

# Double pendulum simulator

## Developer documentation

Bence Göblyös

November 22, 2023

## 1 Custom data types

- `triple` is an alias for long double.
- `ulong` is an alias for unsigned long int.
- `constants` stores the basic constants of the simulation,  $g$ ,  $l$  and  $m$ , all `triple`.
- `pend_state` stores the current state of the pendulum,  $t1$ ,  $t2$ ,  $p1$ ,  $p2$ , all `triple`.
- `sim_params` stores all parameters of the simulation:  $t$  and  $dt$  (`triple`), `steps`, `freq`, `plot_freq` and `flip_length` (`ulong`) and  $c$  (`constants`).

## 2 main.c

This file contains the menu code, as well as the pipe and file handling.

- `save_sim_data(pend_state *states, sim_params params, char *fname)`  
This function saves the data from `states` to a file called `fname` in a CSV format at the sampling rate set inside `params`.
- `plot_phase_space(pend_state *states, sim_params params, char *filename)`  
This one is similar to the previous, but it sends the data `gnuplot` through a pipe and saves the resulting SVG as `filename`.
- `flip_plot(triple **data, char *filename, sim_params params)`  
This function plots the flipover times from `data` on a heatmap and saves it as a PPM (bitmap) file to `fname`.
- `convert_plot(char *filename, char *target)`  
Just calls `magick filename target`.
- `general_setup(sim_params *p)`  
Handles general menu and allow the user to change the contents of `p`.
- `full_setup(sim_params *p, triple *theta1, triple *theta2, char *csv_def, char *svg_def)`  
Handles full trajectory simulation menu.
- `flip_setup(sim_params *p, char *ppm_def, char *img_def)`  
Handles flipover map menu.

## 3 sim.c

This file contains the simulation itself.

- `pend_state step_sim(pend_state old, pend_state prev, constants c, triple h)`  
Steps the simulation by  $h$  seconds and returns the new state.

- `pend_state *full_sim(triple theta1_0, triple theta2_0, sim_params params)`  
Runs a full trajectory simulation with the specified conditions and returns the array of states.
- `triple flip_sim(triple theta1, triple theta2, sim_params params)`  
Runs a simulation with the specified parameters and returns the time it took for the lower pendulum to flip over. Returns -1 if the time runs out.
- `triple* linspace(ulong length)`  
Creates a `length` long array and fills it with values between  $-\pi$  and  $\pi$ .
- `triple **flip_matrix(sim_params params)`  
Creates a matrix filled with the flipover times.

## 4 `input.c`

This file contains input handling.

- `char *get_fname(char *prev)`  
Reads in a filename from `stdin`. If unsuccessful, it returns `prev`.
- `ulong get_ulong(ulong def)`  
Reads in an `ulong` from `stdin`. If unsuccessful, it returns `def`.
- `triple get_triple(triple def)`  
Reads in a `triple` from `stdin`. If unsuccessful, it returns `def`.
- `int get_bool()`  
Reads in a yes/no answer from `stdin`, returning 1 on 'Y' or 'y', 0 otherwise.