Some would call her barmy; others say she plays a deeper game than any of us can see through. She is evil, through and through, making the fiends you see in the area seem positively divine when compared to her. She is the reach of men now, thank the powers, for she was mazed by the agony of Pain."
Nameless One - "How do I find her?"
Lothar - "I did she do?"
Nameless One - "My thanks. Farewell, Lothar."

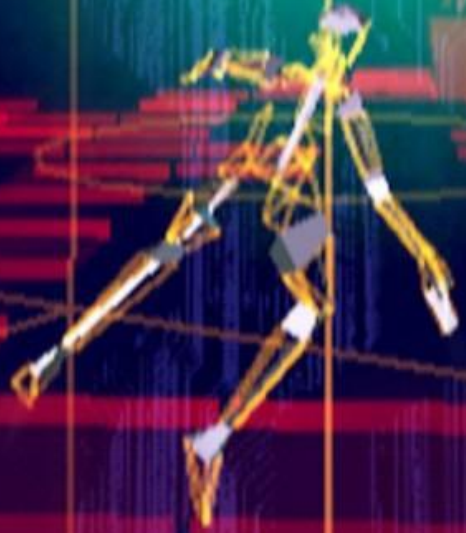
A. Liapis, G. N. Yannakakis, and J. Togelius, "Computational game creativity," in Proceedings of the Fifth International Conference on Computational Creativity, 2014.




visuals




CORE
FIRE_ (2X)
ARM
ARM
ARM
ARM
ARM
ARM
FIRE_ (5X)



SELECT YOUR PIRATE!

 Back

 More Pirates

Edit Geometry Generator

Polygons : 29479 (60 per sec)

VArray Blocks : 1759

CommitCalls : 0

A. Howlett, S. Colton, and C. Browne, "Evolving pixel shaders for the prototype video game subversion," in AI and Games Symposium (AISB'10), November 2010.



Grass-Poison Bulbasaur



Fire-Ground Bulbasaur



Water-Ghost Bulbasaur



Water



Water-Fire



Water-Grass



Water-Ground



Water-Ground



Water-Poison



Bug



Ghost



Psychic-Fighting



Grass



Fire-Ground



Psychic-Flying

A. Liapis: "Recomposing the Pokémon Color Palette," in Applications of Evolutionary Computation. Springer, 2018.









GENERATOR

PICKUP/COIN

LASER/SHOOT

EXPLOSION

POWERUP

HIT/HURT

JUMP

BLIP/SELECT

MUTATE

RANDOMIZE

LD48

MANUAL SETTINGS

SQUAREWAVE

SAWTOOTH

SINEWAVE

NOISE

ATTACK TIME

SUSTAIN TIME

SUSTAIN PUNCH

DECAY TIME

START FREQUENCY

MIN FREQUENCY

SLIDE

DELTA SLIDE

VIBRATO DEPTH

VIBRATO SPEED

CHANGE AMOUNT

CHANGE SPEED

SQUARE DUTY

DUTY SWEEP

REPEAT SPEED

PHASER OFFSET

PHASER SWEEP

LP FILTER CUTOFF

LP FILTER CUTOFF SWEEP

LP FILTER RESONANCE

HP FILTER CUTOFF

HP FILTER CUTOFF SWEEP

VOLUME

PLAY SOUND

LOAD SOUND

SAVE SOUND

EXPORT .WAV

44100 HZ

16-BIT



Nameless One - "Nameless One! This is between Ravel and I. Look, Ravel --"

Ravel - "Skull, skull, skull..." Ravel clicks her tongue and her expression widens. "Your expression is difficult to read. Your skin wrapping, but I feel your FEAR from here. Come, this was *not* your choice."

Morte - "Well, I didn't have anything BETTER to do except go to one of the Lady's mazes and meet one of the vilest creatures ever to set foot in Sigil, so I said 'sure! Why n-?"

1. "Morte, be quiet. Ravel, I..."



70898







Grace, are you angry at Trip?

M. Mateas, and A. Stern. "Façade: An Experiment in Building a Fully-Realized Interactive Drama", Game Developers Conference (GDC'03), 2003.





Look. You're really into dead bugs. That's cool and everything, but I'm much more of a diamond kind of girl.

J. McCoy, M. Treanor, B. Samuel, A. A. Reed, N. Wardrip-Fruin, and M. Mateas, "Prom Week: Designing past the game/story dilemma," in Proceedings of the International Conference on the Foundations of Digital Games, 2013.

R. Hodhod and B. Magerko "Reaching Cognitive Consensus with Improvisational Agents," Proceedings, The Eighth AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment. 2012.



You:FOLLOWSOMEONE:: Agent: DROPTOGRO

Medusa
Level 1

Swap Hero Options:

- 1 - Skeleton King
- 2 - Bristleback
- 3 - Faceless Void
- 4 - Shadow Shaman

Type **-swap #** to make a choice or **-swa** to cancel swap requests

[Allies] tosh_00 (Leoric): who want??
 [Allies] inferno90 (Bristleback): -swap 1
 [Allies] mPExcalibur (Rhasta): -swap 1
 [Allies] Bladebomber (Medusa): -swa



416 / 416
247 / 247

Medusa

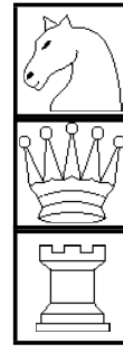
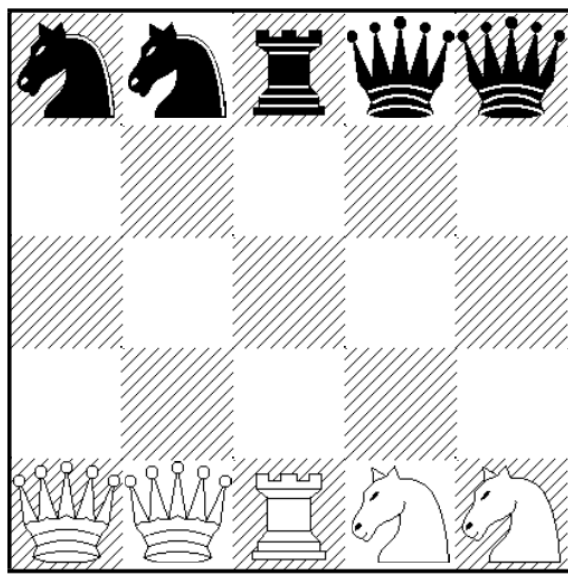
Level 1 Gorgon

 Damage:	44 - 50	 Strength:	14
 Armor:	2	 Agility:	20
Status:		 Intelligence:	19

Inventory

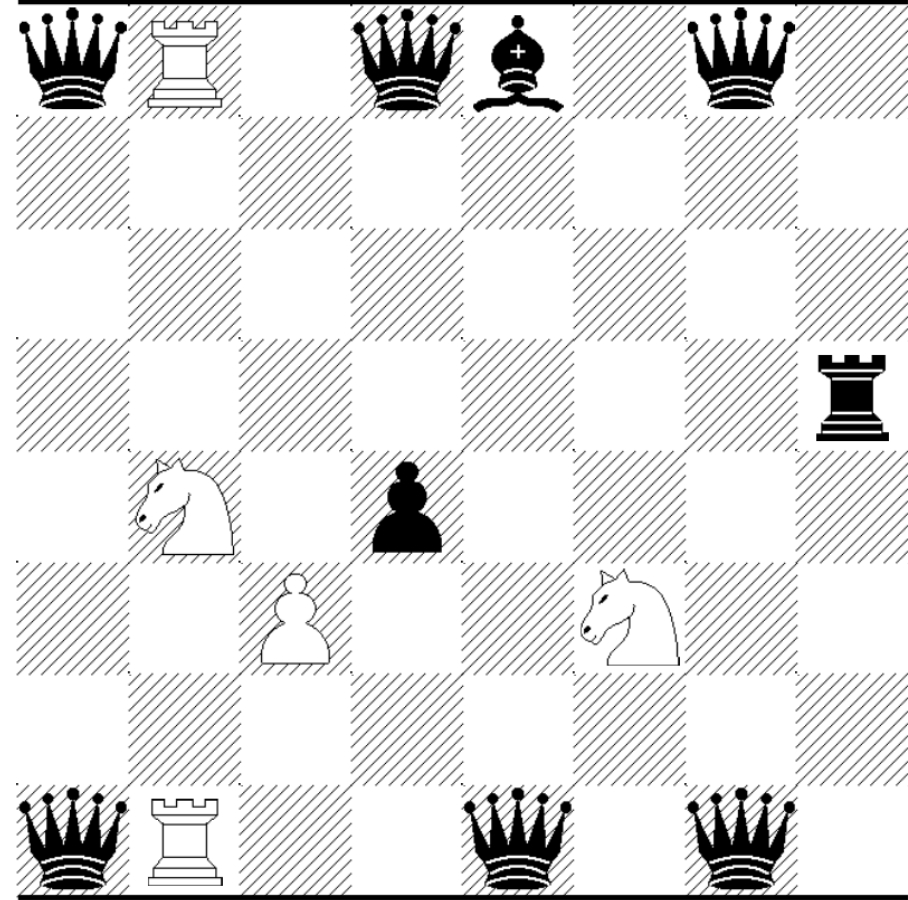
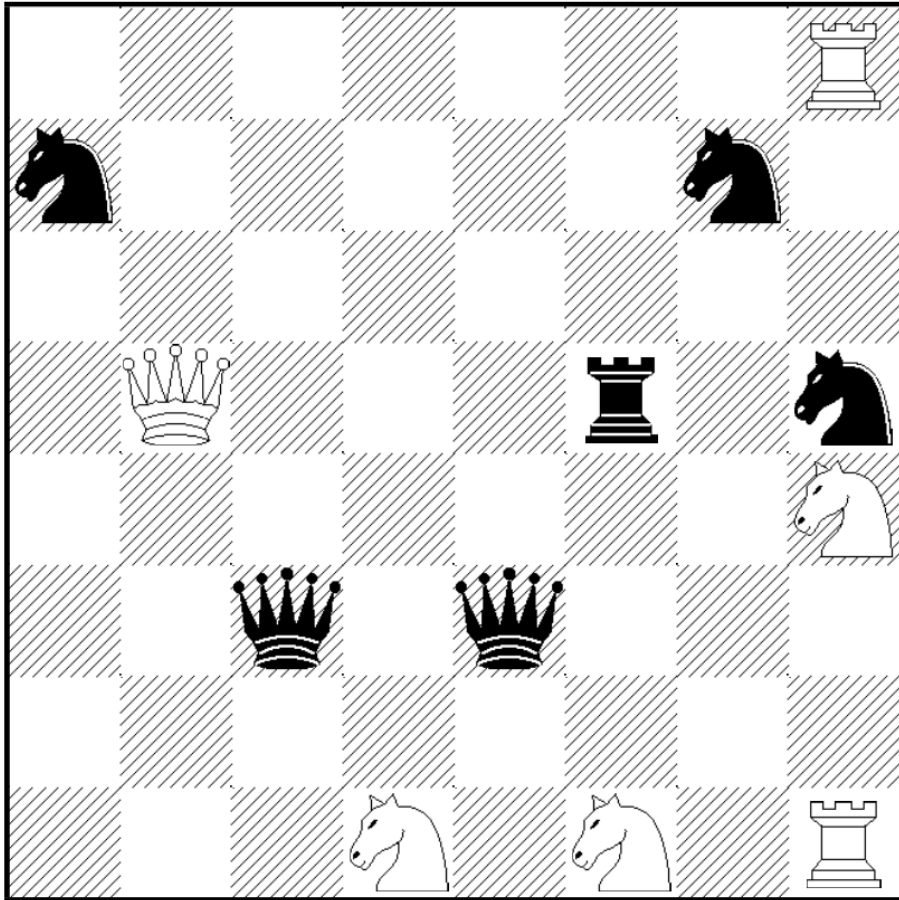


