

Games with Freedom

Programming Procedural Generation and AI

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Freedom?

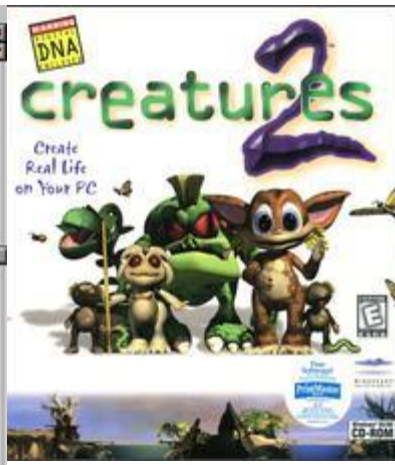
- Freedom for the game
- AI gives characters freedom to act.
- PCG gives content freedom to vary.





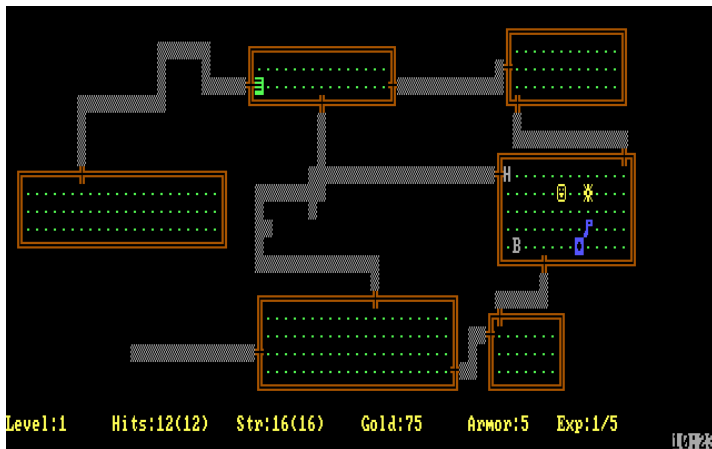
Exploration of AI and Simulation

- Sim City 2000
- Creatures 2
- Black and White





Procedural Content Generation



Not necessarily Random Generation



The Binding of Isaac;
Don't Starve;
FTL

- 'Roguelikes': Getting to the heart of the it-genre (Christian Nutt)

