Virtual Reality for Spatial Visualization Skills: Using Reinforcement Learning To Generate 3D Shapes

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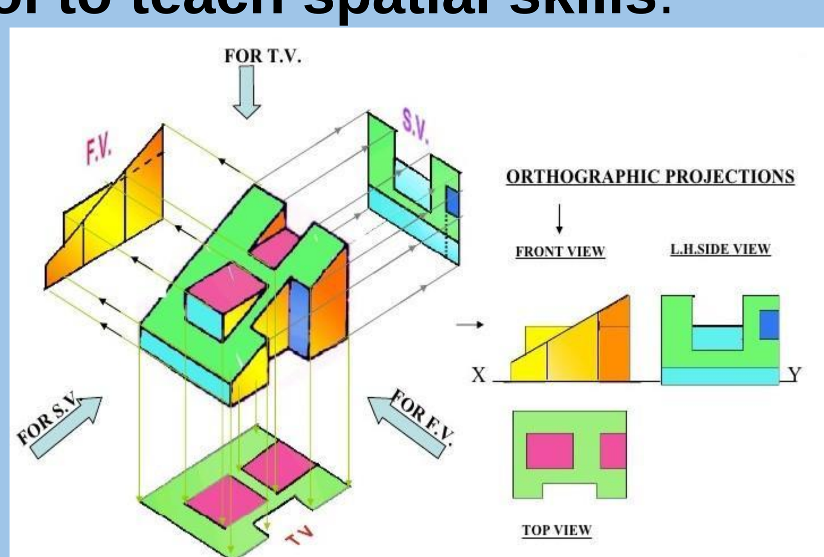
Motivation

A vital part of STEM education is **Spatial skills** and **VR is an effective tool to teach spatial skills**.

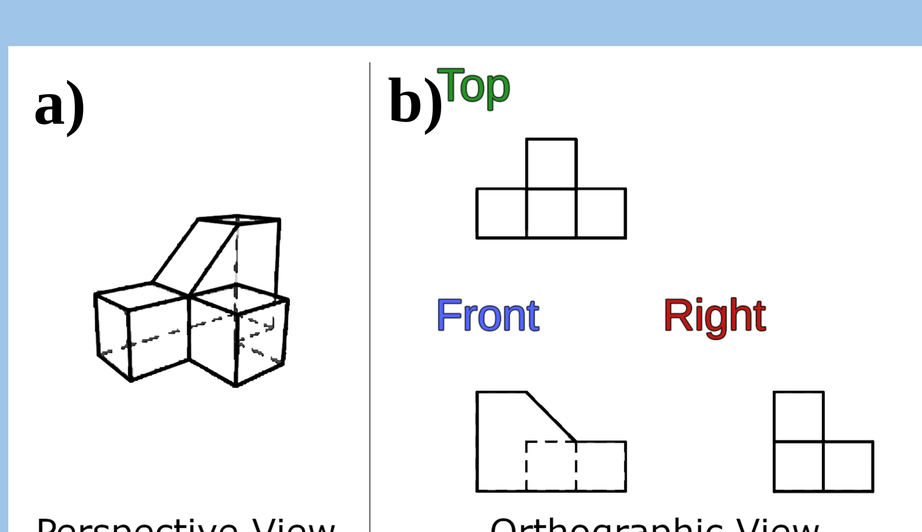


There are limitations to VR as well:
1) The novelty effect
2) Time to generate an application

Machine learning would help overcome these limitations by enabling the application to generate **large quantities of unique shapes to** train with and to **adapt to the user's skill level**.

Versions and Modules

VR with hand tracking
VR without hand tracking
Desktop version



All versions will have both modules:

a)Perspective Viewer. Single isometric view of the object.

b)Orthographic Viewer. Three orthographic images of one object from different sides.