↳ Firefly

↳ Termite

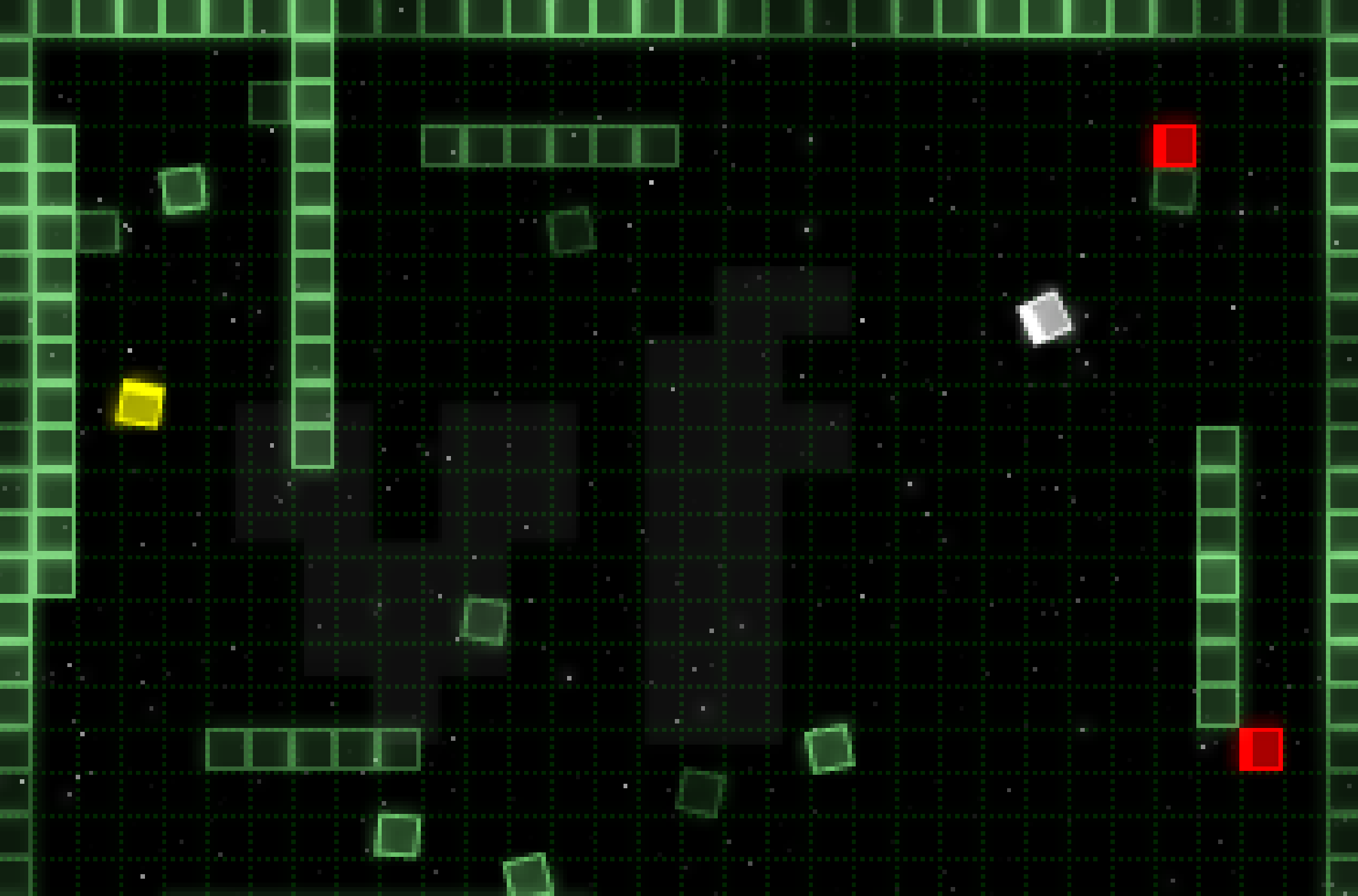
↳ Slug

B. Pell. "Metagame: A New Challenge for Games and Learning". Heuristic Programming in AI 3, 1992.

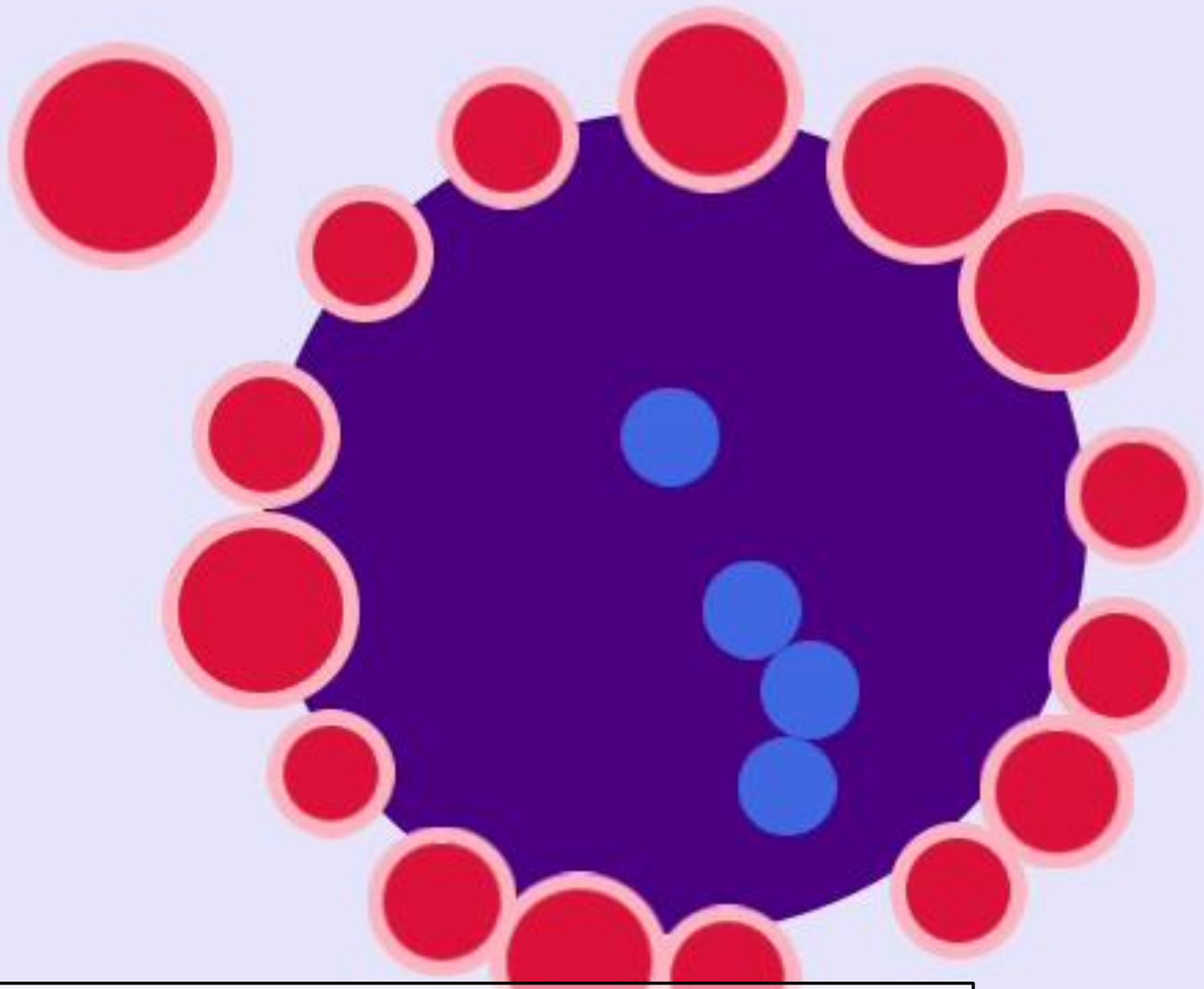




C. Browne and F. Maire, "Evolutionary game design," IEEE Transactions on Computational Intelligence and AI in Games, vol. 2, no. 1, pp. 1–16, 2010.



A. M. Smith and M. Mateas, "Variations forever: Flexibly generating rulesets from a sculptable design space of mini-games," in Proceedings of the IEEE Symposium on Computational Intelligence and Games (CIG), 2010.



