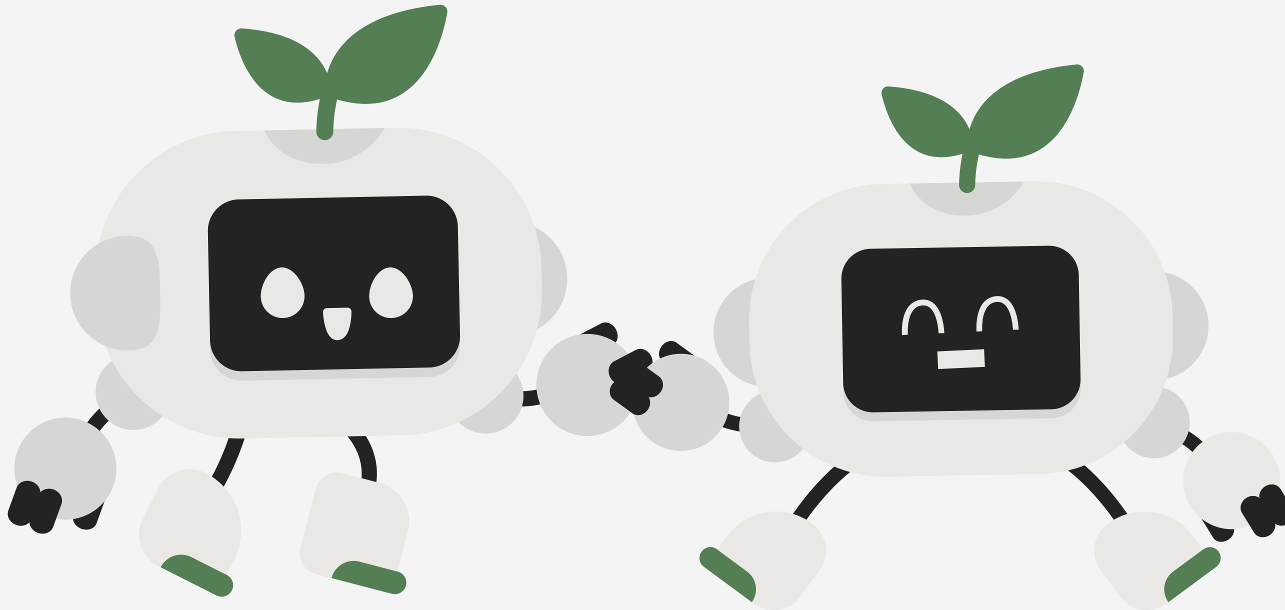
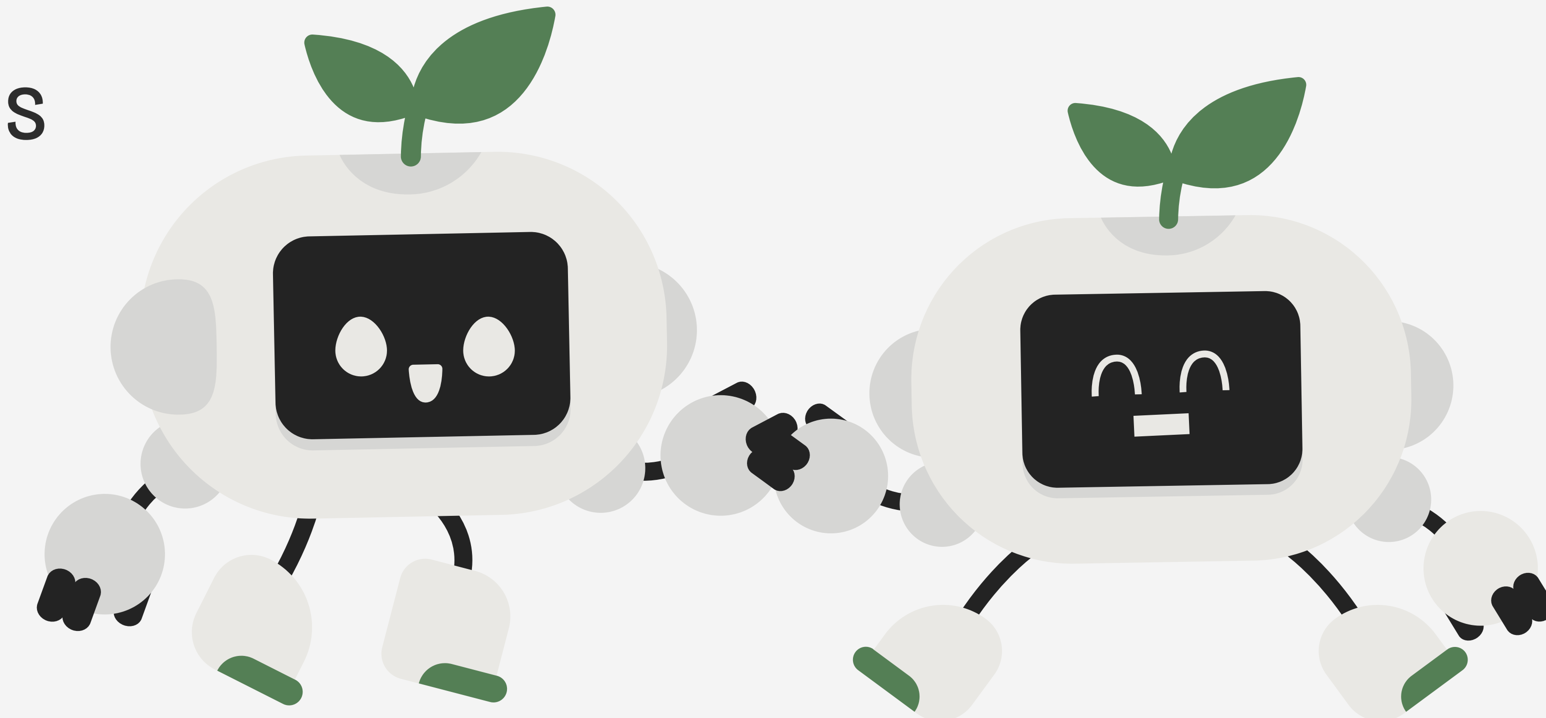
Evolving a Simple Gait for a Bipedal Robot