• Borderlands

<p>LEVEL REQUIREMENT: 48</p> <p>PRO CAUSTIC PROTECTOR</p> <p>Damage 108 Accuracy 72.8 Fire Rate 4.3</p> <p>Highly effective vs Armor Chance to Corrode enemies Ammo is no longer an issue. +50% Reload Speed</p> <p>TEDIORE</p> <p>12 x2</p> <p>\$0103209</p>	<p>LEVEL REQUIREMENT: 48</p> <p>BLR6 NASTY REBEL</p> <p>Damage 137 Accuracy 78.0 Fire Rate 5.5</p> <p>Never stop shooting! +39% Fire Rate +24 Magazine Size +11% Damage</p> <p>VLADOF</p> <p>36</p> <p>\$0099239</p>	<p>LEVEL REQUIREMENT: 48</p> <p>GGN VOLCANO</p> <p>Damage 107 Accuracy 78.0 Fire Rate 5.5</p> <p>Highly effective vs Flesh Chance to light enemies on fire Pele demands a sacrifice! High Elemental Effect chance</p> <p>VLADOF</p> <p>36</p> <p>\$0165399</p>
<p>LEVEL REQUIREMENT: 48</p> <p>SG30 BLAST HAMMER</p> <p>Damage 138 x7 Accuracy 23.0 Fire Rate 1.8</p> <p>Chance to cause explosions Drop the Hammer! +31% Fire Rate</p> <p>VLADOF</p> <p>7 x2</p> <p>\$0234566</p>	<p>LEVEL REQUIREMENT: 48</p> <p>GGN VOLCANO</p> <p>Damage 439 Accuracy 96.7 Fire Rate 0.8</p> <p>Highly effective vs Flesh Chance to light enemies on fire Pele demands a sacrifice! High Elemental Effect chance</p> <p>MALIWAN</p> <p>6 x4</p> <p>\$0165399</p>	<p>LEVEL REQUIREMENT: 48</p> <p>DEF11 TERRIBLE DEFENDER</p> <p>Damage 107 Accuracy 78.0 Fire Rate 5.5</p> <p>I can do this all day... +18 Ammo Regeneration +58% Reload Speed -2% Damage</p> <p>MALIWAN</p> <p>6 x4</p> <p>\$0145551</p>
<p>LEVEL REQUIREMENT: 48</p> <p>EQ12 RAW EQUALIZER</p> <p>Damage 371 Accuracy 83.9 Fire Rate 1.9</p> <p>Unending Firepower +18 Ammo Regeneration +57% Reload Speed +33% Fire Rate</p> <p>TEDIORE</p> <p>6</p> <p>\$0132451</p>	<p>LEVEL REQUIREMENT: 48</p> <p>KLR13 PESTILENT DEFILER</p> <p>Damage 541 Accuracy 93.6 Fire Rate 1.0</p> <p>Highly effective vs Armor Chance to Corrode enemies Give Sick High Elemental Effect chance</p> <p>MALIWAN</p> <p>3 x4</p> <p>\$0231243</p>	<p>LEVEL REQUIREMENT: 48</p> <p>EQ1 STABILIZED EQUALIZER</p> <p>Damage 541 Accuracy 93.6 Fire Rate 1.0</p> <p>Unending Firepower +41% Reload Speed +18 Ammo Regeneration +50% Recoil Reduction</p> <p>MALIWAN</p> <p>3 x4</p> <p>\$0180616</p>
<p>LEVEL REQUIREMENT: 48</p> <p>CR280 DESERT RAVEN</p> <p>Damage 213 Accuracy 90.4 Fire Rate 10.0</p> <p>DAHL</p> <p>70 x3</p> <p>\$0132451</p>	<p>LEVEL REQUIREMENT: 48</p> <p>SG330 BLAST BUTCHER</p> <p>Damage 70 x3 Accuracy 58.8 Fire Rate 8.8</p> <p>HYPERION</p> <p>70 x3</p> <p>\$0231243</p>	<p>LEVEL REQUIREMENT: 48</p> <p>SV440 MALEVOLENT SAVIOR</p> <p>Damage 213 Accuracy 90.4 Fire Rate 10.0</p> <p>HYPERION</p> <p>70 x3</p> <p>\$0180616</p>



Expressive Space

- The space of possible outcomes of an algorithm.
- Often implicitly defined.



Left 4 Dead



Structured Unpredictability

51

Legionus Clan

23 0 21

High Cliff

3 3 0



23/30 5 10
21/37 4 7

REUS



Reus

- Set out to be:
 - Bottom-up nature simulation
 - Bottom-up human simulation
- Became
 - Strategy game with a god theme

51

Legionus Clan

23 0 21

Highcliff

3 3 0



23/30 5 10
21/37 4 7

REUS





Defeat all enemies!



Anna



Intimidate
Speech action
Range: 2 tiles
Cooldown: 0 turns
Deals 5 Distress damage to the target's Will by striking fear into the target's heart.