M. J. Nelson, S.E. Gaudl, S. Colton, E.J. Powley, B. Perez Ferrer, R. Saunders, P. Ivey, M. Cook: "Fluidic Games in Cultural Contexts," in Proceedings of the 8th International Conference on Computational Creativity, 2017.

Husbandry improvement complete.
 Pickaxe improvement complete.
 Hand Axe improvement complete.
 Hunting Dogs improvement complete.
 Flood of the Nile improvement complete.
 Hands of the Pharaoh improvement complete.
 Grant Phoenix Egg improvement complete.
 A new Pharaoh has arisen to lead your people!
 Disable Atlantean Favor improvement complete.
 You cannot build another Mercenary.
 Mercenary created.
 You cannot build a House there.
 You cannot build another House.



Buy	Sell
129	79
14957	/ 0
14800	/ 0
13950	/ 0
14 / 18	
10 Monuments	

[DoD_]Fox__

- 100000
- 100000
- 100000
- 100000





E Take
Bucket

WEIGHT **0.5** VALUE **1**

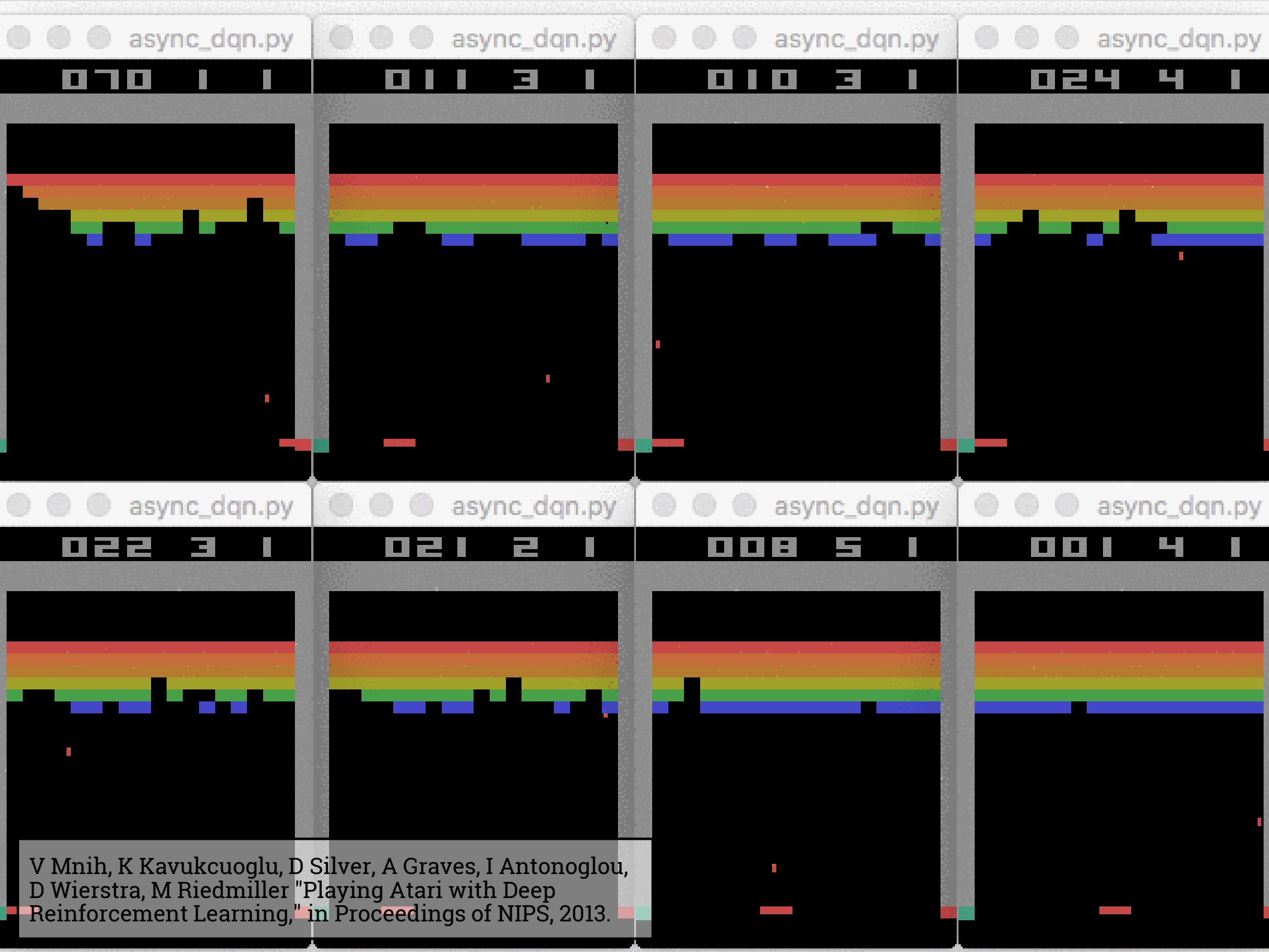
Press Esc to exit full screen mode.

MARRY
ME





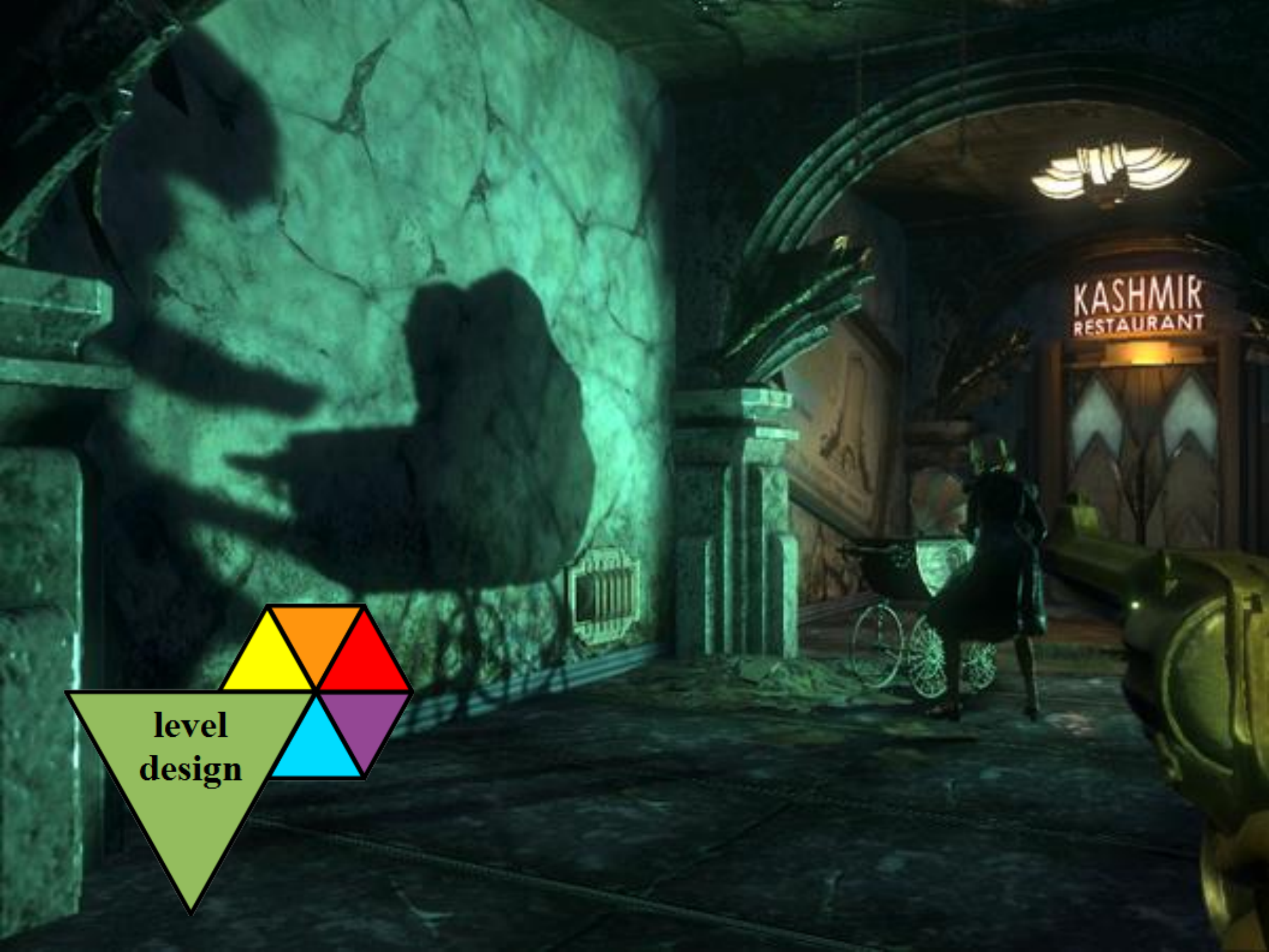
D. Perez-Liebana, S. Samothrakis, J. Togelius, T. Schaul, S. Lucas: "General Video Game AI: Competition, Challenges and Opportunities," in Proceedings of the Thirtieth AAAI Conference on Artificial Intelligence, 2016.



V Mnih, K Kavukcuoglu, D Silver, A Graves, I Antonoglou, D Wierstra, M Riedmiller "Playing Atari with Deep Reinforcement Learning," in Proceedings of NIPS, 2013.



