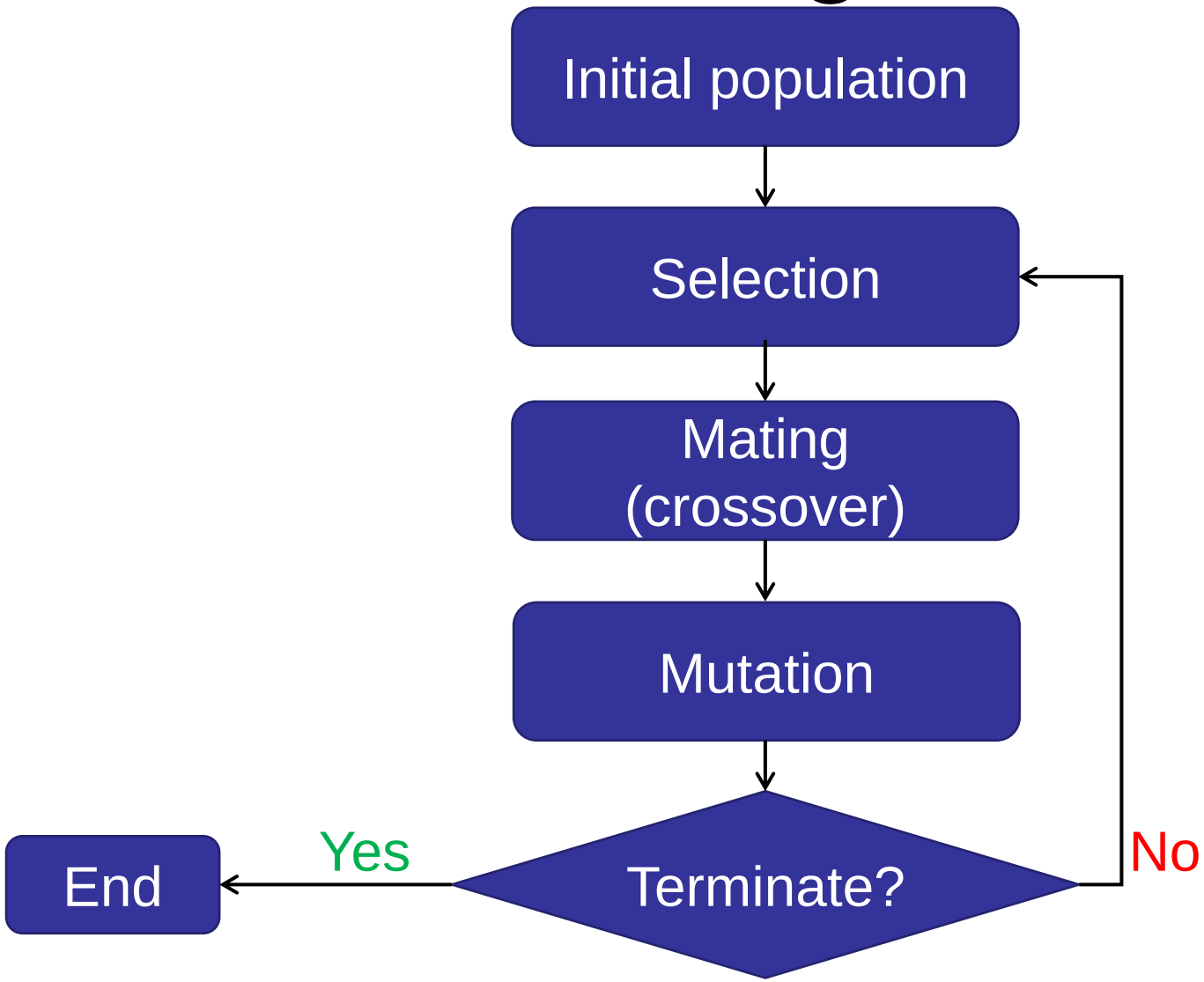
Solving modular exam scheduling problem with genetic algorithms

