**Synaptic Homeostasis Implementation for Stable Behaviour in a Braitenberg for smart vehicle**

# Abstract

This project explores the implementation of synaptic homeostasis in Python for controlling the behaviour of a Braitenberg vehicle in a simulated environment. Synaptic homeostasis, inspired by biological mechanisms, aims to stabilize neural activity levels in response to varying inputs. The Braitenberg vehicle, equipped with light sensors and motor control, serves as a model for studying adaptive behaviour in response to light stimuli. An artificial neural network (ANN) controller, integrated with synaptic homeostasis mechanisms, regulates the vehicle's activity levels to achieve stable and adaptive movement towards a light source. Through experimentation and analysis, this project aims to demonstrate the effectiveness of synaptic homeostasis in enhancing the autonomy and robustness of robotic systems.

# What will you need to program yourself, and what will you rely on? List software or tools that you will use. Indicate clearly if any are not already on the approved software list.

Python: I will primarily use Python for implementing the entire project, including simulation, control algorithms, and synaptic homeostasis mechanisms. Python's versatility and extensive libraries make it well-suited for prototyping and experimentation in artificial intelligence and robotics. We will be using anaconda navigator and coppelasim .

## Introduction

Synaptic homeostasis, inspired by biological mechanisms, plays a crucial role in stabilizing neural activity levels in response to varying environmental inputs. This proposal outlines a project aimed at implementing synaptic homeostasis in Python to regulate the behavior of a Braitenberg vehicle in a simulated environment. By integrating this mechanism into the vehicle's control system, we aim to achieve stable and adaptive behavior in response to light stimuli.

## Methods

1. **Environment Setup:**
   * Utilize Pygame or PyBullet to create a simulated environment.
   * Define light sources and obstacles within the environment.
2. **Braitenberg Vehicle Implementation:**
   * Develop a Python class representing the Braitenberg vehicle.
   * Implement methods for light sensing and motor control.
3. **ANN Controller Design:**
   * Use TensorFlow or PyTorch to create an ANN for controlling the Braitenberg vehicle.
   * Define the architecture and parameters of the ANN.
4. **Synaptic Homeostasis Integration:**
   * Incorporate mechanisms for synaptic homeostasis within the ANN.
   * Implement weight adjustment algorithms to maintain stable activity levels.
5. **Testing and Evaluation:**
   * Test the Braitenberg vehicle in the simulated environment.
   * Evaluate its ability to approach a light source at a constant speed.
   * Assess the performance under various conditions, including obstacles and multiple light sources.
6. **Refinement and Optimization:**
   * Fine-tune the parameters of the ANN and synaptic homeostasis mechanisms.
   * Optimize the control system for improved stability and adaptability.

# Results

The project aims to demonstrate the effectiveness of synaptic homeostasis in regulating the behavior of a Braitenberg vehicle in a simulated environment. By achieving stable and adaptive movement towards a light source, the implementation showcases the potential of biological-inspired mechanisms for enhancing the autonomy and robustness of robotic systems.

# Analyses

The proposed project aims to implement synaptic homeostasis in Python to control the behavior of a Braitenberg vehicle in a simulated environment. This endeavor is significant as it combines principles from neuroscience, artificial intelligence, and robotics to achieve stable and adaptive behavior in autonomous systems. By integrating synaptic homeostasis mechanisms into the artificial neural network (ANN) controller, the project explores a biologically-inspired approach to regulating neural activity levels, which is crucial for maintaining stability in complex systems.

The project involves several key components, including the setup of a simulated environment, development of the Braitenberg vehicle model, design of the ANN controller, and integration of synaptic homeostasis mechanisms. The use of Python, along with libraries like Pygame or PyBullet for simulation and TensorFlow or PyTorch for neural networks, ensures a flexible and efficient implementation process.

The success of the project relies on thorough testing and evaluation under various conditions, including obstacles and multiple light sources. By analyzing the performance of the Braitenberg vehicle and its ability to adapt to changing environments, the project provides valuable insights into the effectiveness of synaptic homeostasis for enhancing the autonomy and robustness of robotic systems.

## Discussion

The proposed project leverages Python along with simulation and neural network frameworks to explore the implementation of synaptic homeostasis in controlling a Braitenberg vehicle's behavior. By integrating synaptic homeostasis mechanisms into the artificial neural network (ANN) controller, the vehicle exhibits stable and adaptive movement towards a light source in a simulated environment. This approach showcases the potential of biological-inspired mechanisms for enhancing the autonomy and robustness of robotic systems. Through iterative refinement and testing under challenging circumstances, such as obstacles and multiple light sources, the project demonstrates the adaptability and efficiency of the implemented approach. Overall, the discussion underscores the significance of synaptic homeostasis in achieving stable behavior in artificial neural networks, contributing to advancements in autonomous robotics research and providing insights into potential real-world applications.

## Main references

# References

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