Game Design using Creative AI

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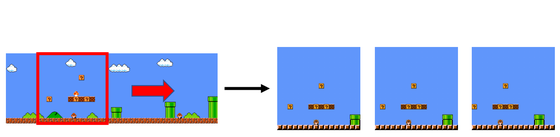
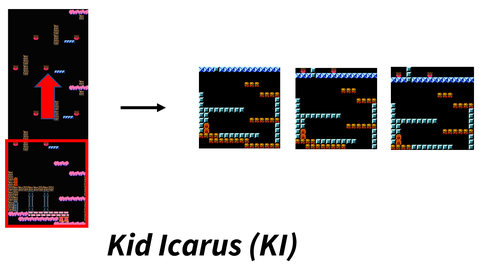
Introduction

- ML approaches have become popular for creative tasks like image and music generation and style transfer
- However such methods have been restricted to visual art and music and not been applied for game design
- ***Procedural Content Generation via Machine Learning (PCGML)*** is a field of games research referring to automated production of game content using generative models
- ***Creative AI + PCGML*** → Co-Creative Game Design
- We repurpose creative AI techniques in visual art for game design using VAEs trained on ***Super Mario Bros.*** and ***Kid Icarus*** to demonstrate the feasibility of applying creative AI for game design

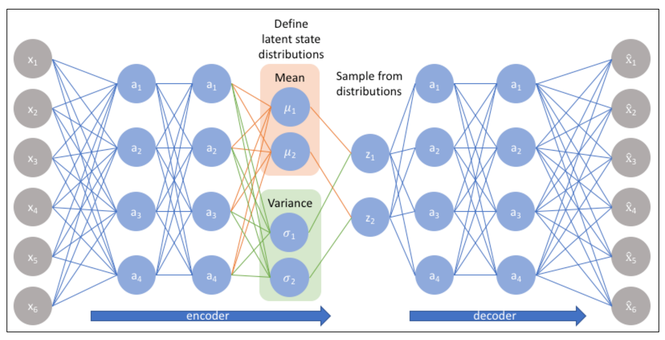
Approach



Super Mario Bros. (SMB)



Kid Icarus (KI)



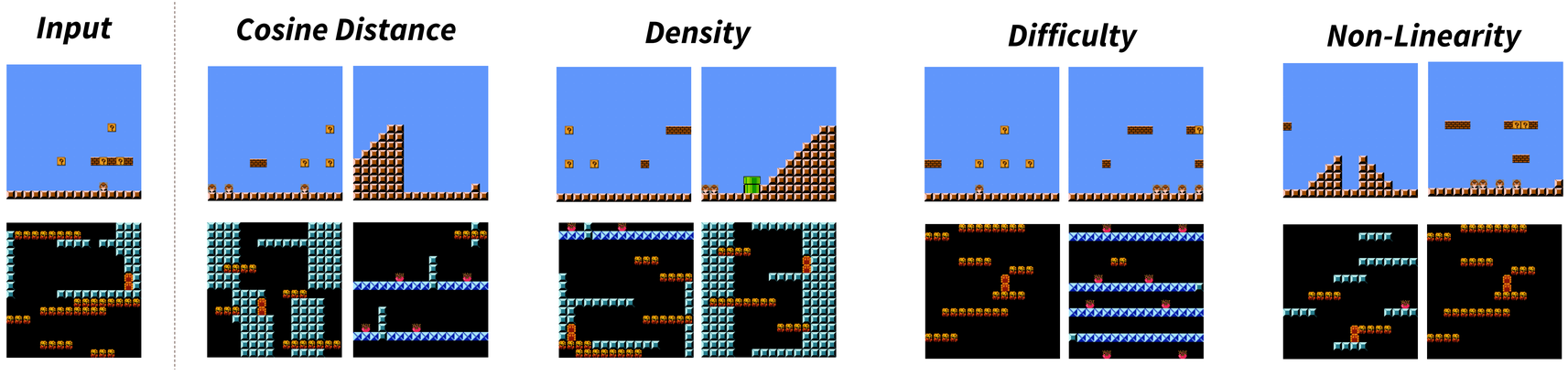
Variational Autoencoder

- Trained variational autoencoders (VAEs) on 16x16 level segments from both games
- To demonstrate creative AI approaches for game design, calculated shortest distance between level segments and performed reverse level search and interpolation between level segments

Results

Reverse Level Search

- Search for level segments in VAE latent space using evolutionary algorithms with an input segment and some metric-based objective
- Results show pairs consisting of closest and furthest match on left and right respectively for corresponding metrics