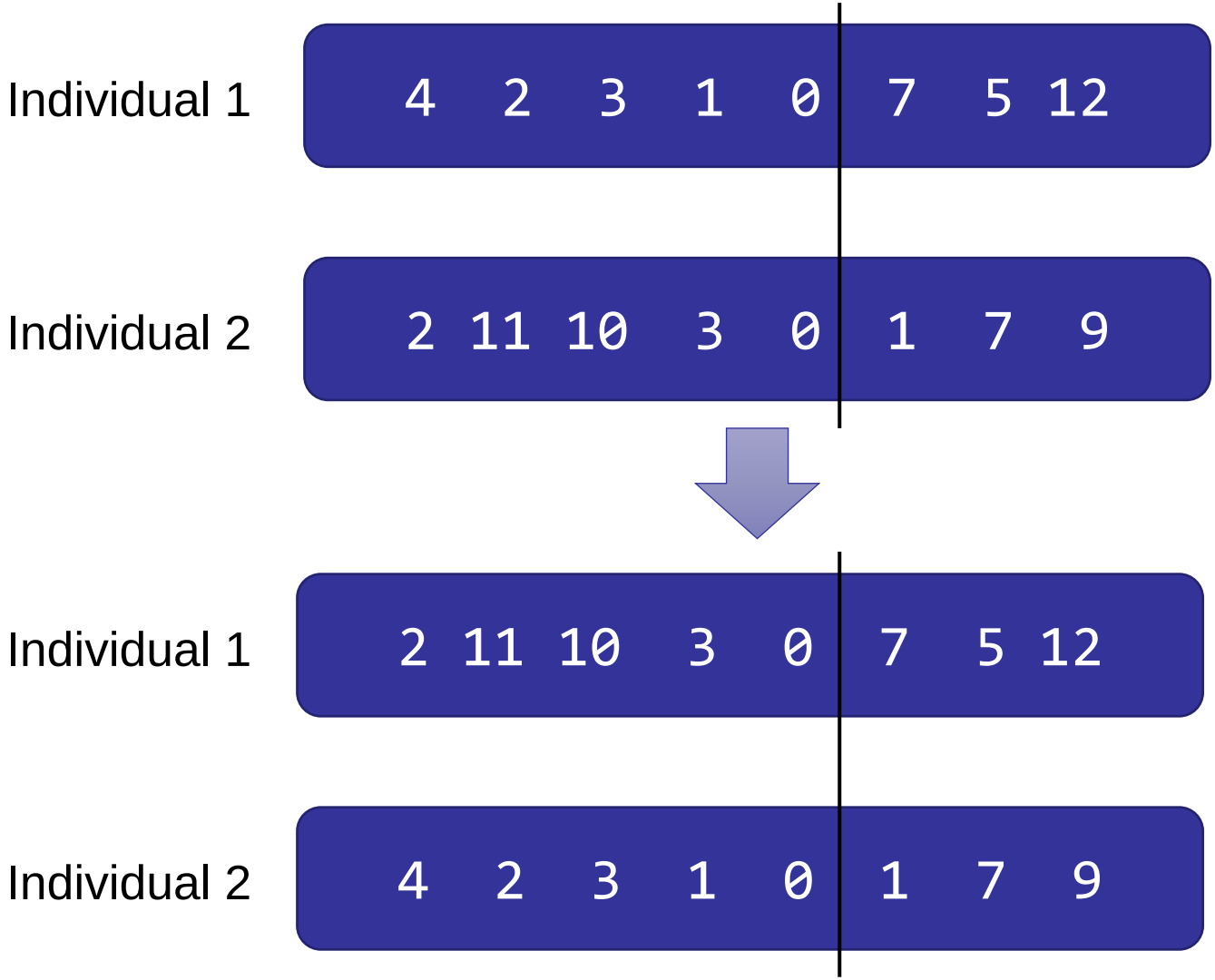
Dominik Czarnota

AGH University of Science and Technology

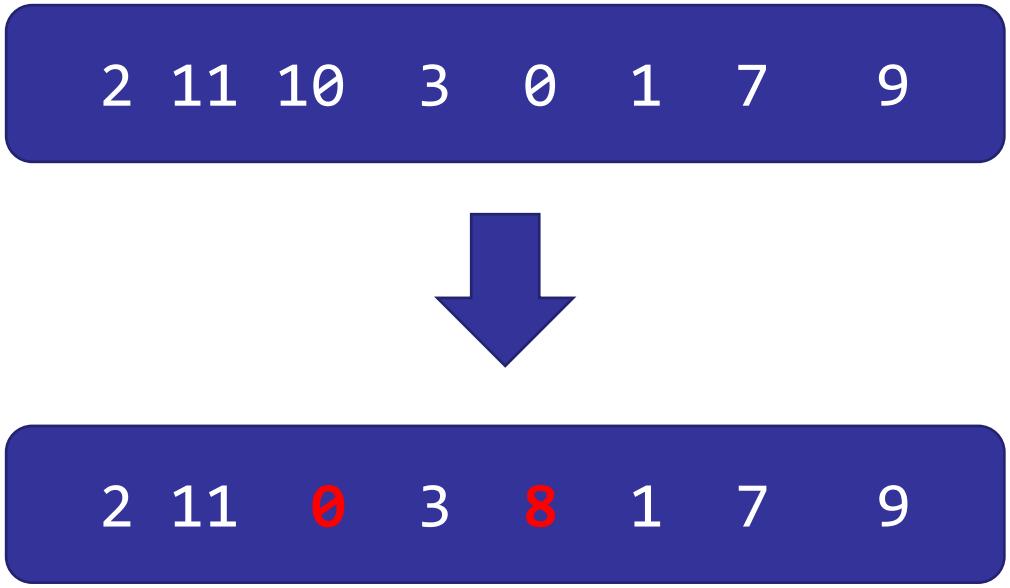
Genetic algorithm



Crossover


Individual 1
4 2 3 1 0 7 5 12
Individual 2
2 11 10 3 0 1 7 9
Individual 1
2 11 10 3 0 7 5 12
Individual 2
4 2 3 1 0 1 7 9

