Procedural Generation of Roads with Conditional Generative Adversarial Networks

Lin Ziwen Kelvin
Computer Science Department
National University of Singapore
Singapore
e0014961@u.nus.edu

Bhojan Anand
Computer Science Department
National University of Singapore
Singapore
banand@comp.nus.edu.sg

ABSTRACT

Procedural terrain generation refers to the generation of terrain features, such as landscaping, rivers or road networks, through the use of algorithms, with minimal input required from the user. In the process of game development, generating terrain is often an important part of the game development process. Traditional generation methods are often too time consuming especially with larger terrain maps. On the other hand, procedural methods that generate terrain automatically often do not have much user control over the output. We explore the usage of conditional generative adversarial networks in the creation of road maps, as well as the application of such road maps in the creation of game levels in game development engines such as Unreal Engine 4.

ACM Reference Format:
Lin Ziwen Kelvin and Bhojan Anand. 2020. Procedural Generation of Roads with Conditional Generative Adversarial Networks. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Posters (SIGGRAPH '20 Posters), August 17, 2020.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3388770.3407422

1 INTRODUCTION

Procedural Terrain Generation (PTG) refers to the generation of terrain using algorithms, specifically with little to no human input. This is in contrast to traditional terrain creation, where the landscaping was sculpted by hand, and the secondary features are added on manually. PTG allows for terrain and levels to be generated dynamically without needing humans to create the entire landscape by hand.

Road networks are frequently used in games in some form or another. In city-based games such as Sims or Grand Theft Auto, the game takes place within cities, thus road networks directly influence player navigation. In other games such as Player Unknown's Battleground, road networks allow for safer transport of players, and can potentially affect player strategy through usage of chokepoints. Outside of games, road generation may be of use in urban planning, such as for predicting traffic movements and future urban development. However, to the best of our knowledge, most road network generation methods do not have much customizability, and users are often unable to control the types of roads being generated.

SIGGRAPH '20 Posters, August 17, 2020, Virtual Event, USA

ACM ISBN 978-1-4503-7973-1/20/08.
https://doi.org/10.1145/3388770.3407422

We thus explore the usage of conditional Generative Adversarial Networks (cGAN) in creating a framework that allows users to generate road networks that can be used for game development.

2 RELATED WORK

2.1 Example-based Generation Algorithms

Growth-based algorithms were proposed by [Yu and Steed 2012] and [Beneš et al. 2014], where an initial road network is provided, and a city comprising of the road networks is generated by considering the surrounding terrain.

Generative Adversarial Networks (GANs) were used by [Beckham and Pal 2017] in the generation of landscape heightmaps, by using satellite images as the training dataset. In addition, the predicted texturing of the generated terrain for the given heightmap is also generated, which can be imported into the Unity Engine to create landscapes.

[Hartmann et al. 2017] proposed using GANs in the generation of road networks. The resulting GAN from [Hartmann et al. 2017] however makes use of random noise in generating new tiles, leading to a lack of control over the output, making them similar to traditional PTG algorithms in output controllability.

Conditional GANs were used by [Guérin et al. 2017] in the generation of landscapes. Unlike [Beckham and Pal 2017], [Guérin et al. 2017] uses heightmap data from the United State Geological Survey Earth explorer. [Guérin et al. 2017] also features a real-time user sketching tool, that allows users to generate terrain in real time.

3 OUTLINE OF APPROACH

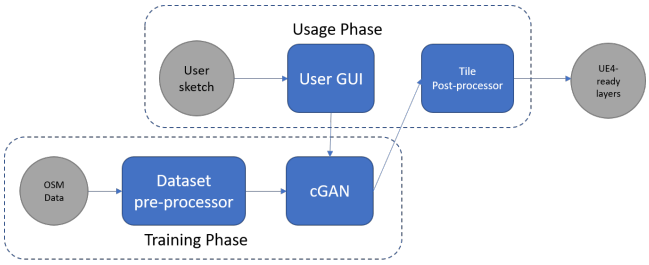

Figure 1: Overall Roadmap Generation Framework

Figure 1 describes the overall pipeline used to generate a full road network, given an initial sketching of primary roads. It consists of a data pre-processor, a conditional Generative Adversarial Network, a simple graphical user interface to input the initial network, and a