



Introduction

Minecraft is a popular game that has been used as an environment for exploring creativity. In our research, we created a program where human users interactively evolve shapes using the EvoCraft API [1]. Users can:

- select favored shapes
- generate shapes similar to those they selected
- choose/alter the blocks that make up the shape
- interact with shapes via the game interface

Interface

The interface is made up of 3 main actions:

- Right lever: allows the user to select a shape
- Left button: generates new shapes based on the shapes that were selected. This selective breeding process emulates real-world evolution.
- Blocks in shape: can be broken and replaced by user to alter makeup of shape in real time

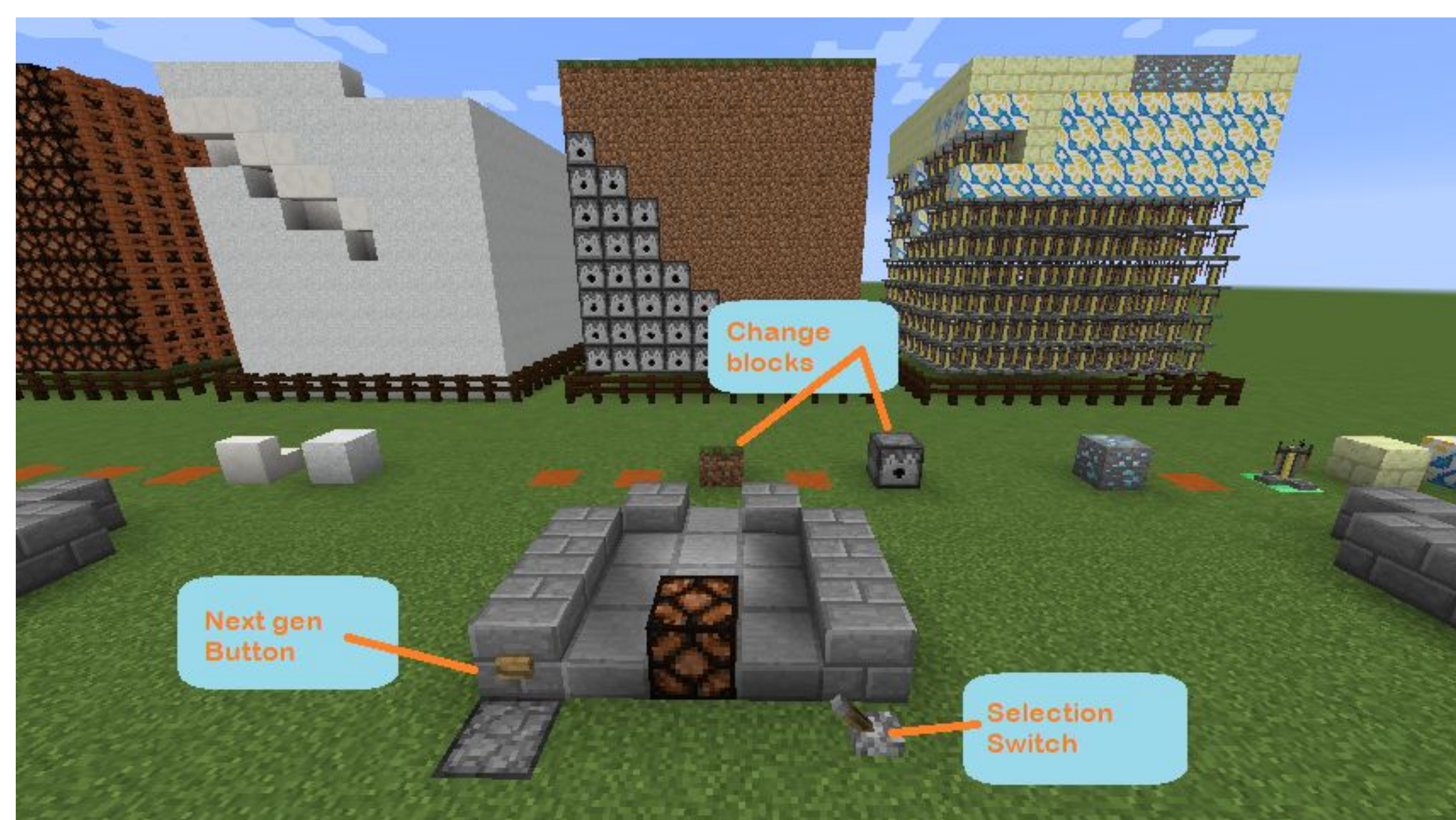
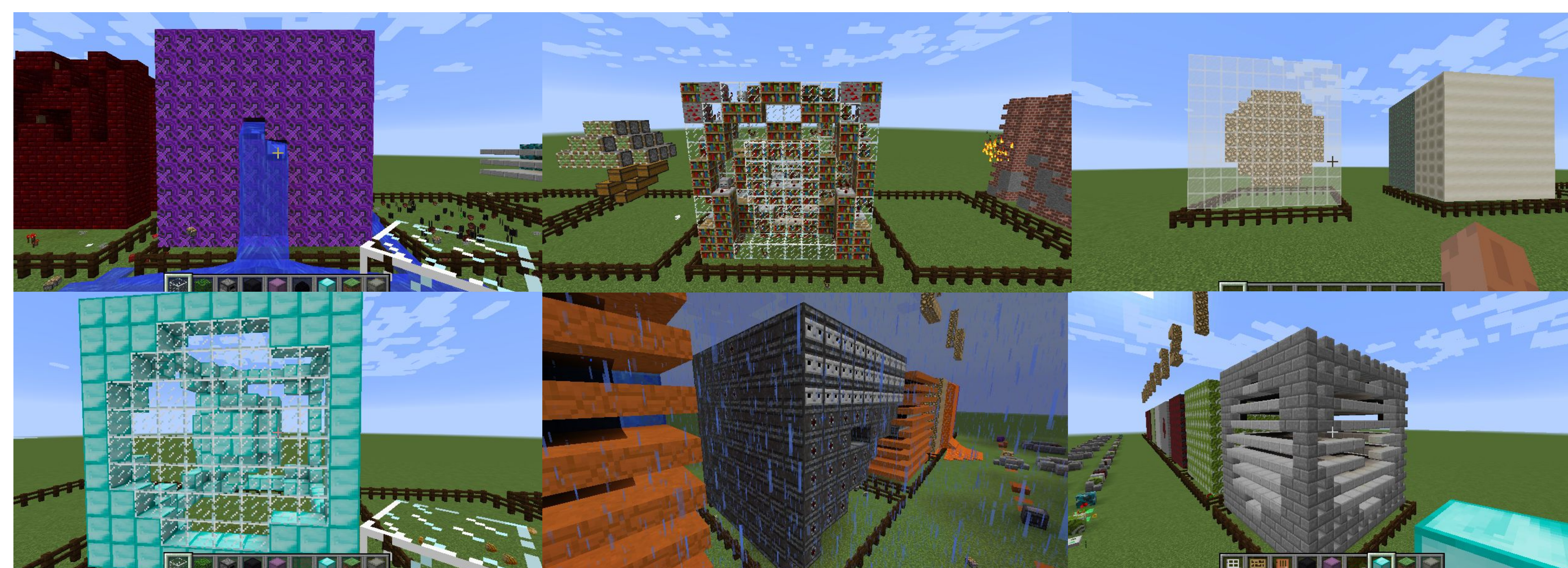
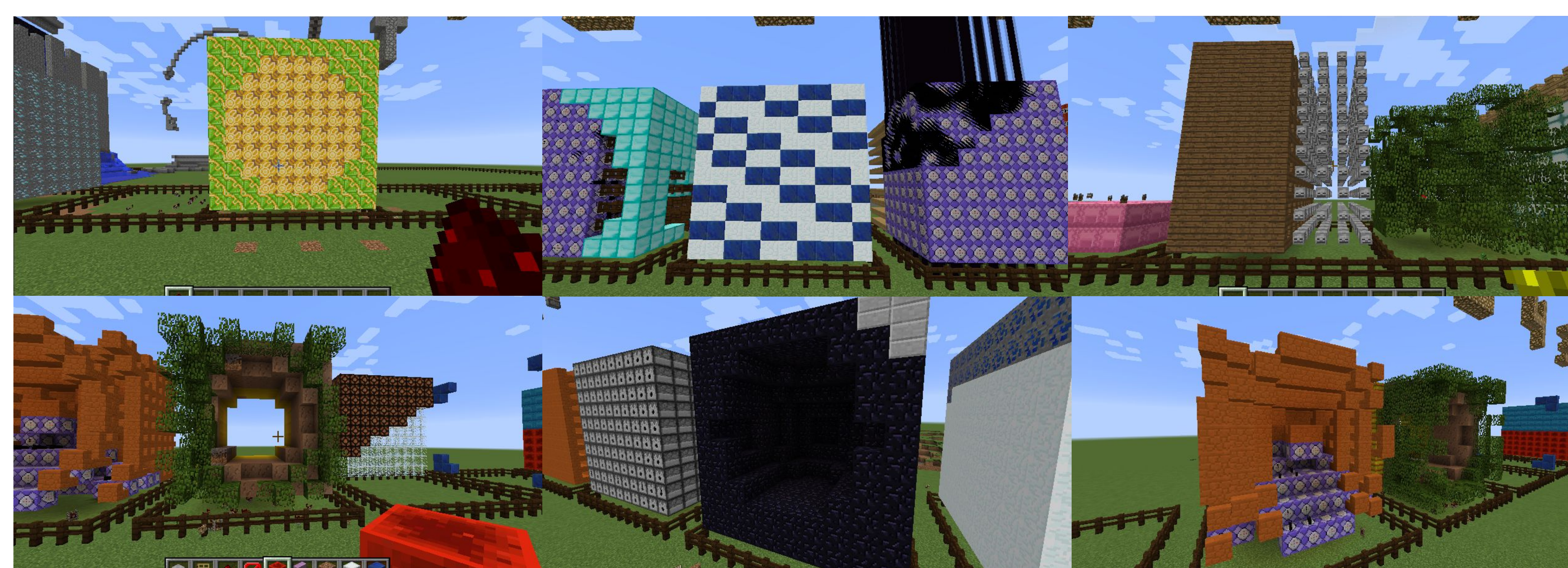