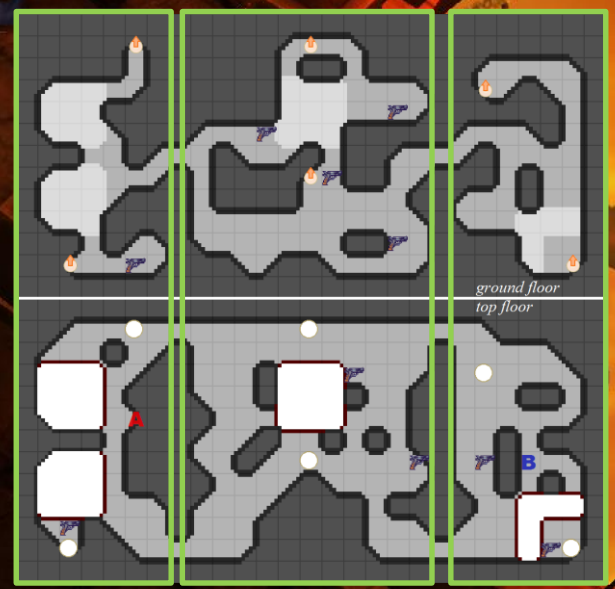
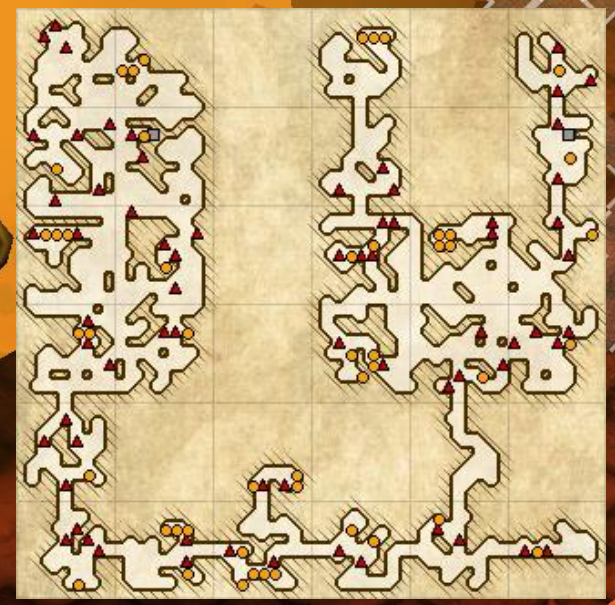
Denzinger, J.; Loose, K.; Gates, D.; and Buchanan, J.: "Dealing with parameterized actions in behavior testing of commercial computer games," in Proceedings of the IEEE Symposium on Computational Intelligence and Games (CIG), 2005.



level
design



A. Liapis: "Multi-segment Evolution of Dungeon Game Levels," In Proceedings of the Genetic and Evolutionary Computation Conference, 2017.
A. Liapis: "Piecemeal Evolution of a First Person Shooter Level," in Applications of Evolutionary Computation. Springer, 2018.



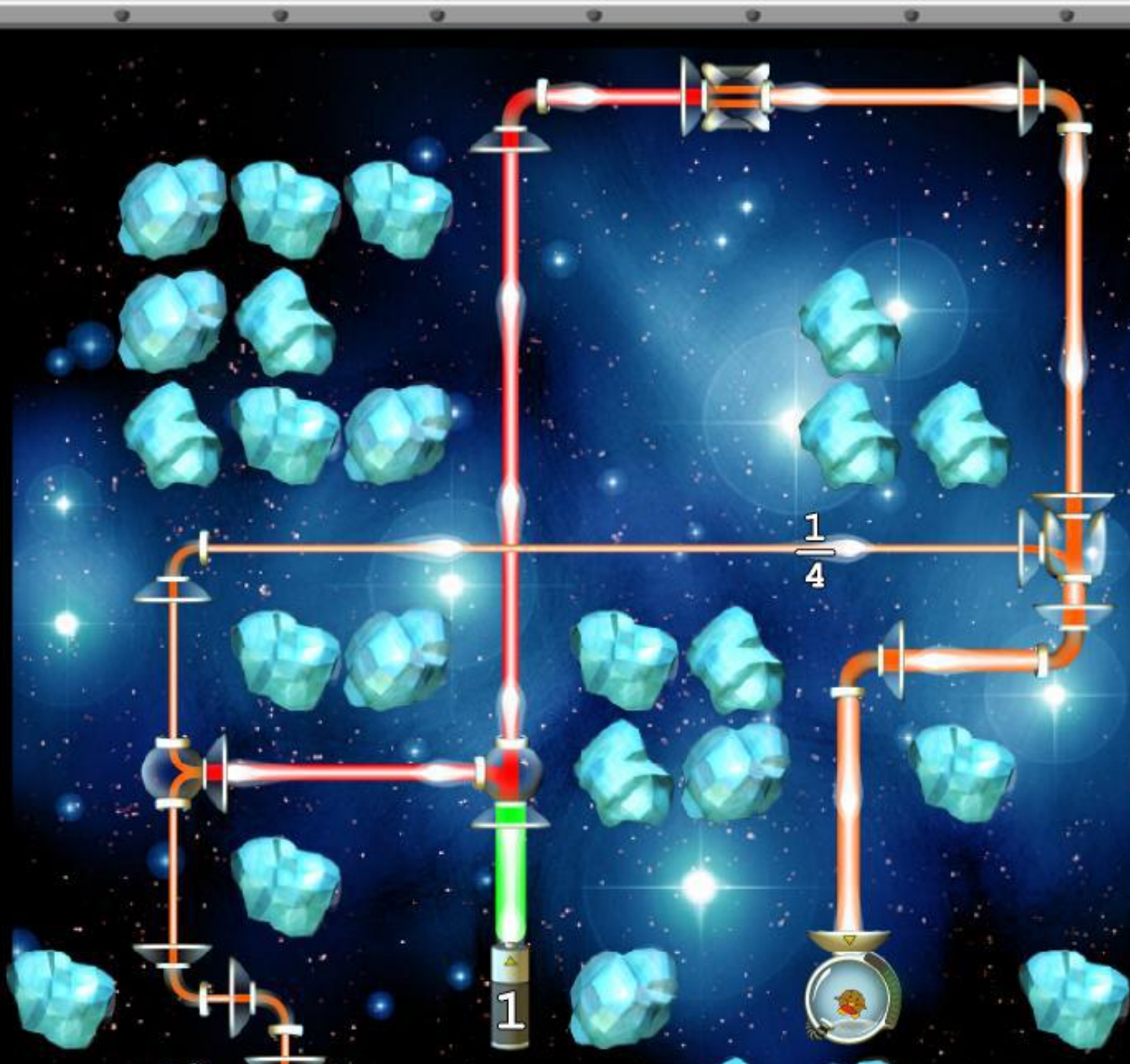


MANUAL LABOR
Come back and search this Ruin with a Delvers unit in your army and a minimum of 30 of Titanium and 30 of Glassteel

