

# Mixed-Initiative Procedural Content Generation

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# Mixed-Initiative

**What do you think  
that means?**

# Mixed-Initiative

human designer

+

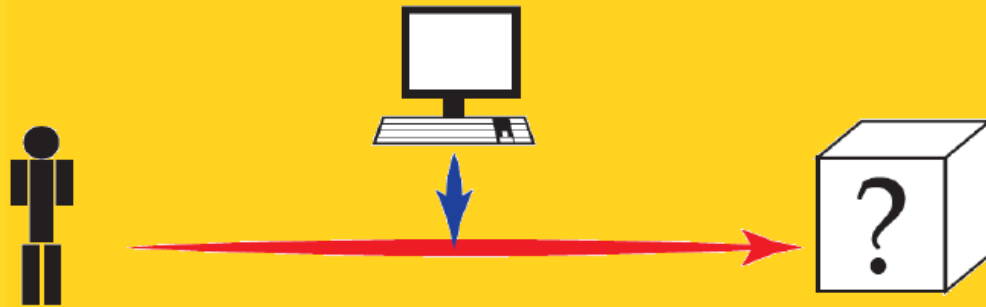
computational designer

# Mixed-Initiative

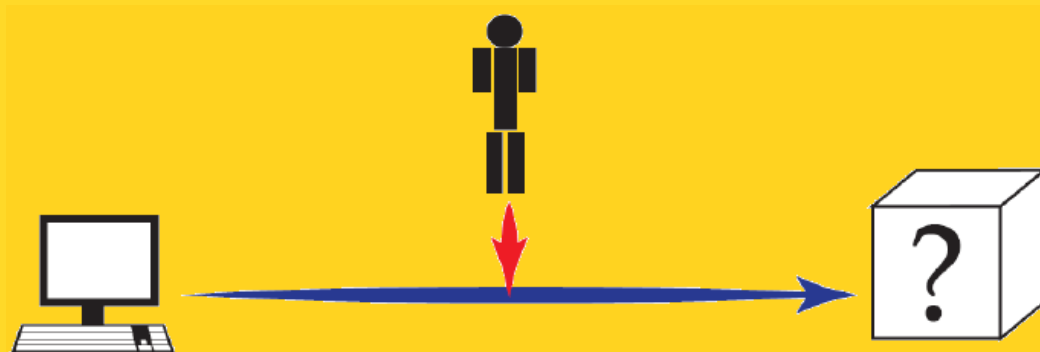
**sliding scale**  
on the type and  
impact of each of  
the human or  
computer initiative

# Sliding Scale of 'initiative'

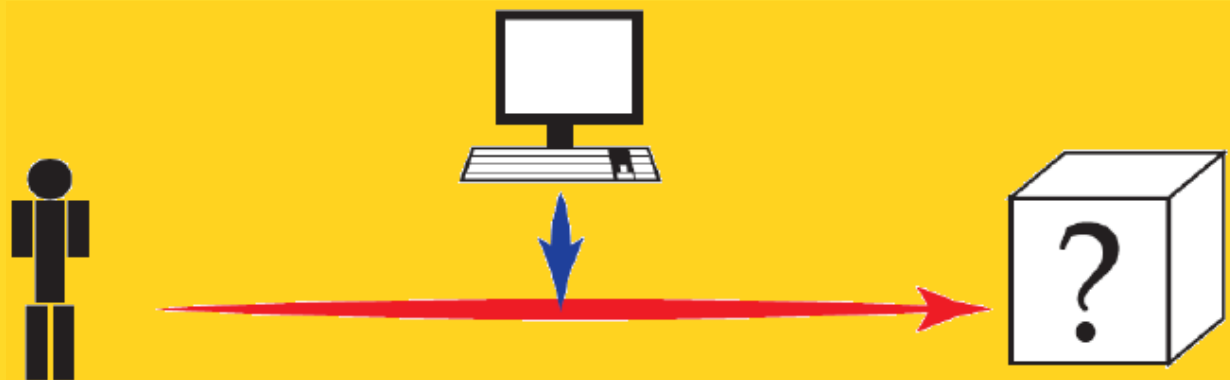
- Human primary initiative, computer as 'slave'
- **Computer-Aided Design (CAD)**



