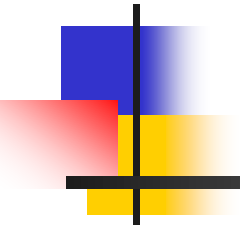
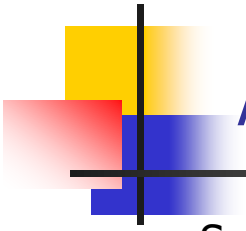


Machine Learning for Optimization

WS 2025: Project/Assignment 2

Nysret Musliu
Database and Artificial Intelligence Group
Institute of Logic and Computation, TU-Wien



Assignment

Select one of problems below:

- **The Social Golfer Problem or**
- **Rotating Workforce Scheduling**
- **Facility Location Problem**
- **Test Laboratory Scheduling**

Task:
Implement two adaptive large neighborhood methods for the selected problem

- A Large Neighborhood Search (LNS) approach that selects destroy operators based on a Multi-Armed Bandit method
- A Large Neighborhood Search approach that selects destroy operators based on a more sophisticated reinforcement learning method.

2 students can work in one group

Task1.1: LNS and Multi-Armed Bandit

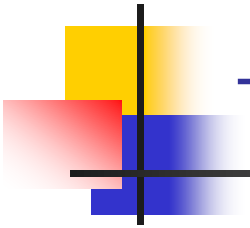
- Use at least three destroy operators for LNS
  Literature for LNS: https://orbit.dtu.dk/files/5293785/Pisinger.pdf

- Use an exact solver as repair operator. You can also apply additional repair operators

- Select operators in each iteration using a Multi-Armed Bandit approach

  Examples from the literature:
  https://www.ijcai.org/proceedings/2025/0286.pdf or
  https://arxiv.org/abs/2412.14382

  https://ojs.aaai.org/index.php/AAAI/article/view/29701



Task1.2: LNS and Reinforcement Learning

- Select operators in each iteration using Reinforcement Learning

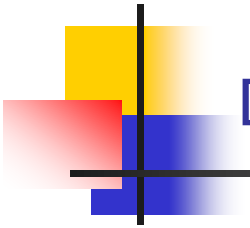
Examples from the literature:
https://ojs.aaai.org/index.php/ICAPS/article/view/31507

https://ojs.aaai.org/index.php/AAAI/article/view/26466

Schedule

- Submission deadline:
  - 15.02.2026, discussions: 16.02 - 17.02.

  OR 23.02. -
- You should submit in TUWEL a zip file that includes:
  - Your source code
  - Slides or a PDF report describing the work in your project (including a short description of your methods, results, and comparison)



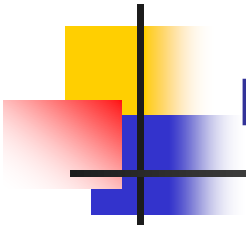
Discussion

Each member of the group should be able to:

- Answer questions about the code and the work done in the project
- Answer questions about the applied methods and be aware of other methods that exist for combinatorial optimization problems (covered in the lectures)

Grading:

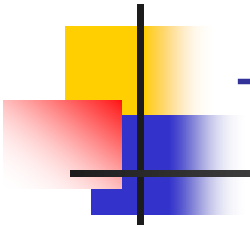
- Grading is based on the submission and the discussion
- The discussion counts as Exam 2 in this class, and you can earn 40% of the total points in this discussion/exam



Problems

Xou can select one of problems below:

- **The Social Golfer Problem or**
- **Rotating Workforce Scheduling**
- **Facility Location Problem**
- **Test Laboratory Scheduling**



The Social Golfer Problem

Problem specification is given in:

http://www.csplib.org/prob/prob010/index.html

> "The coordinator of a local golf club has come to you with the following problem. In her club, there are 32 social golfers, each of whom play golf once a week, and always in groups of 4. She would like you to come up with a schedule of play for these golfers, to last as many weeks as possible, such that no golfer plays in the same group as any other golfer on more than one occasion. "

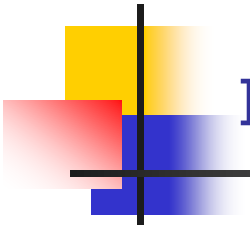
General Problem:

> Schedule m groups of n golfers over p weeks, such that no two golfers play in the same group more than once

Social Golfer Problem

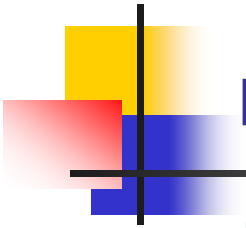
	Week 1				Week 2				Week 3				Week 4				Week 5			
Group 1	25	2	27	4	26	30	2	6	3	5	2	8	23	31	2	10	29	11	2	24
Group 2	29	6	31	8	28	32	4	8	1	7	4	6	21	29	4	12	31	9	4	22
Group 3	17	10	19	12	18	22	10	14	11	13	10	16	19	27	6	14	25	15	6	20
Group 4	21	14	23	16	20	24	12	16	9	15	12	14	17	25	8	16	27	13	8	18
Group 5	9	18	11	20	17	21	9	13	19	21	18	24	7	15	18	26	17	7	14	28
Group 6	13	22	15	24	19	23	11	15	17	23	20	22	5	13	20	28	19	5	16	26
Group 7	1	26	3	28	25	29	1	5	27	29	26	32	3	11	22	30	21	3	10	32
Group 8	5	30	7	32	27	31	3	7	25	31	28	30	1	9	24	32	23	1	12	30