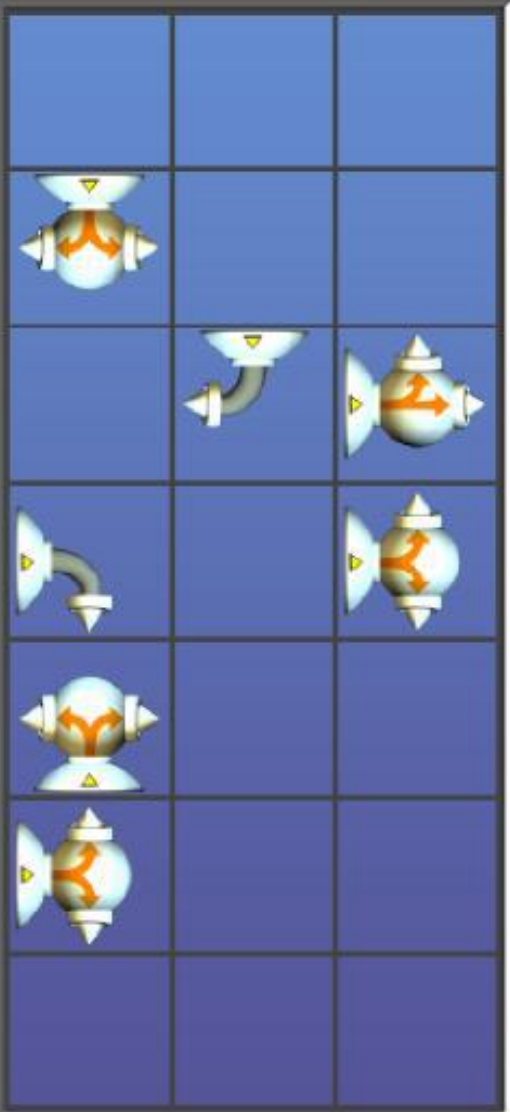
11 ♣ Perrandy
3 150 7



TURN 149
End Turn



ADVANCE

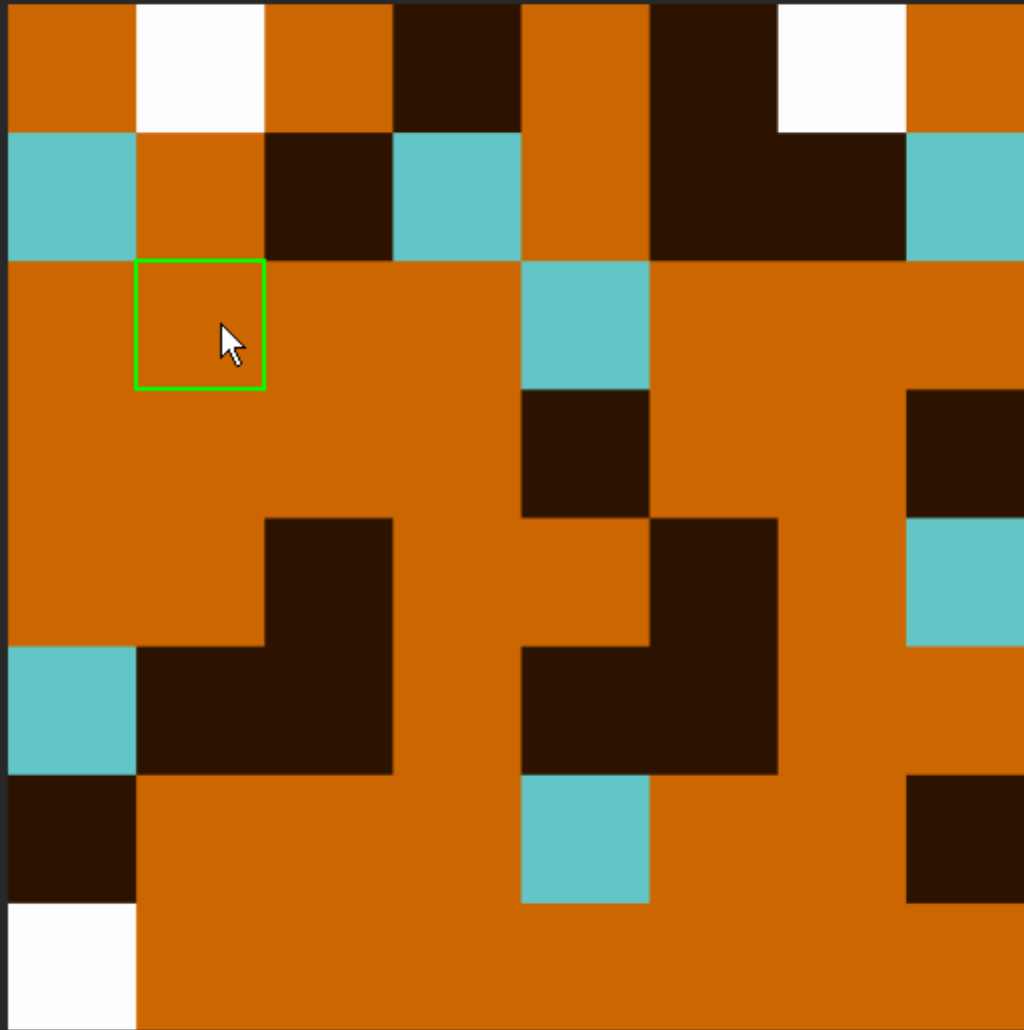


MENU

OPTIONS

A. M. Smith, E. Andersen, M. Mateas, and Z. Popovic, "A case study of expressively constrainable level design automation tools for a puzzle game," in Proceedings of the Seventh International Conference on the Foundations of Digital Games, 2012.

Strategy Game Map Sketching

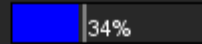


Clear Map

Viewing Modes



Resource Safety



Resource Safety Fairness



Safe Area



Safe Area Fairness



Exploration



Exploration Fairness



Bases: 3

3

Choke Points: 4

3

Resources: 7

10

Dead Ends: 7

4

Used Space: 94%

96%

Open Areas: 0

4

Max Base Distance: 14

9

Avg Base Distance: 12

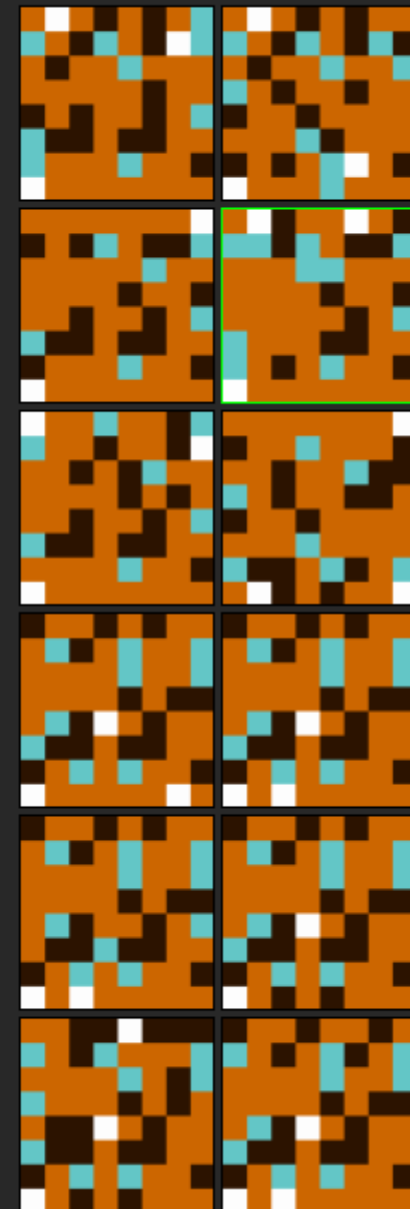
8

Min Base Distance: 10

7

Apply

Retry



Back

Export

A. Liapis, G. N. Yannakakis, and J. Togelius, "Sentient sketchbook: Computer-aided game level authoring," in Proceedings of the 8th Conference on the Foundations of Digital Games, 2013.



Relations between Facets

(the Chicken and Egg problem)



Facet Orchestration

- One facet as cause, another facet as effect.
 - jump action → animation → sound effect.



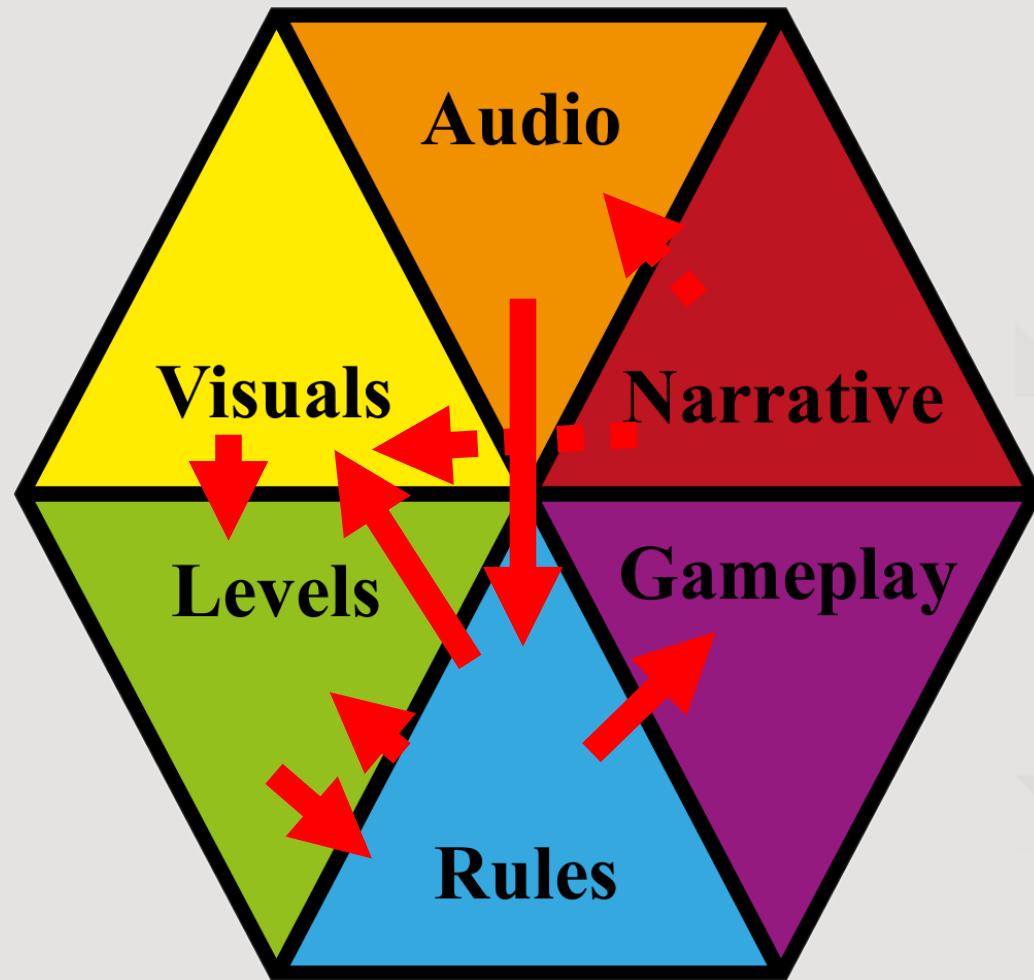
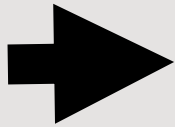
Facet Orchestration

- One facet as cause, another facet as effect.
- Usually, all facets interweave less clearly.
 - level design → narrative → game design



What comes first?

Genre






AI as a facet orchestrator

- Why orchestrate different PCG domains?
 - Perform prototypical or full game generation
 - Novel games that don't exist yet in design space
 - Find bridges/patterns/stitches/semantics between facets
 - Plug-n-play modular components

How to orchestrate facets?

- Machine-machine, human→machine, machine→human?
- **Conductor** (top-down) or **free-form jam** (bottom-up)?

FROM WHERE? <i>input</i>	HOW? <i>process</i>	WHAT? <i>output</i>	FOR WHOM? <i>end-user</i>
human creator	top-down ↕ bottom-up	 <p>game facets</p>	player
human-based computation embedded	interactive ↕ non- interactive		designer

