# BOSCH-INTER-PROJECT-MCTS-based-autonomous-driving-decision-making

A Monte Carlo Tree Search Approach for Autonomous Driving Decision Making at Intersections

## Abstract

## Introduction

The forthcoming epoch of transportation is embodied by autonomous driving, marking a change in basic assumptions towards enhanced safety, optimization of efficiency, and augmented accessibility. Yet, this futuristic proposition brings forth a multitude of substantial challenges, within the intricate sphere of decision-making under conditions of uncertainty. This complexity escalates when autonomous vehicles encounter intersections, necessitating the integration of multiple parameters such as the vehicle's velocity and trajectory, the dynamic behavior of surrounding traffic, the prediction of their intentions, and the requisite adherence to traffic regulations.

In the quest for an innovative solution to this intricate problem, this paper delineates a pioneering application of the Monte Carlo Tree Search (MCTS) algorithm specifically tailored for decision-making in autonomous vehicles navigating intersections. MCTS, an esteemed heuristic search algorithm, acclaimed for its immense accomplishments within the realm of game-oriented artificial intelligence, emerges as an extraordinary tool capable of addressing the multifaceted and simultaneous decision-making prerequisites inherent to autonomous navigation. Employing stochastic simulations to traverse diverse action sequences, MCTS demonstrates the potential to effectively navigate the broad and uncertain decision terrain that autonomous vehicles encounter when engaging with intersections.

## Objective

The primary objective of this study resides in the formulation and critical assessment of a decision-making paradigm predicated on the Monte Carlo Tree Search (MCTS) for an autonomous vehicle maneuvering through intersections. The proposed model seeks to significantly enhance three pivotal aspects of the autonomous driving experience: safety, efficiency, and comfort. The MCTS-based model leverages the power of simulating diverse action sequences and probing their prospective outcomes to make informed decisions. This intricate process allows for a judicious balance among the objectives, each holding substantial importance and often presenting trade-offs.

## Methods

1. **Cost of stimulation:**

It promotes the car to move forward when the car has not reached the speed limit.

The standard level of this amount is 0.0.

If speed < speedlimit:

cost = a \* (speedlimit – speed) - b \* (currentAcc)

In this situation, a \* TimeResolution = b; so we let e.g. a = 0.5, b = 0.1 when TimeResolution = 0.2. As the formula (speedlimit – speed) \* a = b \* (speedlimit – speed) / TimeResolution.

Elseif speed > speedlimit:

expectAcc = (speed - speedlimit) / TimeResolution;

cost = abs(acc - expectAcc);

This case determines how much should we decrease the acceleration when we have already reached the speedlimit.

Else cost = 0.0, the standard level.

1. **Cost of comfort:**

cost\_comfort\_jerk = 1 / (1 + exp(-jerk));

1. **Cost of safety:**
2. **Cost of pass goal or not:**

## Results

## Discussion and Implications

## Future Work

## Conclusion