Fig. 1: In-game interface with elements labelled. Each evolved shape has control mechanisms in front of it as described above. The redstone lamp in the center is lit if a shape has been selected for the next generation.

Shapes Bred Via Human Selection



CPPNs

- Compositional Pattern Producing Networks [2] are evolved. Each one produces one shape.
- Generates patterns using various activation functions and queries over 3D coordinate space
- Queries CPPN at each voxel coordinate, which generates one block per query.

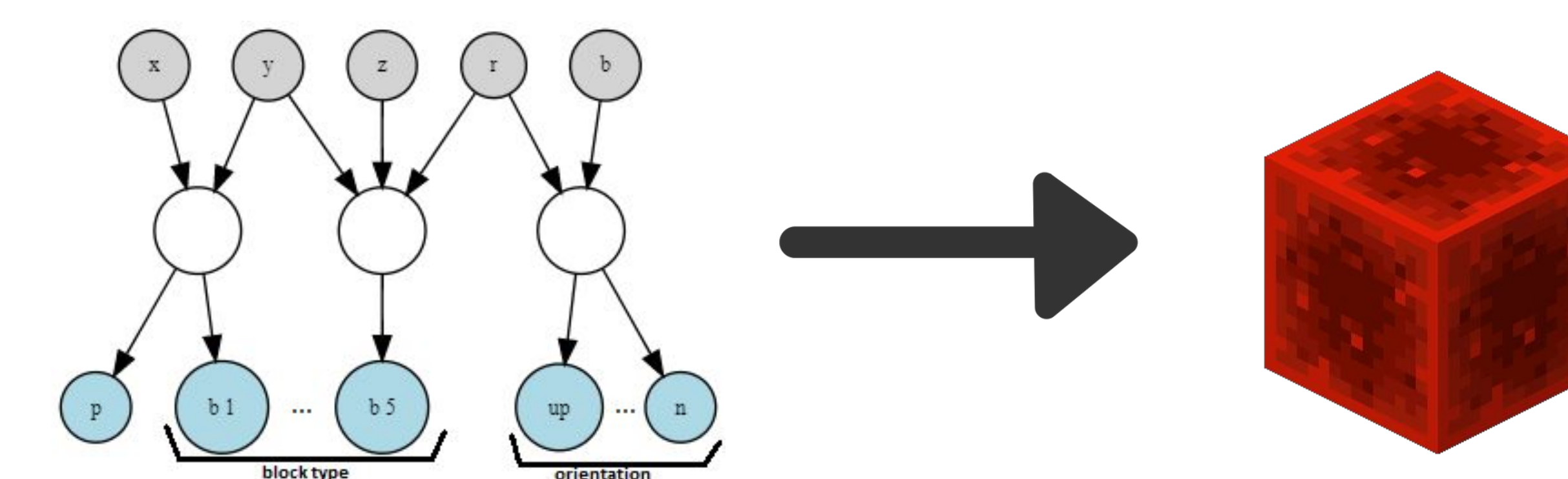


Fig. 2: CPPN generating single block. Potential block coordinates (x,y,z), radial distance from the center of the shape (r), and a constant bias value (b) determine if a block is present, and its type and orientation.

Evolved Neural Networks

- Neuro-Evolution of Augmenting Topologies evolves CPPNs with arbitrary topologies [2]
- Elitism lets selected shapes survive to the next generation of shapes
- Other shapes are offspring of selected shapes: CPPNs randomly modified and/or combined

Conclusion

Interactive evolution allows users to influence not only the future generations of shapes, but also the shapes in real time. Users can create and interact with a wide variety of novel, artistic shapes.

References

[1] Djordje Grbic, Rasmus Berg Palm, Elias Najarro, Claire Glanois, and Sebastian Risi. EvoCraft: A new challenge for open-endedness. *Applications of Evolutionary Computation* (2021), 325–340. 2021.

[2] Stanley, Kenneth O. "Compositional pattern producing networks: A novel abstraction of development." *Genetic programming and evolvable machines* 8.2 (2007): 131-162.