- Computer creating content, human as 'guide'
- **Interactive Evolution**



# Computer-Aided Design



# Creativity Support

- Support for non-expert designers
- “magic crayons” and sketches
  - software that supports a **novice’s creativity** while also being **intuitive, powerful, and expressive**

# Open Questions

- ***Who is your target audience?***
  - Professional designers?
  - Gamers?
  - Novices/Kids?



# Open Questions

- *What novel and useful editing operations can be incorporated?*
  - Automated Refinement?
  - Agent Simulation?
  - Rhythm Assessment?
  - Design Pattern Recognition?

# Open Questions

- *How can the method for control over content be balanced?*
  - Direct control?
  - Indirect control/modeling?
  - Computer that changes human choices?
  - Taking turns relinquishing control?

# Open Questions

- ***How to resolve conflicts that arise due to the human stating conflicting desires?***
  - Undo method?
  - Error message?
  - Silent “crash” (ignore own desires)?
  - Multiple solutions to minimize conflict?

# Open Questions

- ***How expressive is the system?***
  - Does it only make weapons for Diablo?
  - Can it create unplayable levels?
  - Can it only create balanced hero abilities?

# Open Questions

- ***Can the computer explain itself?***
  - Is it simply following the rules?
  - Is it learning from the human user?
  - Is it learning from itself?

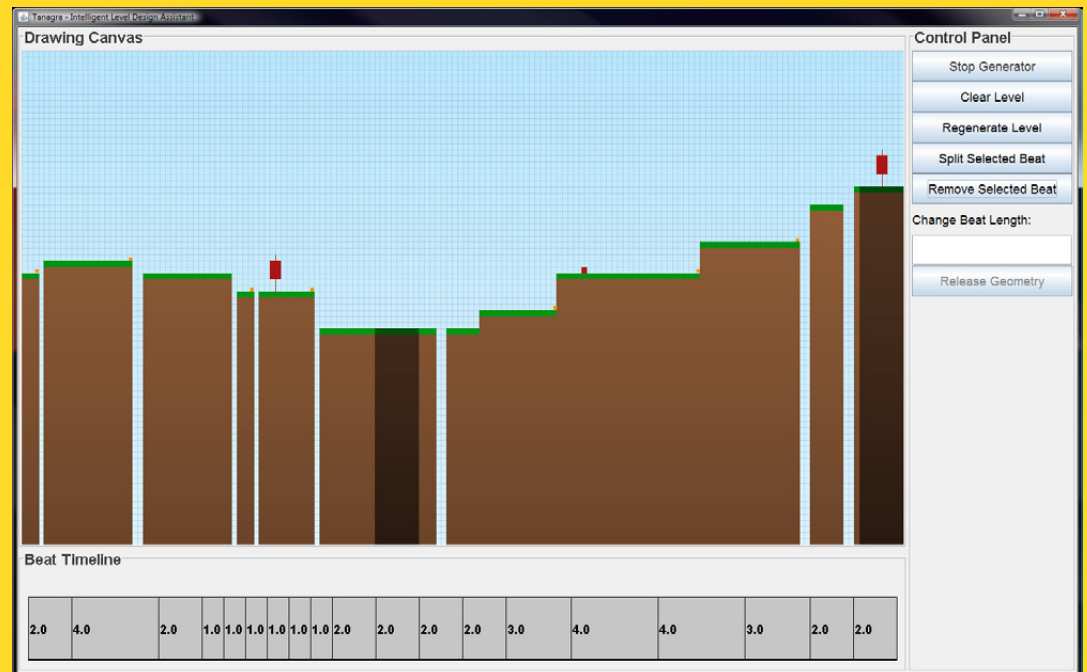
# Examples of “Smart” CAD Tools for Games

Yeah, we'll talk  
about our own...