The **core idea** is to use a genetic algorithm within a physics simulation (Webots) to evolve a functional and efficient walking behavior for a two-legged robot.



Ideology / Concept

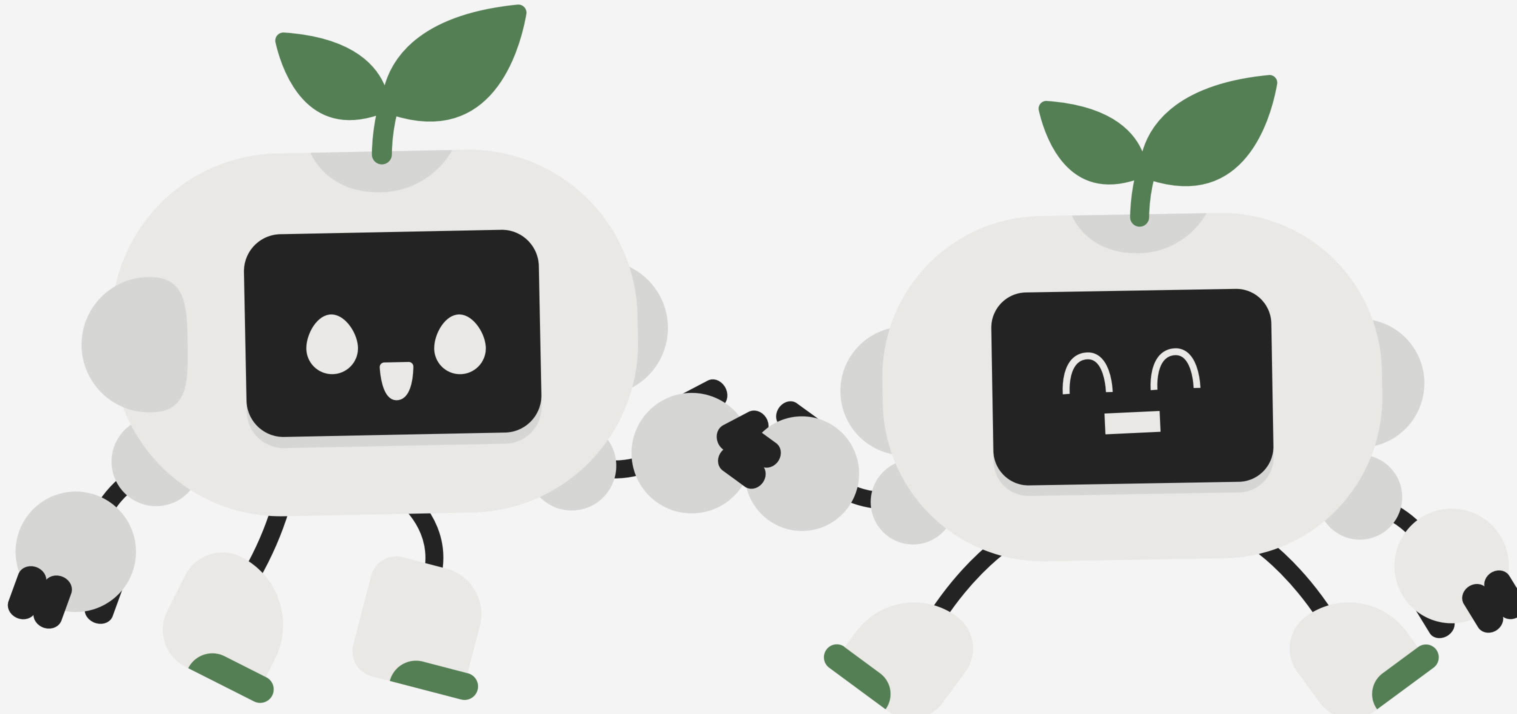
- Simulate evolutionary learning in bipedal robots.
- Robots learn, adapt, and evolve walking strategies over generations.
- Evolutionary algorithms allow self-discovery of optimal movement patterns.
- Phase 1 focuses on laying the foundation for this process.