Mutation



Selection

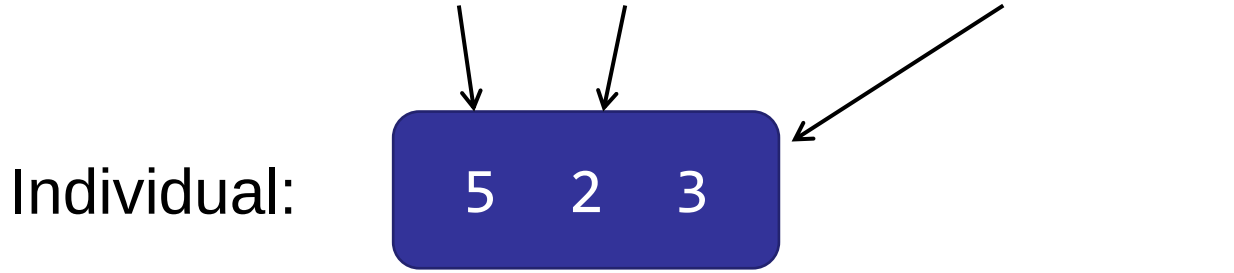
Tested four different selections:

- Best 5
- Tournament 10
- Roulette 20
- Random 20

Modular exam scheduling problem

Timeslots = 0, 1, …, t

Exams = ["Physics", "Math", "Programming"]



Each value of individual is the timeslot for particular exam.

The interpretation depends on the case, for example it can be that:

- 0 is Monday 8:00-10:00
- 1 is Monday 10:00-12:00
- 4 is Tuesday 8:00-10:00 etc.

Test case

The test case consists of 230 students:

- 100 students from first year
- 70 students from second year
- 50 students from third year

Each year has its own 4 separate exams. Each student also has one of three modules – which consists of two subjects.
In the end, there were total of 18 exams and 20 possible terms (that might overlap).

To add some more reality to the data, 10 of second year students also have one exam from first year and 5 of third year students have one exam from second year.

Fitness function

Punishments:

STUDENT_TAKING_TWO_EXAMS_AT_ONCE = 500

STUDENT_TAKING_MORE_THAN_TWO_EXAMS_IN_ONE_DAY = 10

STUDENT_TAKING_EXAMS_ONE_AFTER_ANOTHER = 5

STUDENT_TAKING_TWO_EXAMS_IN_ONE_DAY = 3

Fitness function = 1.0 / (1.0 + punishments)

Results

Tested 864 cases:

```
mutation_probabilities = (0.01, 0.03, 0.05, 0.1, 0.2, 0.3)
mutation_change_probabilities = (0.01, 0.03, 0.05, 0.1, 0.2, 0.3)
crossover_probabilities = (0.01, 0.05, 0.1, 0.2, 0.3, 0.5)
select_methods = (select_best, select_random, select_roulette,
                  select_tournament)
```

38 runs got the best fitness function value of 0.00135869565217 which is 735 punishment value.

Example of best results

Parameters:

- Selection method: best 5,
- Mutation probability = 0.1
- Mutation change probability = 0.03
- crossover probability = 0.5

Individual: [2, 13, 0, 19, 17, 8, 13, 3, 15, 1, 18, 12, 10, 6, 11, 4, 11, 4]
Fitness: 0.0013586956521739 13 (735 punishment value)

Punishments (count * weight):

- 2 exams at once = 0 * 500 = 0
- 2+ exams at one day = 0 * 10 = 0
- Exam after another = 0 * 5 = 0
- 2 exams at one day = 245 * 3 = 735

Results log

Exam Algebra liniowa i geometria analityczna is on day 0 - timeslot 2
Exam Analiza matematyczna is on day 3 - timeslot 1
Exam Matematyka dyskretna is on day 0 - timeslot 0
Exam Fizyka 1 is on day 4 - timeslot 3
Exam Programowanie obiektowe is on day 4 - timeslot 1
Exam Architektury komputerów is on day 2 - timeslot 0
Exam Systemy dynamiczne is on day 3 - timeslot 1
Exam Fizyka 2 is on day 0 - timeslot 3
Exam Przetwarzanie obrazów cyfrowych is on day 3 - timeslot 3
Exam Bazy danych is on day 0 - timeslot 1
Exam Lingwistyka formalna i automaty is on day 4 - timeslot 2
Exam Analiza i modelowanie oprogramowania is on day 3 - timeslot 0

Exam extra1 is on day 2 - timeslot 2
Exam extra2 is on day 1 - timeslot 2
Exam extra3 is on day 2 - timeslot 3
Exam extra4 is on day 1 - timeslot 0
Exam extra5 is on day 2 - timeslot 3
Exam extra6 is on day 1 - timeslot 0