Q



W



E

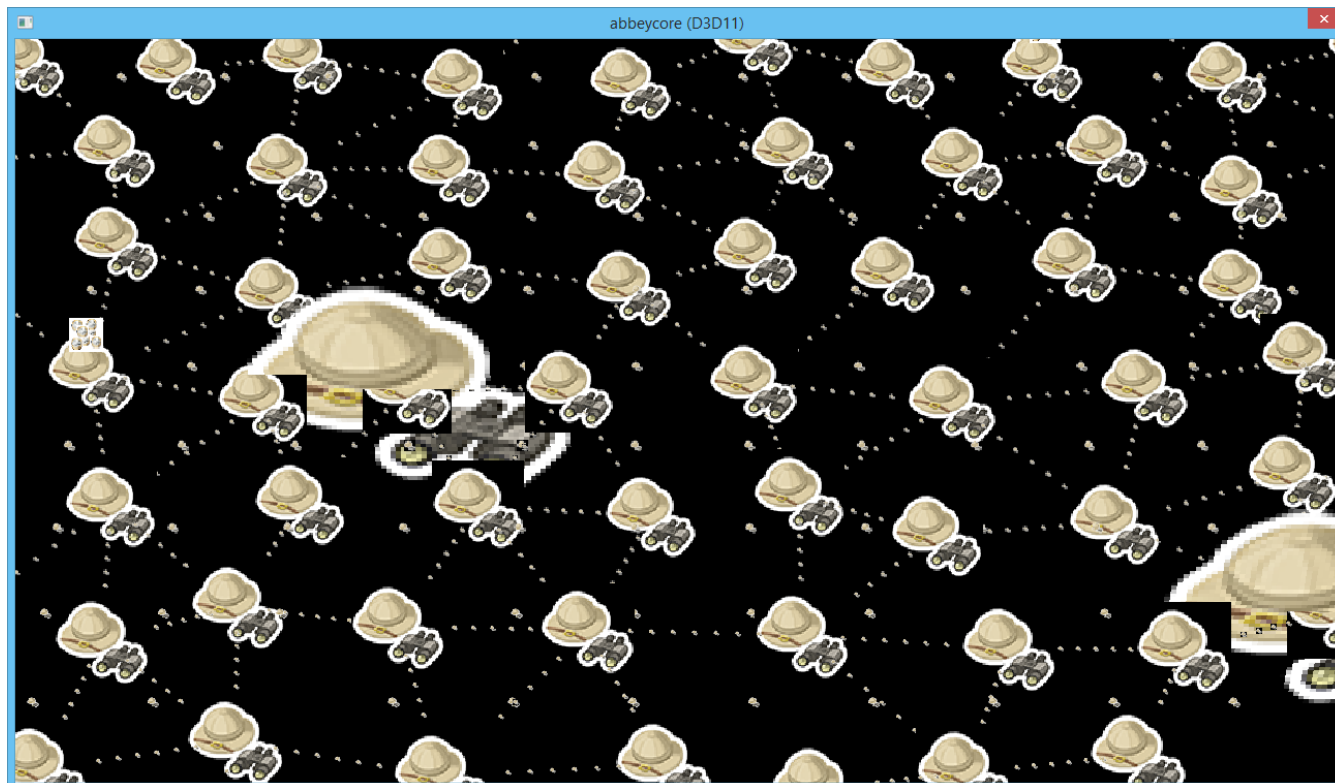


R

End turn

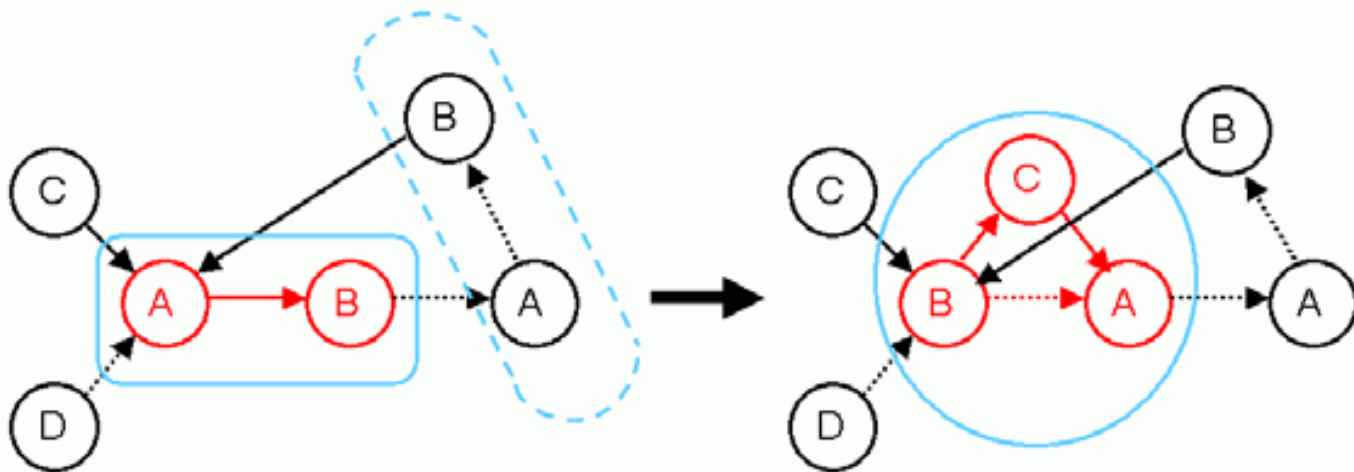


Graphs



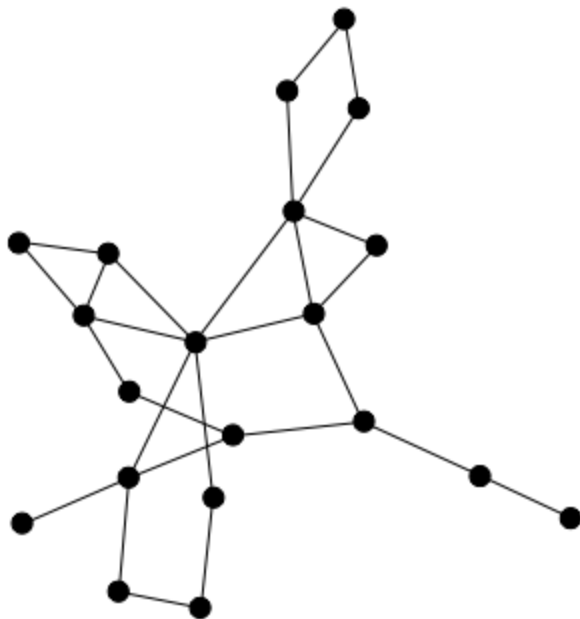


Graph Grammar