Phase 1 Goals & Project Structure

Goals:

- Build the bipedal robot prototype (legs, joints, sensors, motors).
- Set up the evolutionary supervisor for multiple robots and generations.
- Define fitness criteria like distance and balance.
- Organize the project structure for modular development.



Phase 1 Goals & Project Structure

Project Structure

```
bipedal_evolution_project/
├── worlds/
│   └── evolution_world.wbt          # Main Webots world file
├── controllers/
│   ├── evolutionary_supervisor/     # Evolution management
│   │   ├── evolutionary_supervisor.py
│   │   ├── genome.py
│   │   ├── population.py
│   │   └── environment.py
│   └── bipedal_robot/               # Individual robot controller
│       └── bipedal_robot.py
```

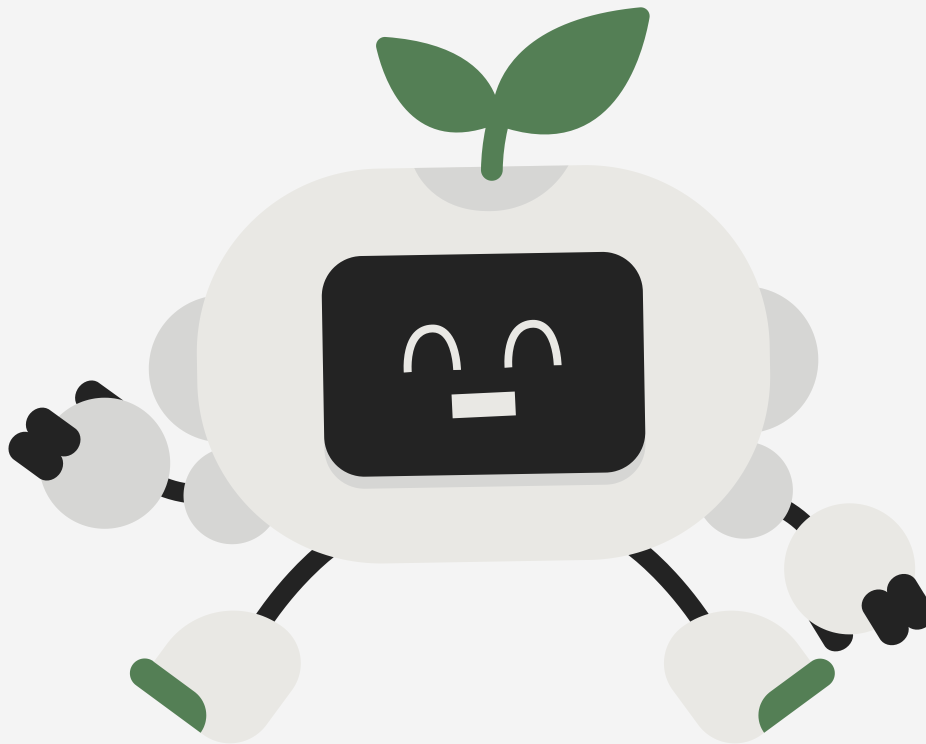
Phase 2 - World File

The world is derived from the Humanoid Robot Marathon, which serves as an example environment provided by Webots.

