

ELAM-Flume-2D Simulation Framework: User Guide

Overview

ELAM (Eulerian-Lagrangian Agent Model) simulates the behavior of agents (fish) in a fluid environment, combining Eulerian CFD flow data with Lagrangian individual agent tracking. It is designed for ecological and behavioral studies of movement in bounded, complex 2D spaces such as river channels.

Script Structure

- `_1_run_ELAM_Einstieg.py`:
 - Main script for configuring parameters, loading input data, running the simulation.
- `_0_function_ELAM_flume_2D.py`:
 - Functional library handling CFD processing, agent behavior modeling, and visualization.

Inputs

- Flow Field (CSV): Contains 2D grid coordinates and flow vectors from CFD simulation.
- Geometry (Shapefile): Defines the 2D boundary (e.g., flume or channel). The model ensures agents remain inside this geometry.

Agent Behavior

Agents (fish) operate in three states - Transitions depend on the balance between motivation and fatigue:

- Migrating: Swim actively against the flow when motivated.
- Holding: Temporarily resist current while recovering.
- Drifting: Let the flow carry them when fatigued.

Motivation and Fatigue

- Motivation increases with time spent stationary and varies by fish type (slow/fast).
- Fatigue increases with active movement and declines during rest. Modeled using decay coefficients.

Boundary check

At every step, each agent's position is checked against the shapefile-defined polygon to prevent exit. If an agent crosses or exits, a corrective re-rotation is applied.

Outputs

- Agent trajectories and flow fields (plots)
- Fatigue and motivation trends over time
- Animated movement GIFs (optional)

How to Run

- Install dependencies: `pip install numpy pandas matplotlib scipy shapely imageio tqdm pyshp numba`
- Place required input files into a 'data/' directory:
 - `data/2d_flow_field.csv`
 - `data/Rhinne_2D.shp`
- 3. Run: `python _1_run_ELAM_Einstieg_document.py`