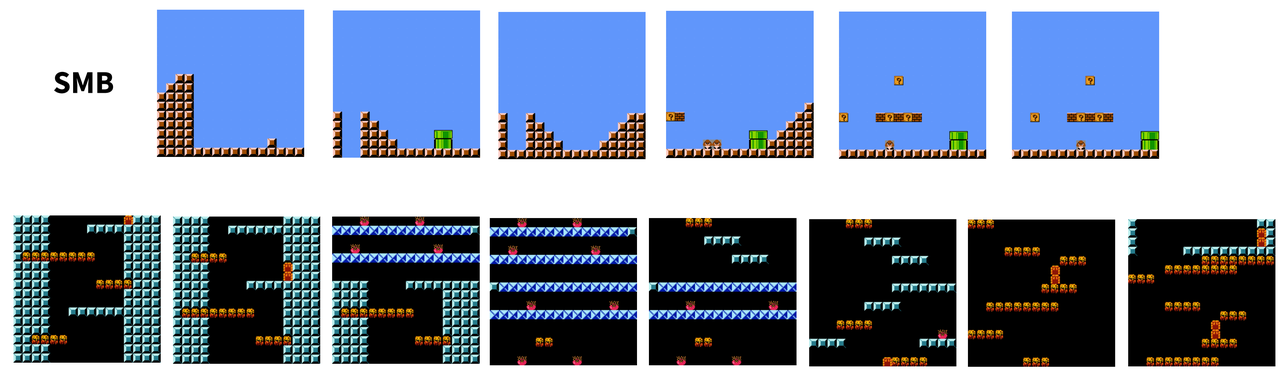


Metrics

- ***Cosine Distance*** – *similarity between two vectors based on cosine of angle between them*
- ***Density*** – *proportion of solid tiles in a level*
- ***Difficulty*** – *number of enemies and hazards in a segment*
- ***Non-Linearity*** – *how closely topology of a level follows a straight line*

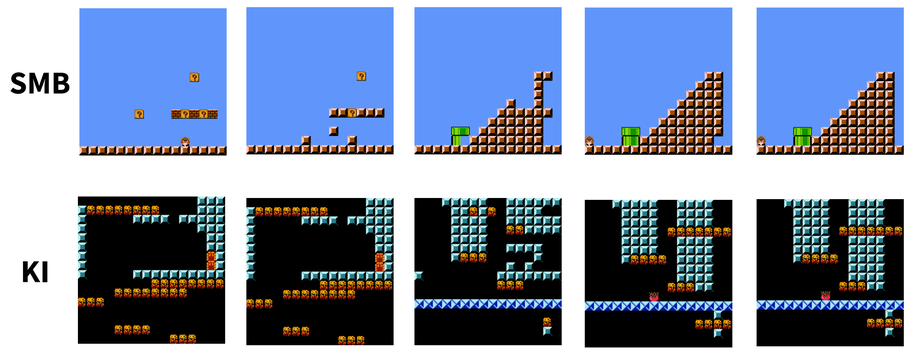
Shortest Path between Levels

- For each game, constructed a graph with nodes representing segments
- Added an edge between a node and each of its k nearest neighbors based on cosine distance
- Computed shortest paths between any two given nodes (represented by segments on either end)



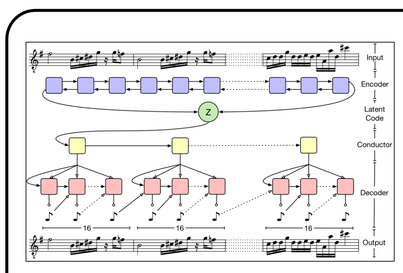
Interpolation between Levels

- For each game, selected two segments (shown on either end) and obtained their latent vectors via the VAE encoder
- Performed linear interpolation between latent vectors to obtain new segments (shown in the middle)

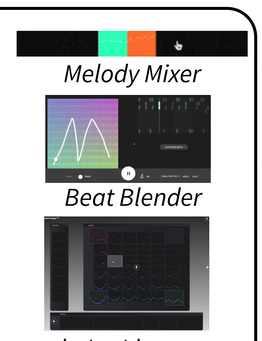


Creative AI for Games and Music

- Like music, games have a hierarchical structure
  - Music → Timbre, Rhythm, Melody, Performance etc.
  - Games → Mechanics/Rules, Aesthetics/Levels, Dynamics
- Additionally, similar to the sequential nature of music, game levels can be represented as sequences of tiles
- Thus, future work in creative AI for game design can take inspiration from creative AI for music



Hierarchical Recurrent VAE architecture for MusicVAE [1]



Melody Mixer

Beat Blender

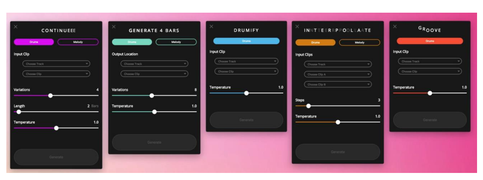
Latent Loops

Mechanic Mixer?

Level Blender? [2]

Gameplay Loops?

Game Design VAE?



Magenta Studio plug-in for Ableton Live [3]

unity

ML-based Game Design plug-in for Unity?

Conclusion and Future Work

- We demonstrated affordances enabled by leveraging creative AI for game design
- Learned latent spaces hold promise for creative applications of AI in the domain of game design
- In the future, existing models widely used for creative AI (e.g. pix2pix and CycleGAN) could be repurposed for game design to enable more complex design applications for games
- *Game Style Transfer* and *Game Design Arithmetic* (e.g. *What is* ***Mario + Zelda – Metroid****?)*

References

[1] A. Roberts et al. A Hierarchical Latent Vector Model for Learning Long-Term Structure in Music, *International Conference on Machine Learning*, 2018

[2] A. Sarkar et al. Controllable Level Blending between Games using Variational Autoencoders. *AIIDE Experimental AI in Games Workshop*, 2019

[3] A. Roberts et al. Magenta Studio: Augmenting Creativity with Deep Learning in Ableton Live, 2019