# Tanagra

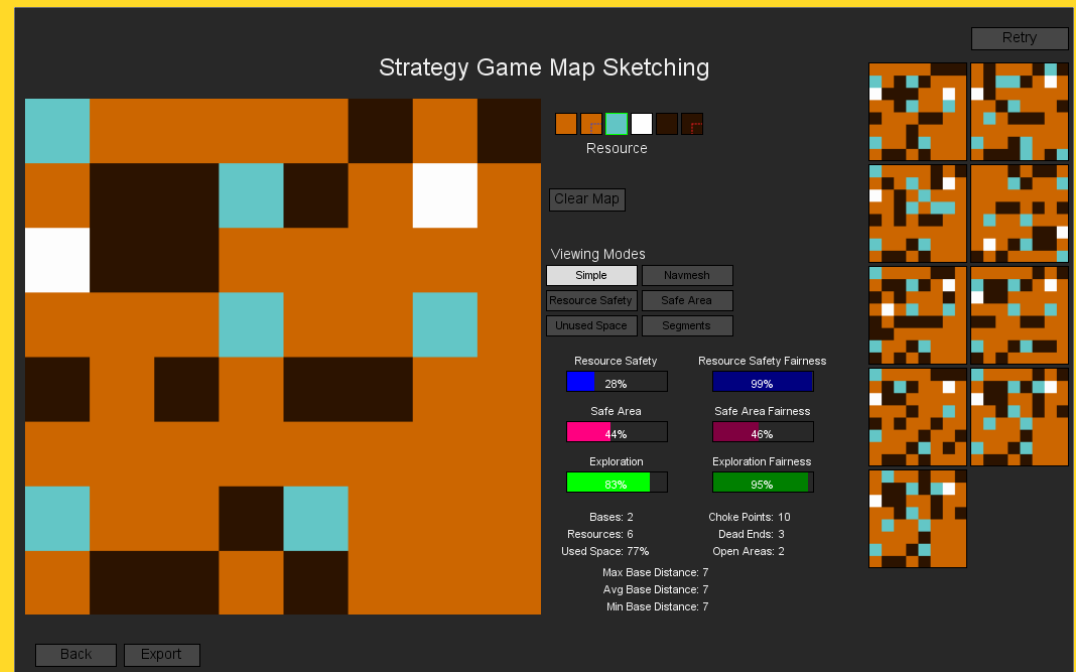
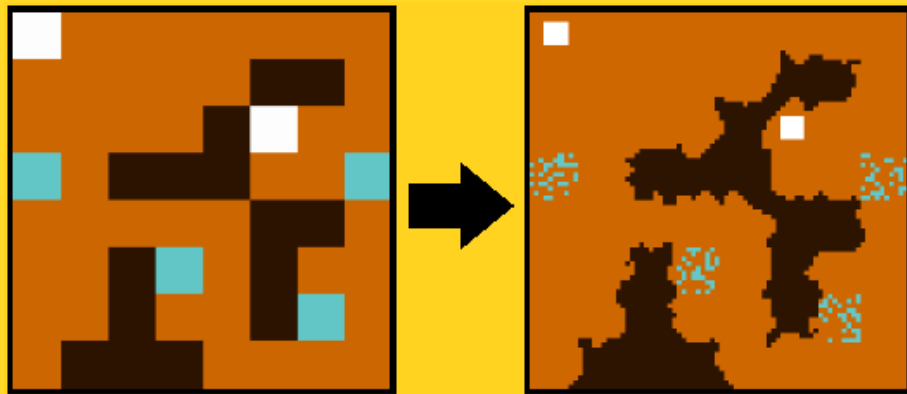
- 2D platformers
  - playability ensured via constraints
  - evaluate and change level according to pacing
  - user can “lock” geometry, computer changes rest

- [Demo](#)