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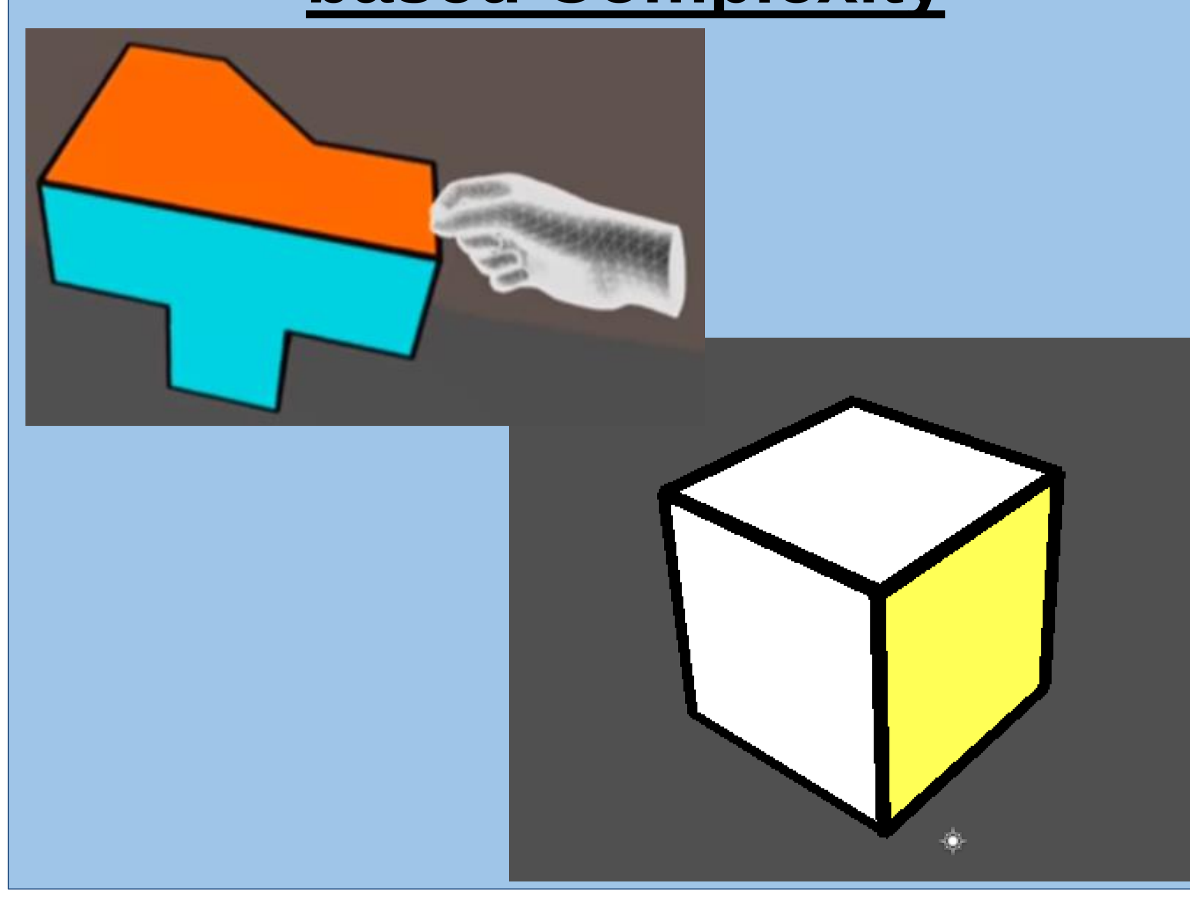
Hand Tracking and Symmetry based Complexity