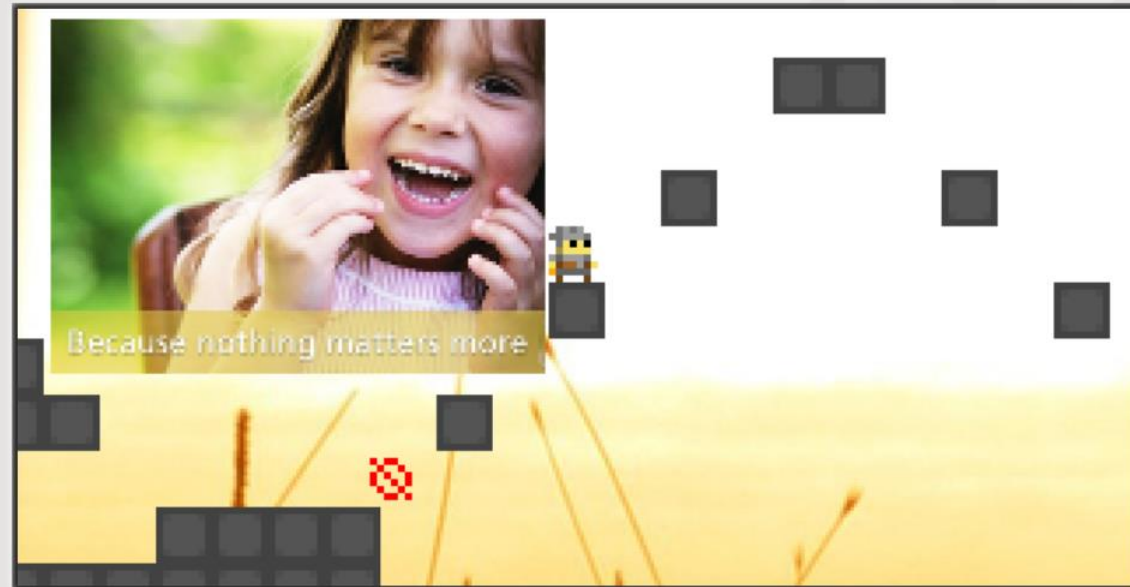
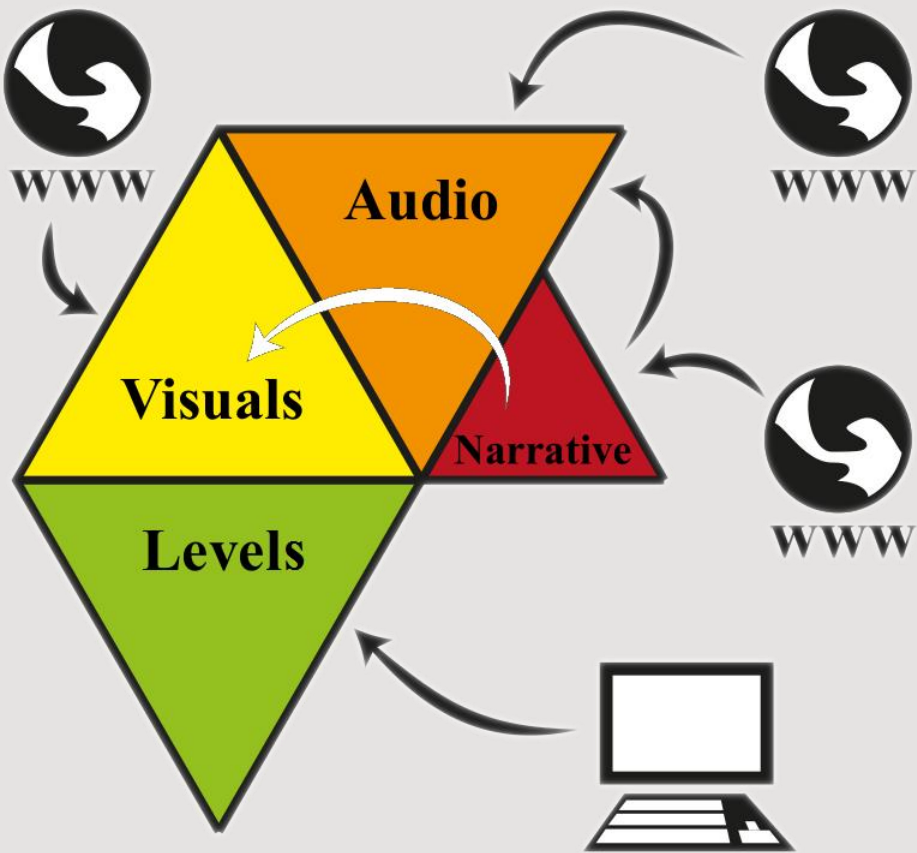


Cases of Orchestration

(first embryos for full game generation)

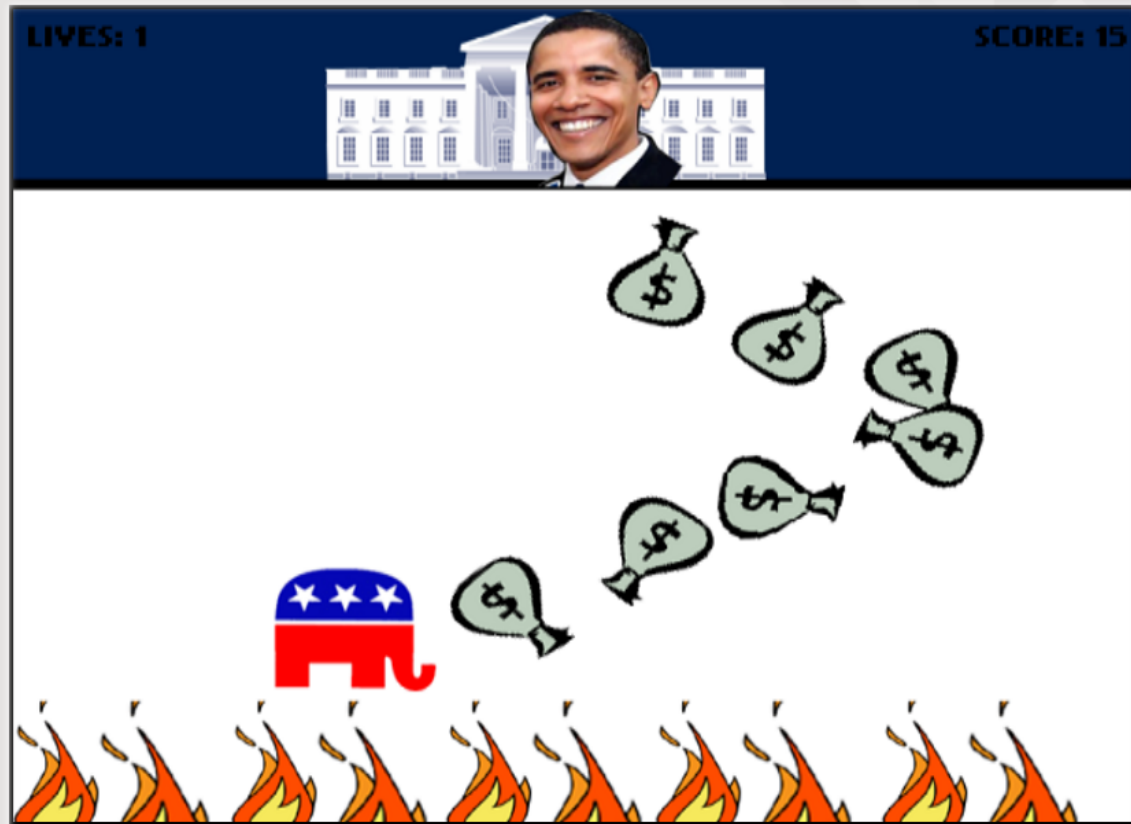
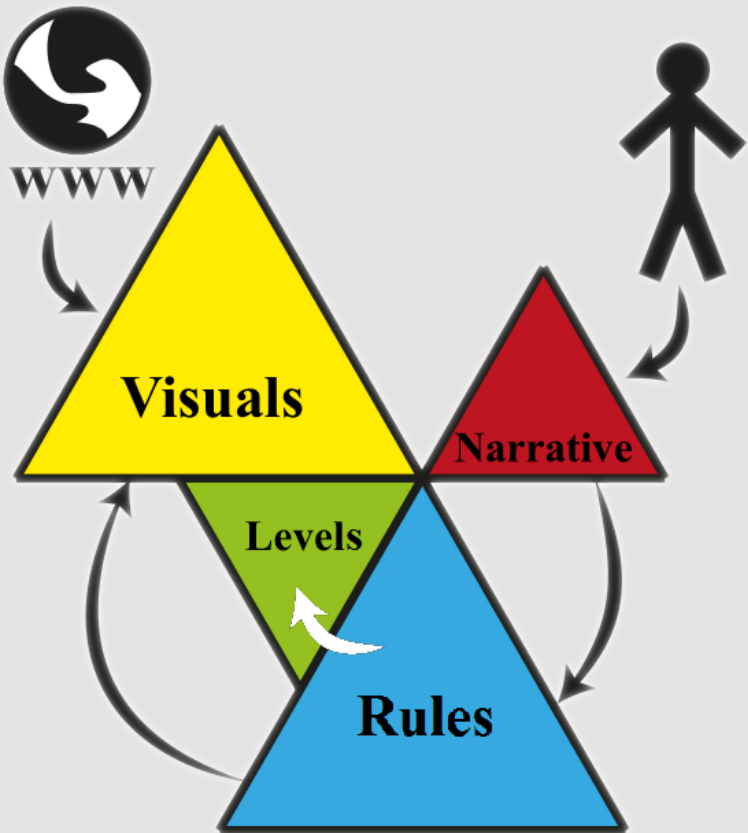


ANGELINA

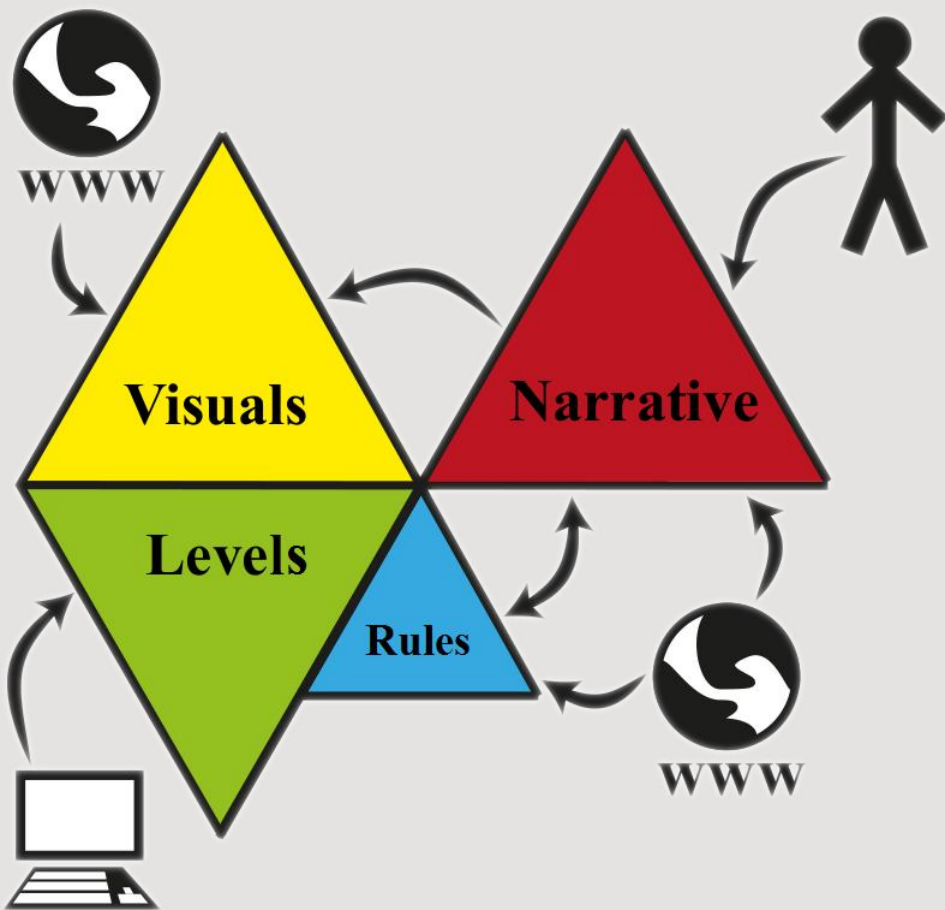


M. Cook, S. Colton, and A. Pease, "Aesthetic considerations for automated platformer design," in Proceedings of the AAAI Artificial Intelligence for Interactive Digital Entertainment Conference, 2012.