# Sketch

- Map Sketches (strategy game, dungeon, FPS level)
  - multiple solutions evolved & shown in real-time
  - fitnesses on area influence, exploration and balance
  - constraints on playability handled with FI-2pop GA

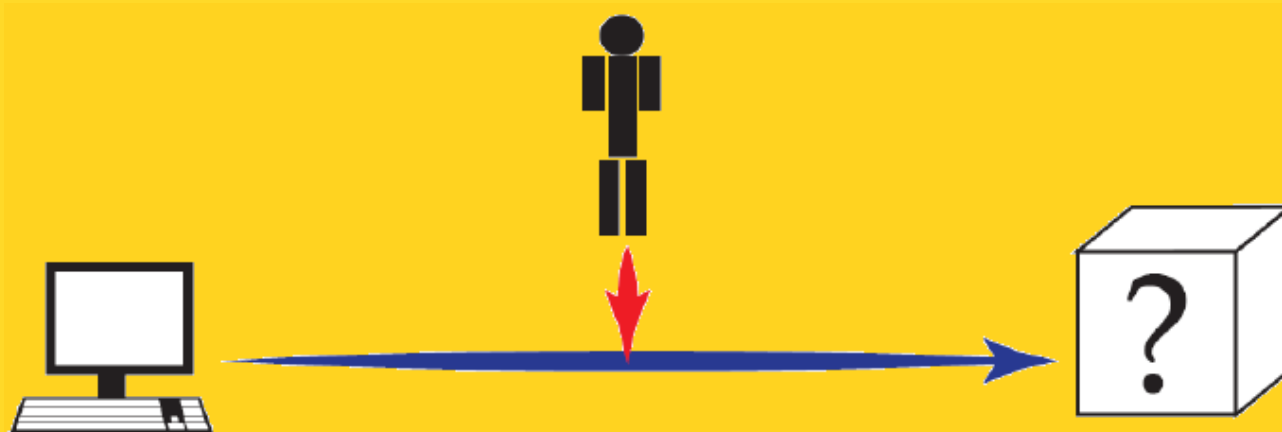




# Ropossum

- Physics-based puzzle “cut the rope”
  - evolutionary grammars for creating new puzzles
  - playability module for testing how (if?) to solve a puzzle
  - using the designer’s input in complete or partial designs
- [Demo](#)