Phase 3 - Robot Implementation

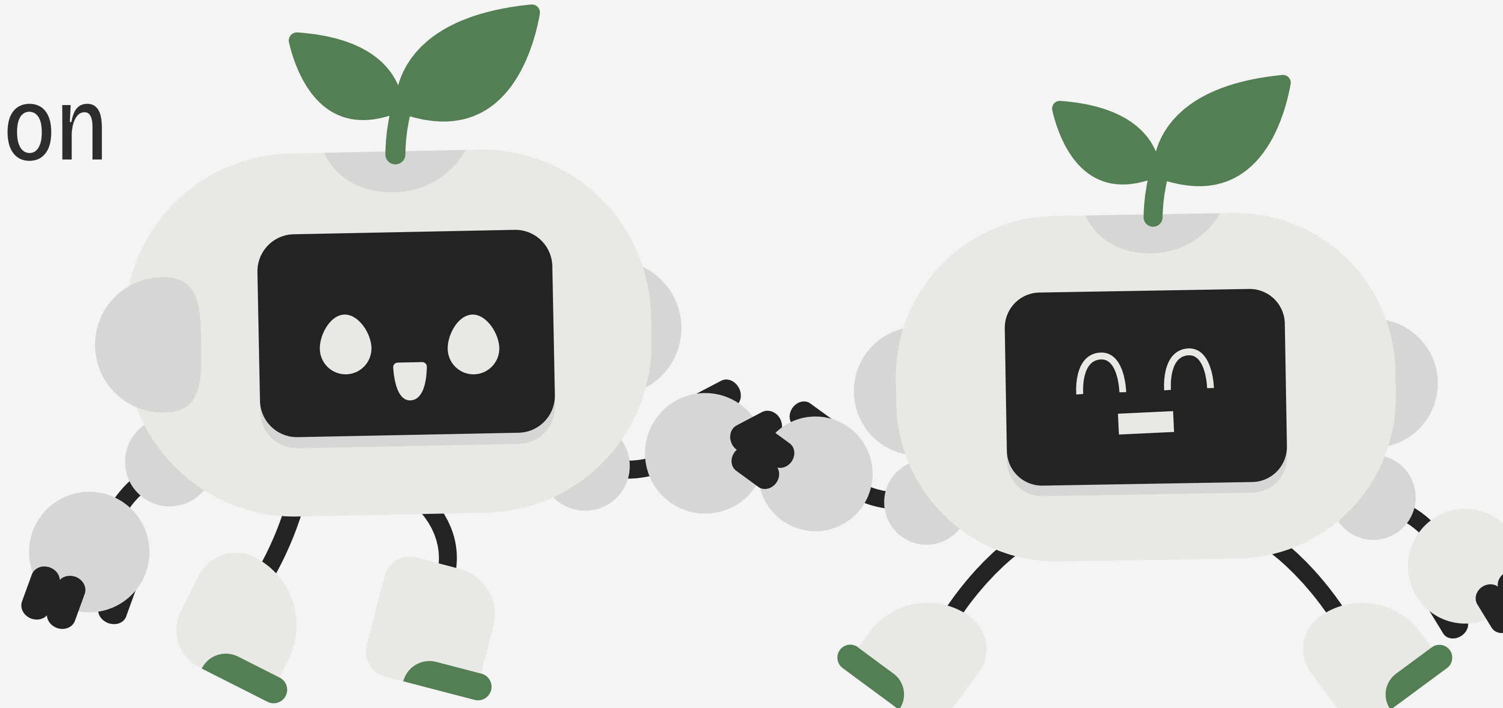
Phase 4 - Challenges in Robot Design

- Hinge joints and leg mechanisms were not functioning correctly.
- Building a robot from scratch was complex and error-prone.
- Few pre-existing bipedal prototypes were available.
- Source code for existing robots was mostly inaccessible.
- Completing a fully functional custom robot was not feasible.



Phase 4 - Solution: Darwin OP3 Robot

- Stable, fully functional robot model available.
- Allows focus on controller programming and evolutionary testing.
- Robot supports walking forward/backward and turning left/right.
- Provides a reliable platform for gait optimization experiments.



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