Game-o-matic

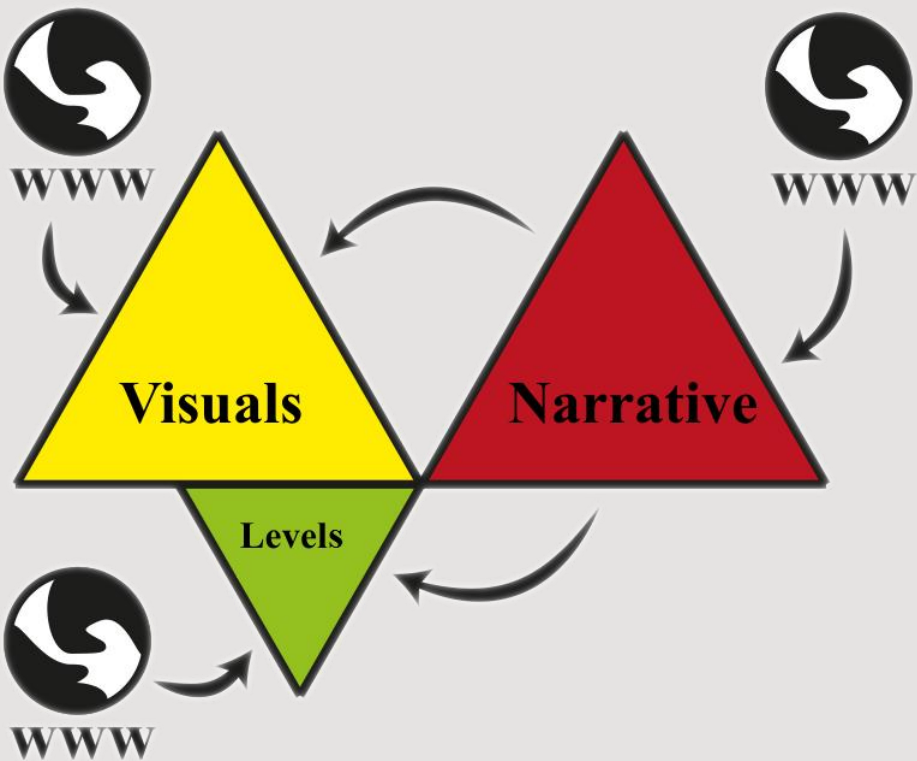


A Rogue Dream

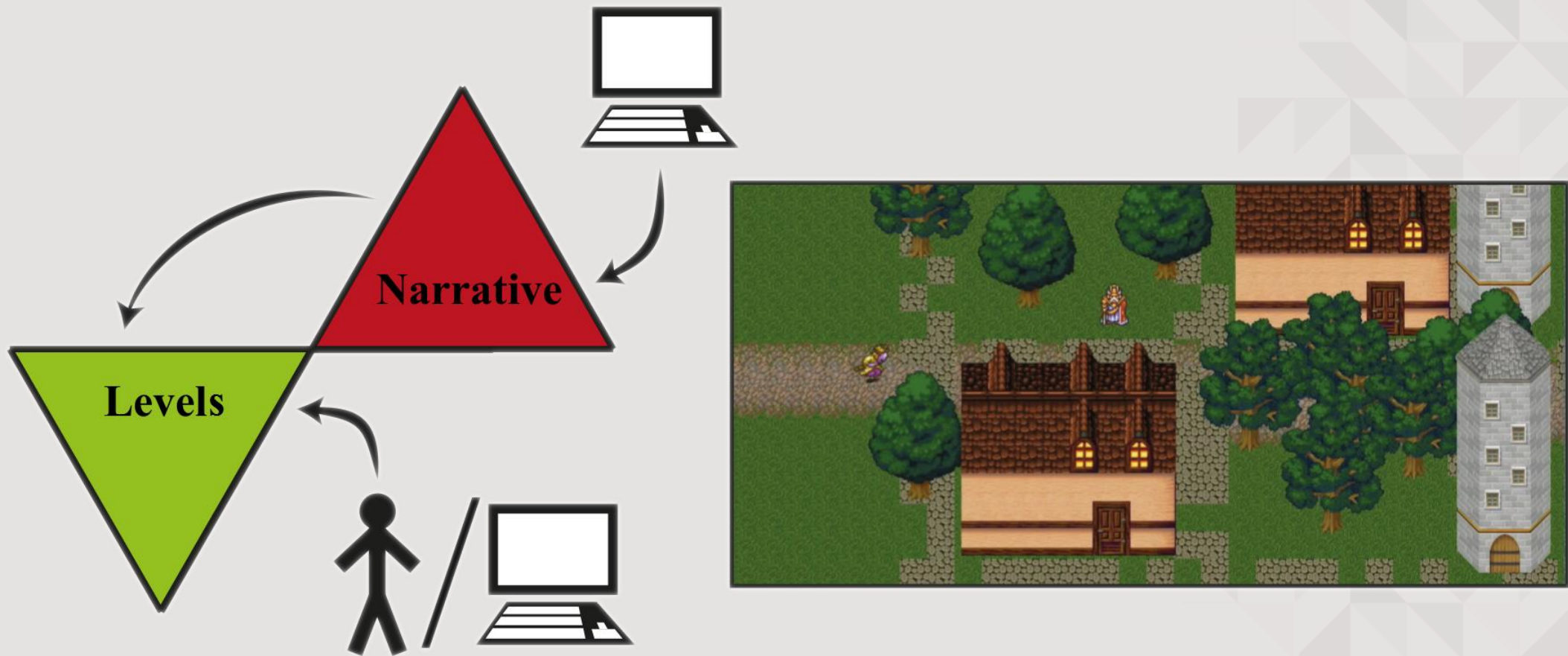


M. Cook and S. Colton, "A rogue dream: Automatically generating meaningful content for games," in Proceedings of the AIIDE Workshop on Experimental AI in Games, 2014.

Data Adventures

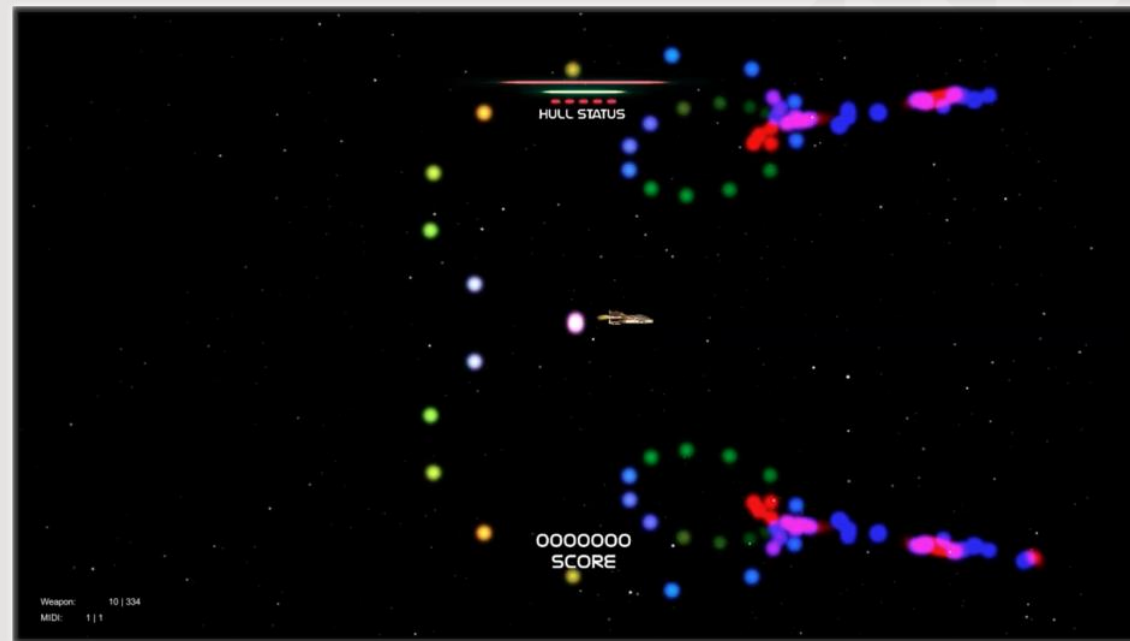
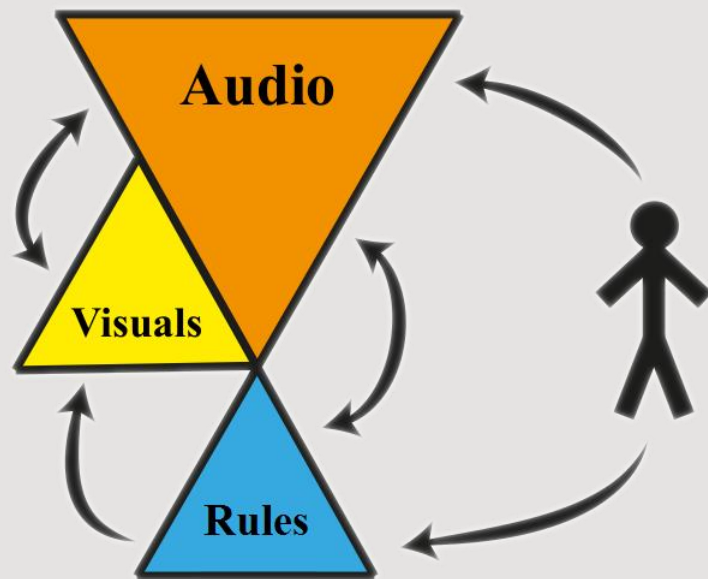