# Interactive Evolution

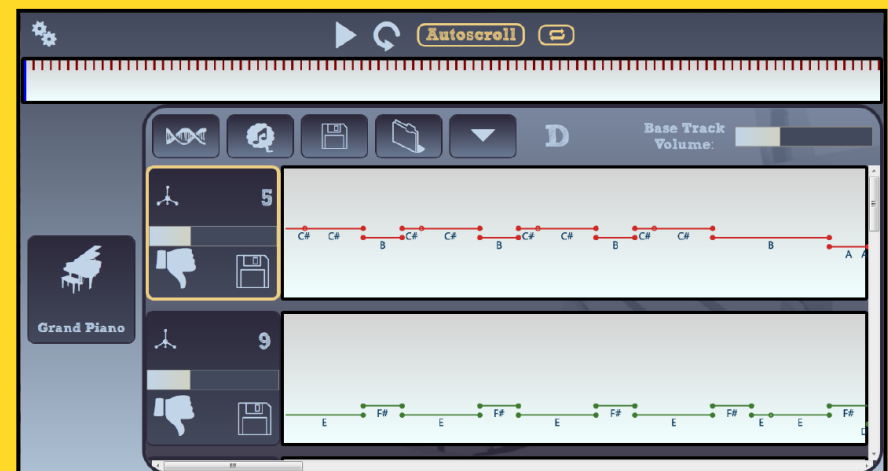
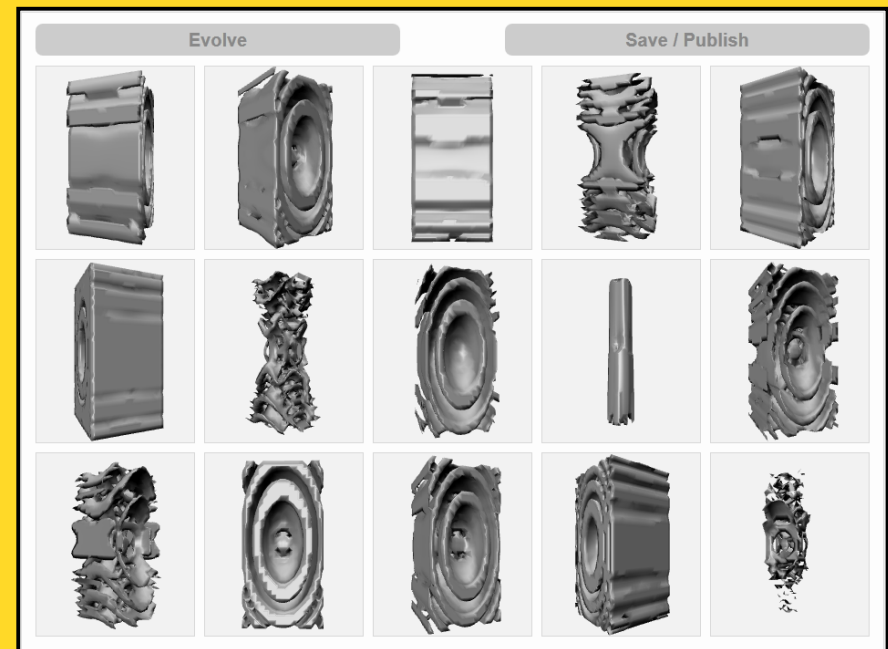
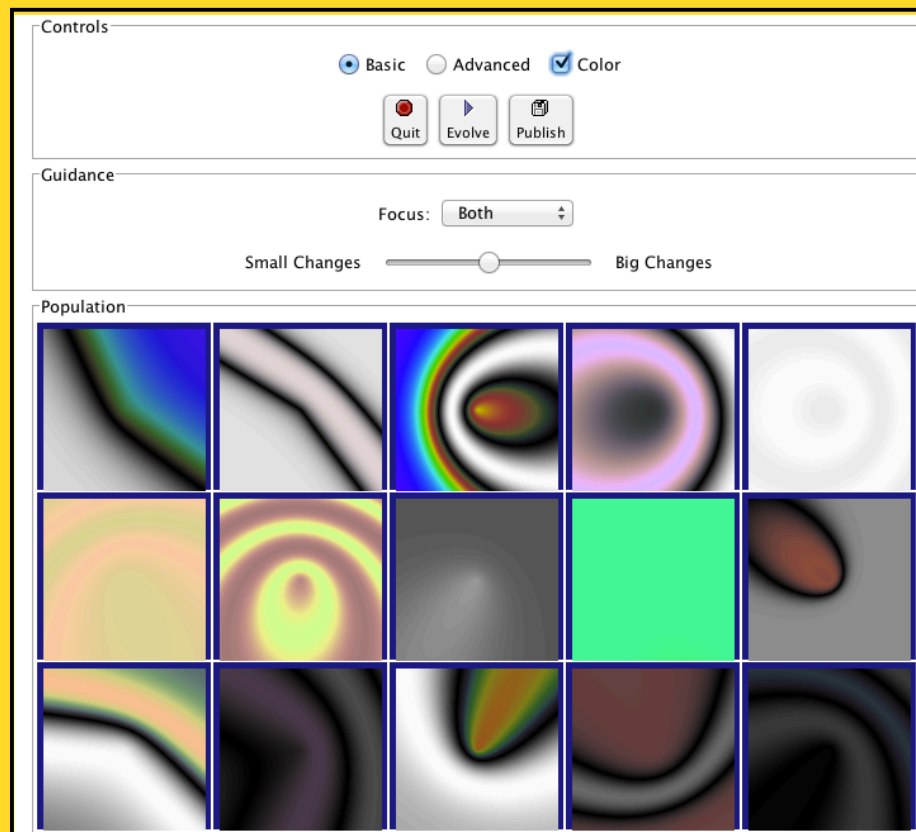


# Interactive Evolution

- Interactive Evolution uses human input to evaluate content
- Designing a fitness function is not always easy:
  - deceptive
  - subjective
  - computationally-heavy
  - unknown

# Evolutionary Art

- Evolutionary Art and Music:  
how do you evaluate a  
“good” painting or sonnet?



