

Timetabling Algorithm

The timetabling algorithm is implemented entirely in the generate-timetable edge function (supabase/functions/generate-timetable). This can be called directly from the frontend using the Supabase API.

A candidate timetable is represented as a matrix where the columns represent classrooms and the rows represent a time slot (of 30 minutes). A class is allocated to a room and time by entering its id into the corresponding entry in the matrix.

Each candidate timetable is assigned an "energy" (a number reflecting how well it satisfies soft constraints, with a lower number being better).

First, an initial timetable is generated that satisfies all hard constraints.

Next, soft constraints are optimised using simulated annealing. The algorithm is roughly:

- Generate a neighbouring timetable (by deallocating and then reallocating classes).
- If the energy of the neighbouring timetable is lower, move there. Otherwise, move there with probability less than one.
- Repeated for a fixed number of iterations (currently set to 1000).

The acceptance probabilities also decrease as the "temperature" decreases. The temperature starts at a high (positive) initial value and converges towards 0 with each iteration. The rational is that we want high acceptance probabilities initially to be able to explore the entire solution space, and then for them to progressively decrease in order to hone in on the optimal solution.

Finally, the optimised timetable is written to the database.

This process is repeated for every campus individually.

Hard constraints include:

- Teaching staff cannot be allocated to two classes at the same time.
- Students cannot be allocated to two classes at the same time.
- Two classes cannot be allocated the same room at the same time.
- A class must take place in a room of the same type (e.g. a lecture must take place in a lecture theatre).
- A class must be allocated a room on the same campus that its course is assigned to.

Soft constraints include:

- It is preferred to start a class at whole hour rather a half hour (e.g. prefer 12:00pm to 12:30pm).
- It is preferred to start a class as close as possible to 12pm.