GAME FORGE



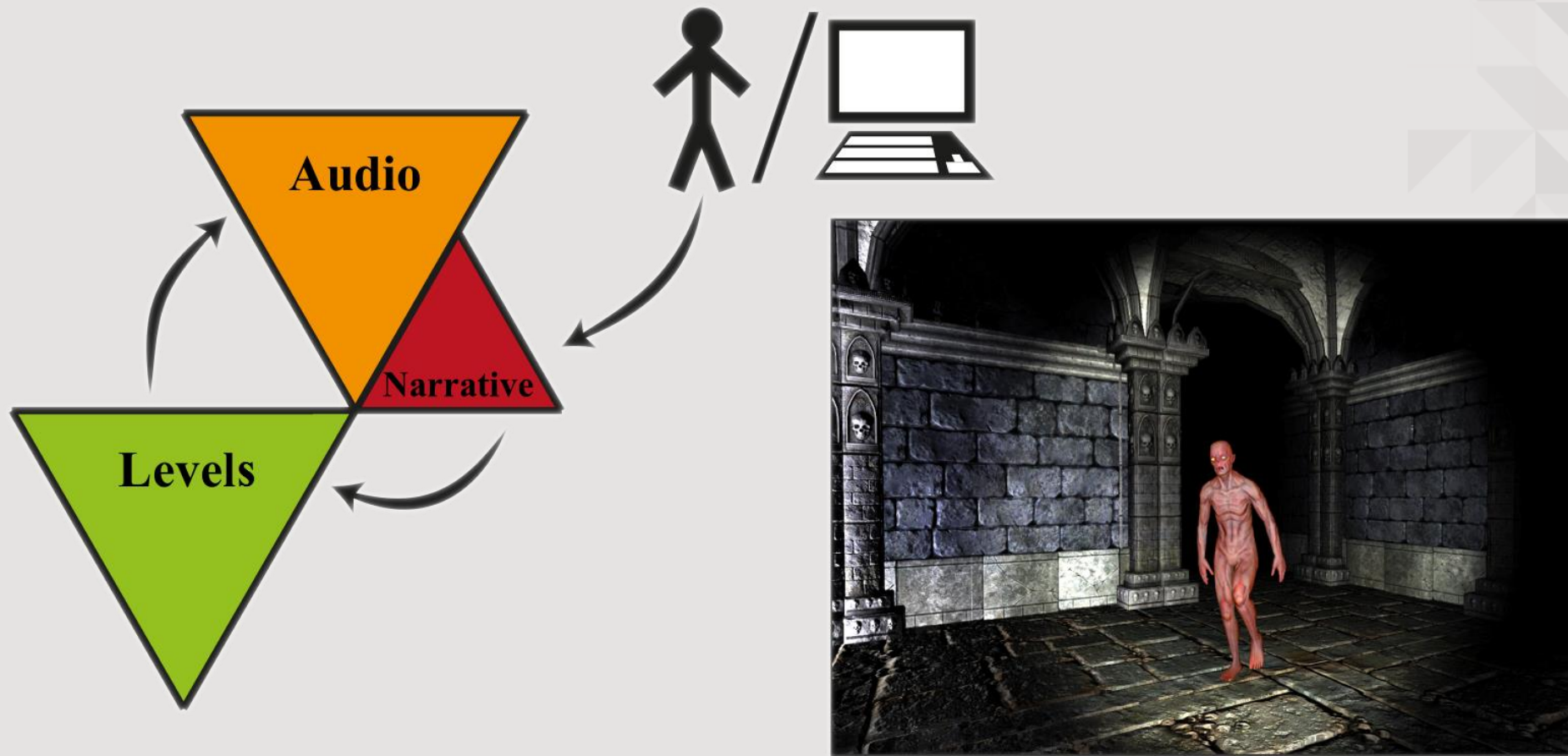
K. Hartsook, A. Zook, S. Das, and M. O. Riedl, "Toward supporting stories with procedurally generated game worlds," in Proceedings of the IEEE Conference on Computational Intelligence in Games, 2011.

Audio in Space

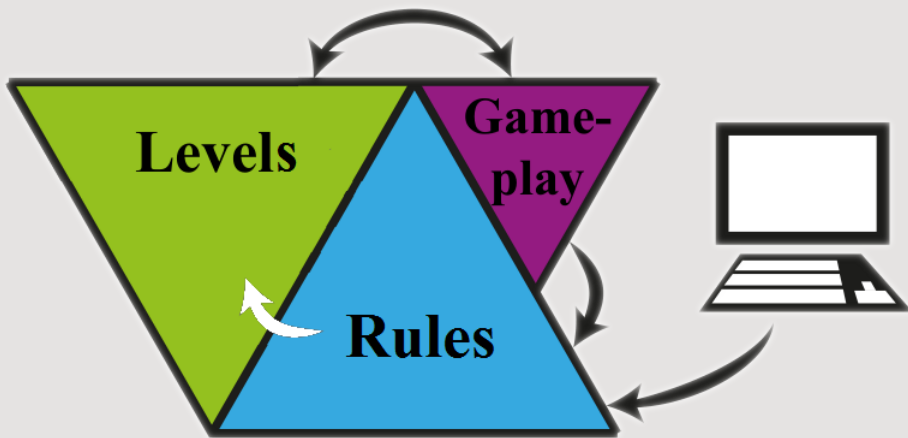


A. K. Hoover, W. Cachia, A. Liapis, and G. N. Yannakakis, "AudioInSpace: exploring the creative fusion of generative audio, visuals and gameplay," in *Evolutionary and Biologically Inspired Music, Sound, Art and Design (EvoMusArt)*. Springer, vol. 9027, LNCS, 2015.

Sonancia

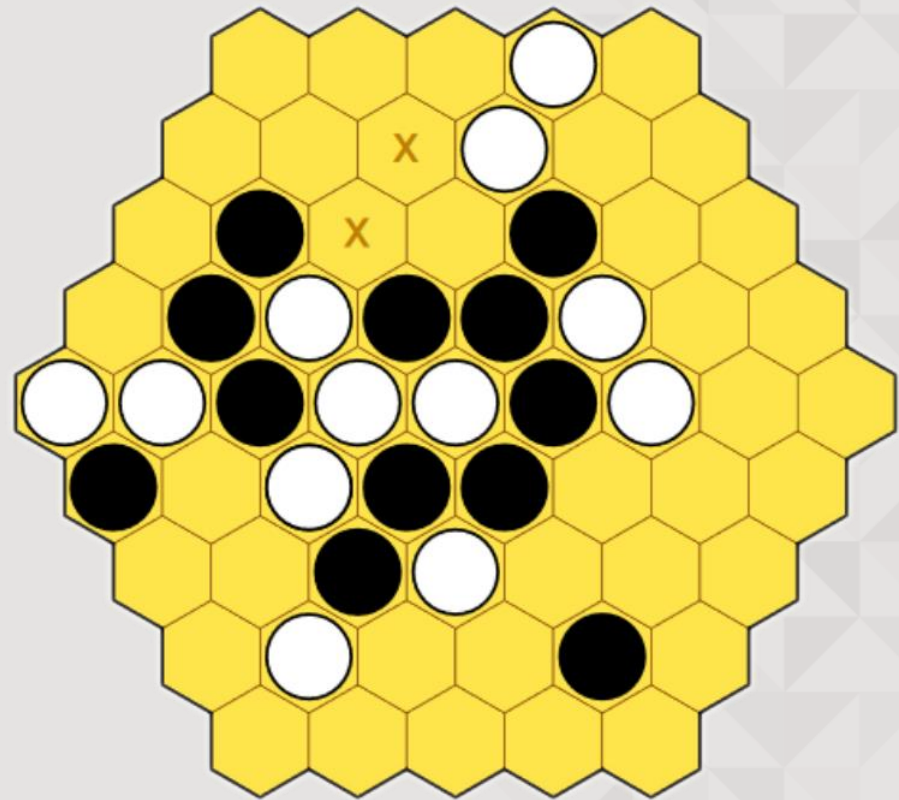
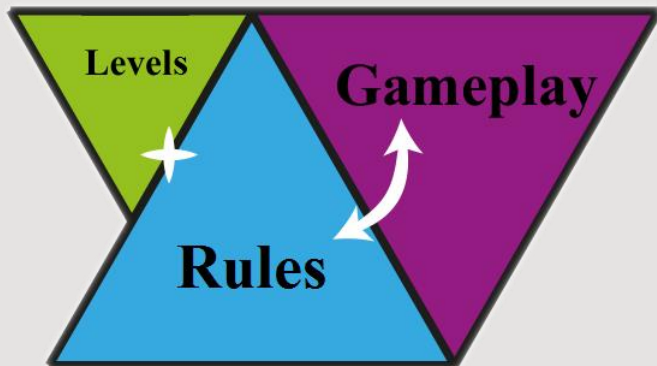


Mechanic Miner



M. Cook, S. Colton, A. Raad, and J. Gow, "Mechanic miner: Reflection-driven game mechanic discovery and level design," in Proceedings of Applications of Evolutionary Computation, vol. 7835, LNCS, 2012.

Ludi





Parting Words



Creative Computers

- **AI can help:**
 - Speed up game development.
 - Allow for unexpected gameplay.
 - Design games that haven't been possible so far.

ELECTRIC EYE



Creative Computers

- **How?**
 - Use big data (semantic, open, simulated, gameplay)
 - Learn from designers.
 - Learn from itself.

ELECTRIC EYE





Thank you!