Forced Directed Graph Drawing



- Dispersion
- Edge length
- Forced angle

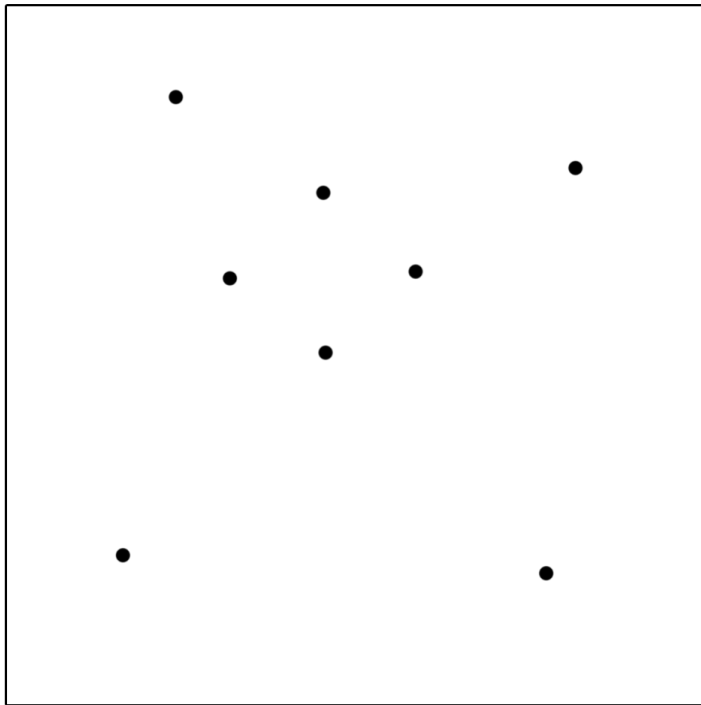


Our targeted expressive space contained only spatially plausible graphs.

