# Reinforcement Learning for Autonomous Vehicles using Visual Lane Detection

Degree programme: BSc in Computer Science
Specialisation: Computer Perception and Virtual Reality
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A customized neural network enables deep learning-based lane detection from camera input in Unity. A Bézier-based road system supports training data generation and simulation. Predicted Bézier control points are post-processed for real-world usability and serve as perceptual input in a reinforcement learning environment for autonomous driving.

## Introduction

Autonomous driving continues to gain relevance in both industry and research. Autonomous vehicles (AVs) depend on various sensing technologies to perceive their surroundings, often relying on LiDAR (Light Detection And Ranging) for 3D object detection. However, one of the most fundamental elements of road perception, traffic lane markings, is inherently two-dimensional.

This thesis explores the use of neural networks for visual lane detection in autonomous driving. Unity serves as a simulation platform for experimentation and demonstration purposes. Several deep learning-based approaches were assessed, with a custom implementation based on recent neural architectures such as BezierLaneNet forming the core of the system.

## Concept

This project explores the use of deep learning for visual lane detection in autonomous driving, using a simulated environment as testbed. A neural network processes camera input to detect lane boundaries and provide structured perceptual information. To train and evaluate this system, synthetic test and training data and a simulation environment are required. The detected lane information is then used as input for a reinforcement learning agent, enabling autonomous lane-following behavior within the simulation.

## Goals

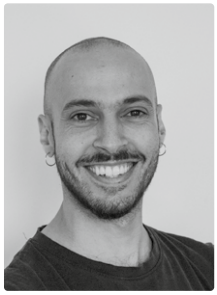
The main objectives of this thesis are:

- Identify suitable neural network architectures for lane prediction in Unity and adapt or implement a solution based on evaluation results.
- Provide a scalable system for road generation and labeled data creation for training and testing.
- Convert network outputs into usable world-space geometries.
- Integrate predicted lane information as perceptual input for a reinforcement learning driving agent.

## Results

All main objectives were achieved. A custom neural network for lane detection was implemented, based on insights from the existing model BezierLaneNet. In Unity, a procedural road system using Bézier curves was created. It enabled the demonstration of the neural network deployment, training data generation, and simulation.

The network output was projected into world space and processed for lane tracking and collision detection. In a reinforcement learning setup, a driving agent successfully learned basic lane following on simple roads. Further tuning is needed for more complex scenarios.



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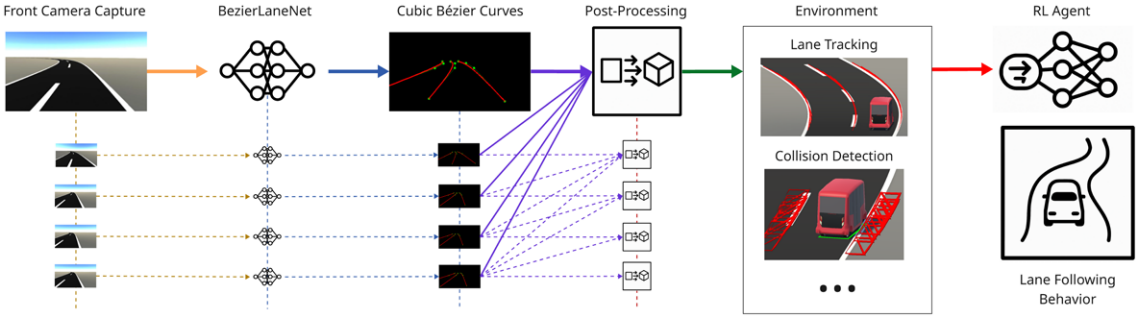


The system's pipeline: from image input to learned behavior