	Week 6				Week 7				Week 8				Week 9				Week 10			
Group 1	7	13	2	12	32	20	2	14	15	31	2	17	9	19	2	28	1	21	2	22
Group 2	5	15	4	10	30	18	4	16	3	19	4	20	11	17	4	26	3	23	4	24
Group 3	3	9	6	16	5	11	6	12	5	21	6	22	13	23	6	32	5	17	6	18
Group 4	1	11	8	14	7	9	8	10	7	23	8	24	15	21	8	30	7	19	8	20
Group 5	23	29	18	28	19	31	13	1	9	25	10	26	1	27	10	20	9	29	10	30
Group 6	21	31	20	26	15	29	17	3	11	27	12	28	3	25	12	18	11	31	12	32
Group 7	19	25	22	32	21	27	22	28	13	29	14	30	5	31	14	24	13	25	14	26
Group 8	17	27	24	30	23	25	24	26	16	1	32	18	7	29	16	22	15	27	16	28



Instances

- Use the original problem 8-4-x (x=6…10) and other instances that you generate (e.g. 5-3-5, 5-3-6…)
- You should generate at least 100 instances



References

- Markus Triska. Solution Methods for the Social Golfer Problem, Master Thesis, Vienna University of Technology, 2008. http://www.logic.at/prolog/mst.pdf OR
  - Markus Triska, Nysret Musliu: An effective greedy heuristic for the Social Golfer Problem. Ann. Oper. Res. 194(1): 413-425 (2012) https://link.springer.com/article/10.1007/s10479-011-0866-7
  - Markus Triska, Nysret Musliu: An improved SAT formulation for the social golfer problem. Ann. Oper. Res. 194(1): 427-438 (2012) https://link.springer.com/article/10.1007/s10479-010-0702-5
- http://www.cs.brown.edu/~sello/golf.html
- C. Cotta, I. Dotú, A. J. Fernández, and P. V. Hentenryck (2006). Scheduling social golfers with memetic
- evolutionary programming. In Hybrid Metaheuristics, volume 4030 of LNCS, pages 150–161.http://www.springerlink.com/content/u4x98578w5669716/
- I. Dotú and P. V. Hentenryck (2005). Scheduling social golfers locally. In CPAIOR, volume 3524 of
- LNCS, pages 155–167. http://www.springerlink.com/content/nxc82hrhrtpajfl9/
- Harvey, W. and Winterer, T. (2005). Solving the MOLR and social golfers problems. In CP'05, volume 3709 Of LNCS, pages 286–300. http://www.springerlink.com/content/u613864820134778/

Rotating Workforce Scheduling

The schedule is cyclic

	Mo	Tu	We	Th	Fr	Sa	Su
A	D	D	D			D	D
B	D	D	D	D			
C	A	A	A	A			A
D	A	A	A	A	A		
E	D	D	A	A	A		
F	A	A	N	N	N		
G	N	N	N	N	N		
H		N	N	N	N	N	
I			D	D	D	A	A
J				D	D	N	N
K	N				A	A	N
L	N	N			D	D	D

Number of employees

Employees working shifts:

D: Day shift ; A: Afternoon shift ,

N: Night shift; Day off

Constraints

	Mo	Tu	We	Th	Fr	Sa	Su
A	D	D	D			D	D
B	D	D	D	D			
C	A	A	A	A			A
D	A	A	A	A	A		
E	D	D	A	A	A		
F	A	A	N	N	N		
G	N	N	N	N	N		
H		N	N	N	N	N	
I			D	D	D	A	A
J				D	D	N	N
K	N				A	A	N
L	N	N			D	D	D

Not allowed sequences of shifts:

N - D
N D
A D
N A
N - A
A - D

Maximum and minimum length of periods of successive shifts.

e.g.: N: 2-5, D: 2-6

Temporal requirements:

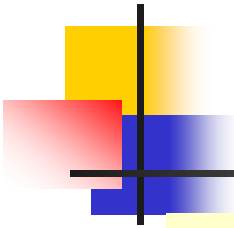
required number of employees in shift *i* during day *j*

Monday (Mo): D: 3, N: 3, A: 3

Maximum and minimum length of work days and days-off blocks

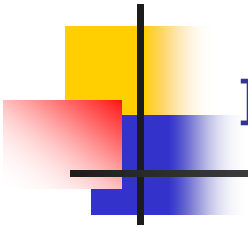
e.g.: days-off block: 2-4

work block: 2-6



Objective

Find a cyclic schedule (assignment of shifts to employees) that satisfies the temporal requirement, and all other constraints



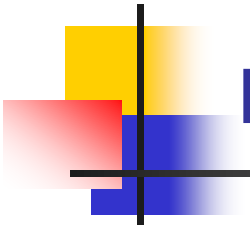
Instances/References

Instances:

- https://www.dbai.tuwien.ac.at/staff/musliu/benchmarks/

References:

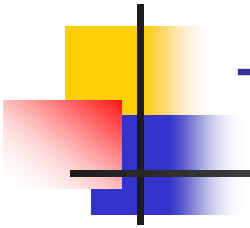
- Musliu, N., Schutt, A., Stuckey, P.J. (2018). Solver Independent Rotating Workforce Scheduling. CPAIOR 2018. https://doi.org/10.1007/978-3-319-93031-2_31
- N. Musliu. Heuristic Methods for Automatic Rotating Workforce Scheduling. https://www.dbai.tuwien.ac.at/staff/musliu/rotHeuristic.pdf
- Kletzander, L., Musliu, N. & Smith-Miles, K. Instance space analysis for a personnel scheduling problem. Ann Math Artif Intell 89, 617–637 (2021). https://doi.org/10.1007/s10472-020-09695-2



Facility Location Problem

See:

https://dl.acm.org/doi/10.1145/3712256.3726355



Test Laboratory Scheduling

https://dl.acm.org/doi/10.1145/3546871