Our algorithm's expressive space contained way more than that.

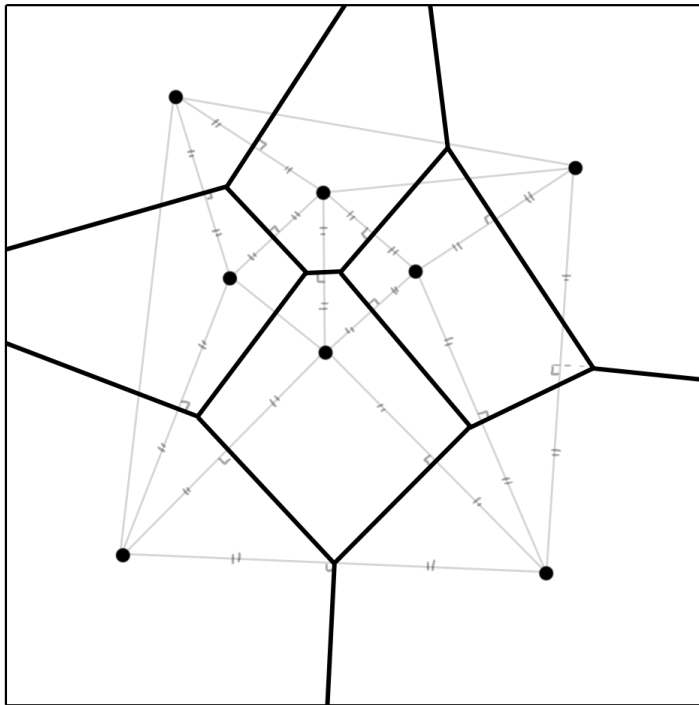


Voronoi



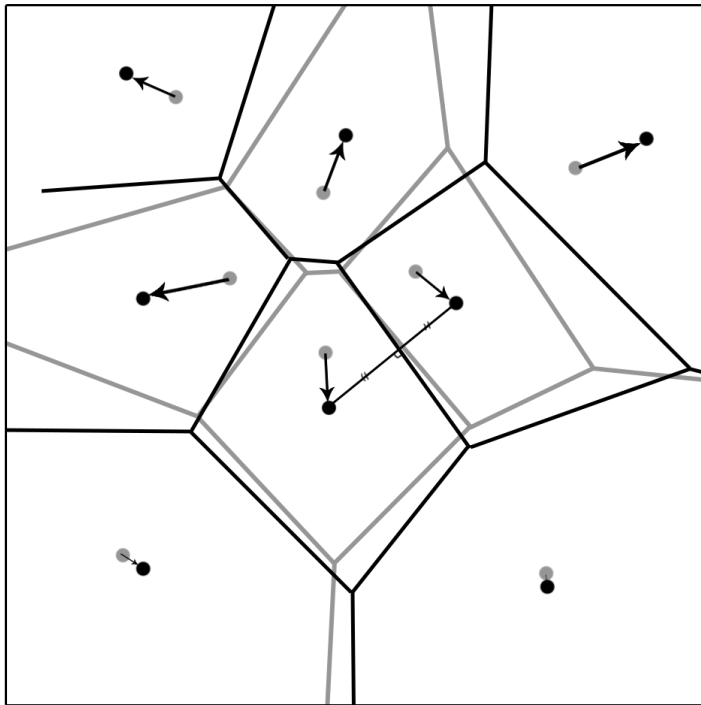


Voronoi



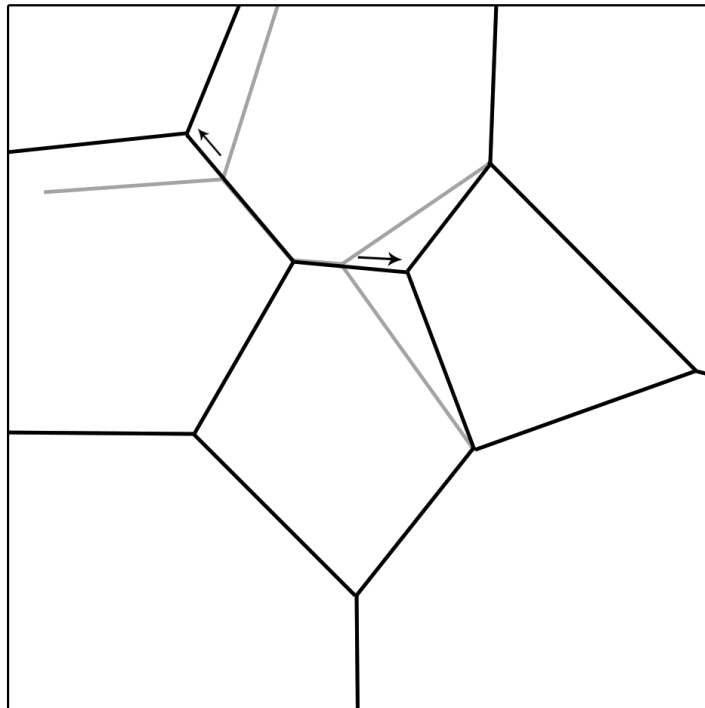


Voronoi



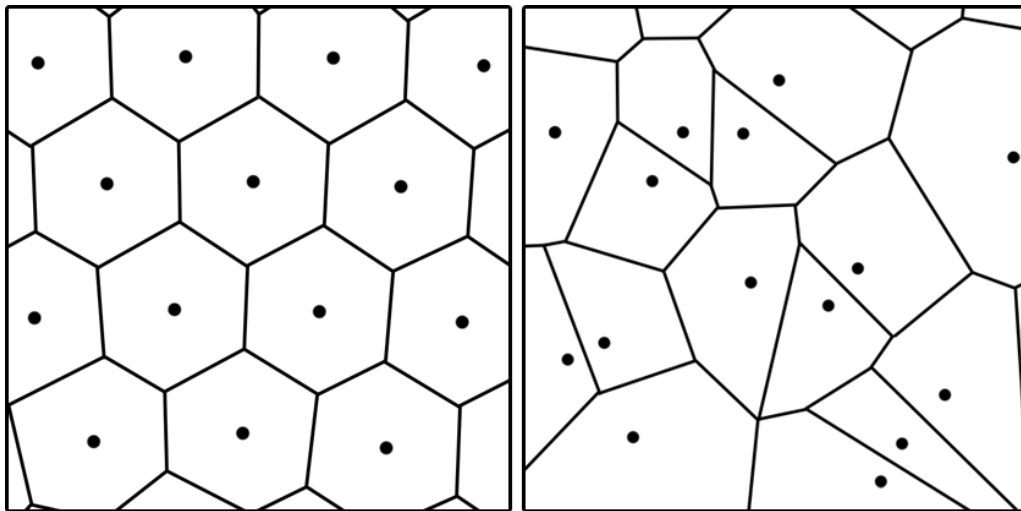


Voronoi





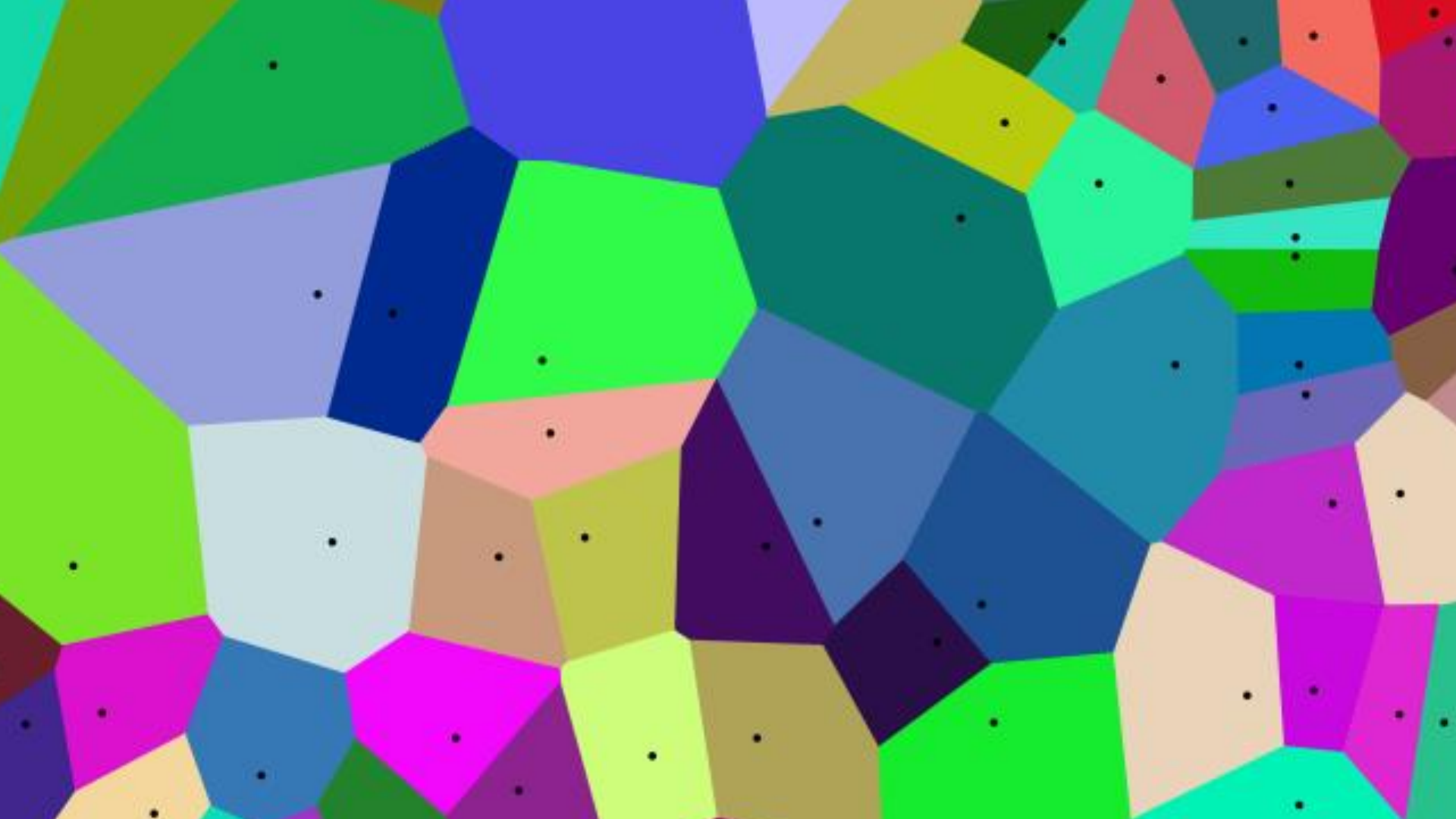
Voronoi





Area distribution







Results

- Generation based on targets
 - Irregularity
 - Evenly spread nodes
 - Areas



Control over expressive space

- Constructive properties
- Constraints & Exceptions
- Parameters & Weighting
- Hand authoring
- Rejection Sampling or Search-Based



Take-aways

- AI and PCG add freedom to your game.
- Determine how much freedom is good.
- Describe the targeted expressive space.
- Choose the implementation afterwards.



Questions?

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Find us at:

Indie MEGABOOTH (Hall 10.1)

Holland Pavillion (Hall 4.2)



Abbey Games