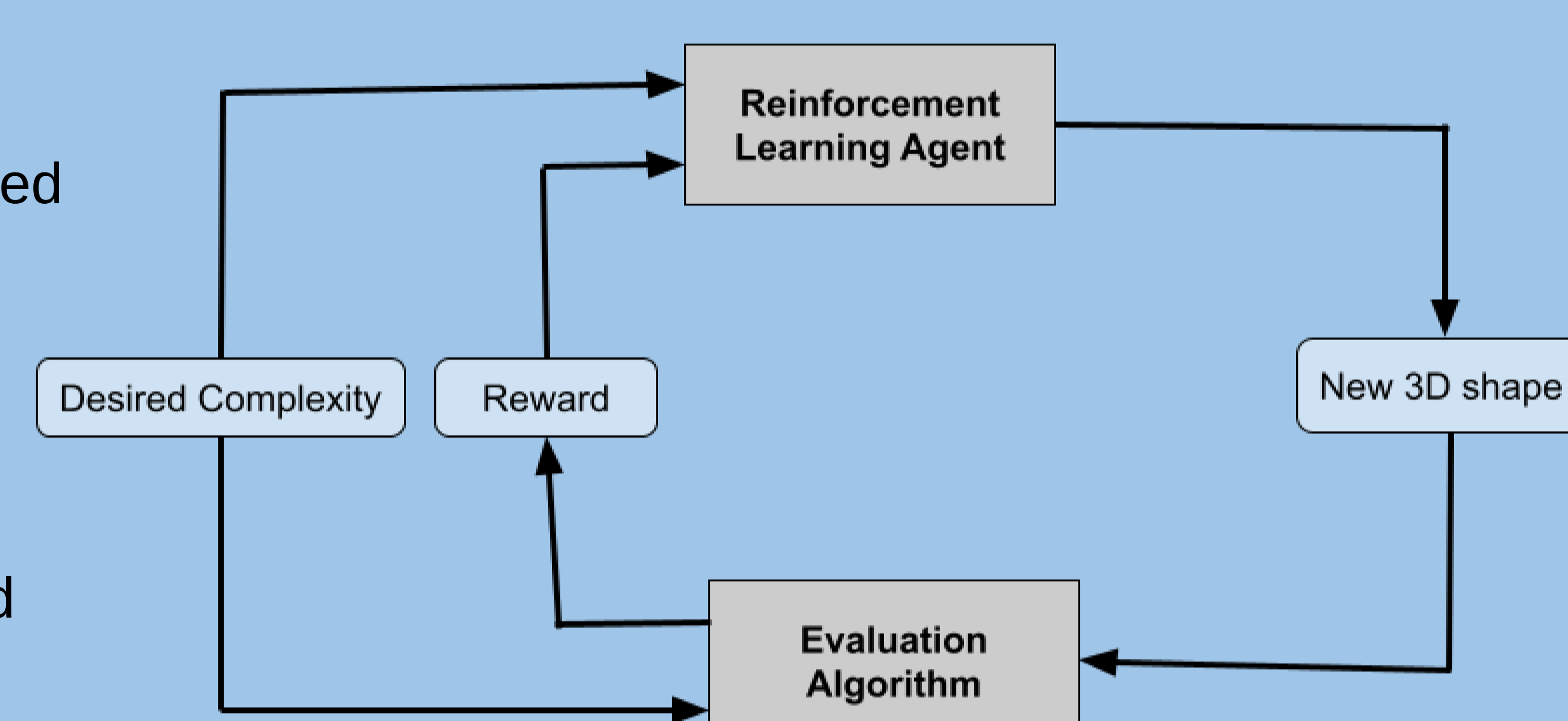


Platforms and Tool Utilized

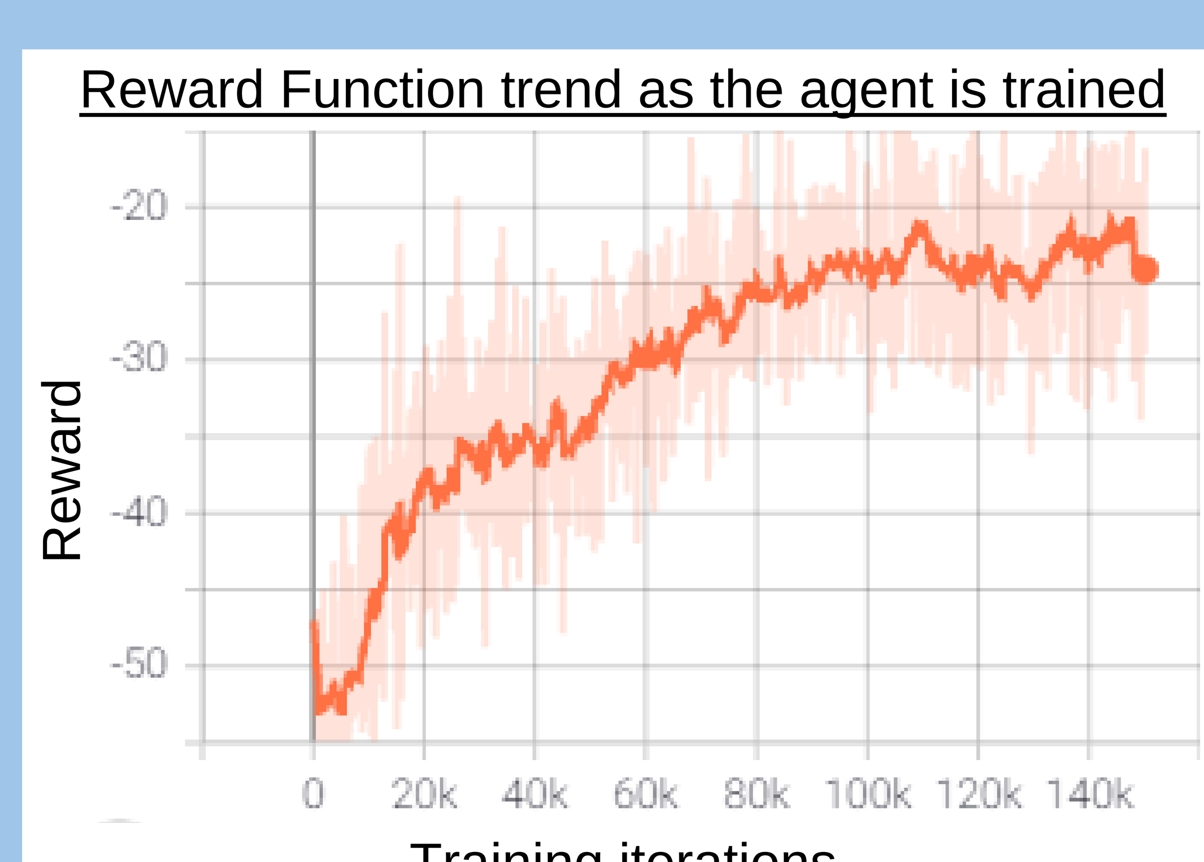
The application was developed in Unity and Python with the target Hardware being the **Oculus Quest.** TensorFlow is also used to track and train the Reinforcement Learning model.

Reinforcement Learning to Generate 3D shapes

1. ML agent generates a shape specified by desired complexity via activating several wedges
2. Evaluation algorithm analyses the shape and rewards the agent based on the function below



Reward Function: -| Calculated complexity – Desired Complexity |



Ideally the reward would trend all the way to zero, however currently the agent doesn't reach that point.

Ongoing updates that improve the agent's learning includes **updating the complexity calculator,** and **altering the Agent's internal settings (hyperparameters).**

Conclusions and Future Goals

The App is ready for testing to compare traditional screen and VR teaching as a stand-alone teaching platform without generating shapes from and RL agent.
In addition, updating and improving the Machine Learning aspects of this project is an ongoing process. Effectively trained agents will enable the application to move onto further phases of development and implementation for testing.

The final goal of this research is to **fully develop our application as a VR learning tool** that is more effective than traditional learning.

lopezbec/VR_SpatialVisualizationApp