# User Fatigue

- Cognitive burden from too many/too complicated human evaluations.
- Solutions:
  - crowdsourcing
  - faster convergence
  - discrete rating levels
  - distance-based fitness prediction
  - user shown a subset of the population

# Examples of Interactive Evolution for Games

# Galactic Arms Race

- Weapon projectiles evolved via neuroevolution of augmenting topologies
- Number of times fired = player preference
- Multiplayer: averaged firing rates across players



# TORCS interactive evolution

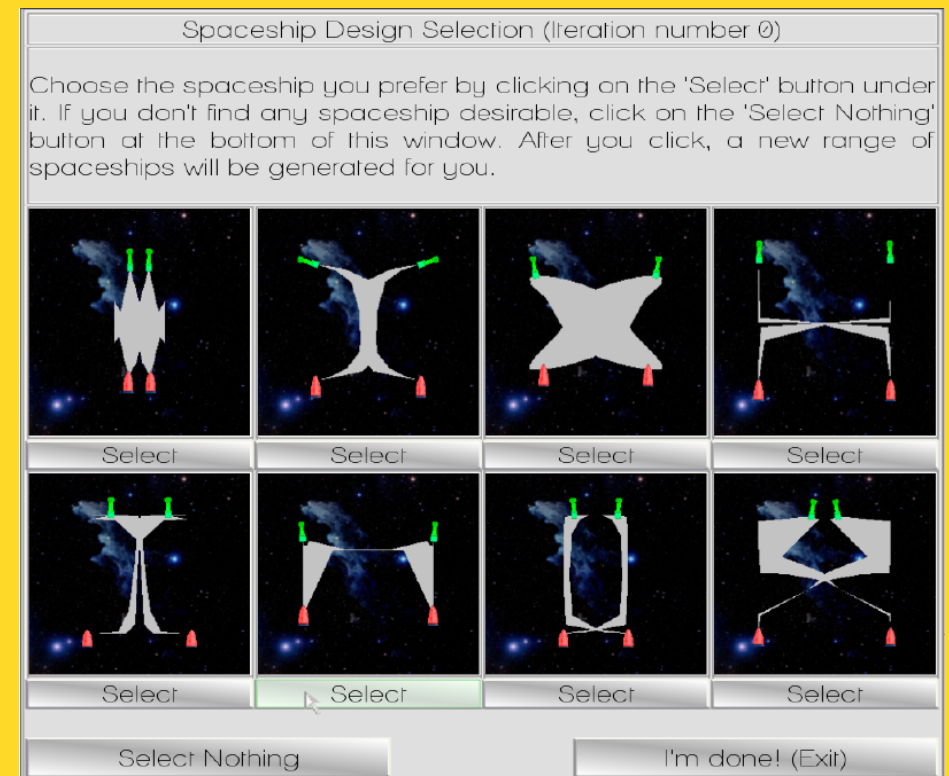
- “Traditional” Interactive Evolution for race-tracks
- Tracks as Bezier splines with evolving control points
- Evolved via **like/dislike** or **5 stars** for single-user
- Evolved via averaging for multiple-users





# Spaceship Design

- Spaceship hulls and thrusters/weapons evolved via neuroevolution of augmenting topologies
- Spaceships evaluated on symmetry, simplicity, etc.
- Predicted fitness via user-selected favorites:
  - increase weight of fitnesses present in selected content  
(e.g. selecting symmetrical spaceships = higher symmetry)



**Thank you!**

