Bachelor thesis – Overview draft

- Topic: Modeling the Behavior of Platoons of Motorcyclists Driving in the Black Forest

- Organizational:
  - Bachelor thesis: 12 ECTS ~ 360h
  - Processing time: Nov. 2022 – Feb. 2023

Part1 ~ 9 weeks

- Aim:

Modelling a Motorcycle Platooning Algorithm on straight and curved roads

→ single lane model with non-periodic boundary condition
- two sublanes for passing other vehicles on the road and perhaps members of the platoon randomly according to a bikers speed preference

→ Asymmetric driving behavior. The left side of the lane is used for passing other vehicles

→ find out rough arguments concerning the length and time scale of the simulation model
- in a complete traffic jam one motorcycle occupies 3.75m

→ modeling motorcyclist behavior rules
- bikers in the Platoon don't pass each other often as it is considered risky
- bikers have heterogeneous preferences for speed
- incentive criteria: a motorcyclist is comfortable when another vehicle is not in front of him depending on relative speed
- safety criteria: probability one biker tries to overtake the car in front of him if there is a gap in front and behind of him on second sublane
- each biker has a simple memory of his fun on winding curves, which increases in curves when a range of optimal speed can be achieved
- there exists a global measure of a natural compression to hold the platoon together influencing group speed behavior

→ modeling curved roads as a cell
- cells have an attribute of curvature, a motorcyclist knows at what speed he can drive safely
- several cells combined create a single curve
- the curve attributes will be randomly set, but clustered together to model a road curve

→ research its various movement phenomena of the platoon
- overtaking maneuver causes a strong "accordion effect" in the platoon
- swarm behavior of the platoon
- strategy to put slow bikers in front leads to faster traversal and overall fun

- Important Diagrams:
  - space-time Diagram like in the original paper of Nagel-Schreckenberg to analyze backward motion if the leader biker decelerates (random or in preparation of a curve)
  - Flow-Density / Fundamental Diagram like in the original paper of Nagel-Schreckenberg
  - lane-changing rate-Vehicle density Diagram like in the paper of Jian-ping Meng et al.
  - lane-changing rate-Flow Diagram
  - Time-Distance diagram and Velocity Distribution amongst the biker see Polichronidis et al.

- Libraries and Languages:
  - Python, Javascript
  - Using Mesa a Python Library specialized for Agent-Based Models
    Javascript for Visualizing motorcycle movements

  → If Framework proves to be too difficult to handle, then visualization and simulation will be done in an array of arrays with Elements representing the position of the biker (like in the original NaSch paper). Possibly using google Colab for easy code distribution and calculation power

Part2 ~ 7 Weeks

Compare actual Data with Simulated Data through reading Biker Forums and possibly an finding out the fun factor of similar Routes but different curves and car density

measure of the curvature parameter will be based on https://roadcurvature.com/,
where curvature on a map is calculated and visualized

Model calibrations to mirror more realistic physical properties, like actual platoon speed. Finding a more suitable set of rules (especially if bikers in a platoon pass each other at all)

Presentation and finalizing the Bachelor thesis

Important Papers found so far

[1] K. Nagel, M.Schreckenberg, A cellular automaton model for freeway traffic
[2] Jian-ping Meng et al., Cellular automaton model for mixed traffic flow with motorcycles
[3] M. Rickert et al., Two lane Traffic Simulations using Cellular Automata
[4] P. Polichronidis et al., Traffic dynamics of carnival processions
[5] L.W. Lan et al., Cellular automaton simulations for mixed traffic with erratic motorcycles' behaviours