Skoltech Schedule

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Course: Optimization methods
(Project, 2016)

Project Proposal

Motivation

Subject of one track must be held in different time

Problem

Obraining schedule for Skolkovo Institution such way that subjects from one specialization don't intersect.

Method

Greedy, Simulated annealing, ILP

Problem statement

Data

$\mathbf{d} = \{d_i\}_{i=0}^4$ — days ,$\mathbf{s} = \{s_i\}_{i=0}^{24}$ — subjects, $\mathbf{a} = \{a_i\}_{i=0}^8$ — auditoriums, $\mathbf{t} = \{t_i\}_{i=0}^6$—time slots

Demand

Building the model

$$f : \mathbf{s} \longrightarrow \mathbf{d}, \mathbf{a}, \mathbf{t}$$

$$Loss(time) + Loss(auditoriums) \longrightarrow min$$

$$s.t. : \begin{cases} x \in [0, 1] \\ constrains \end{cases}$$

Loss — loss function

- $\sum_a state[course][day][time][:] \leq 1$
- $\sum_{t,a} state[course][day][:][:] \leq 1$
- $\sum_s st[:][Tue][16-19][402]st[:][Tue][16.30-18.30][402] = 0$
-
  $\sum_s st[:][Tue][16-19][402] + st[:][Thu][16.30-18.30][402] = 0$
- $\sum_t state[biology][Wed][:][Venue] = 3$
- $\sum_{s_i,s_j} st[s_i][d][t][a] + state[s_j][d][overlap][a] \leq 1$
- $\sum_{s,a_i,a_j} st[a][d][t][a_i] + state[overlap][d][overlap][a_j] \leq 1 + overlap[a, overlap]$

- Modifided greedy algorithm
- Metropolis–Hastings algorithm(expansion of Simulated annealing)
- Gurobipy for ILP (Branch-and-bound)

Comparing methods

Define loss function L:

$$\begin{cases} -1 \longrightarrow 1000 \\ 0 \longrightarrow 100 \\ 1 \longrightarrow 1 \\ 2 \longrightarrow 0 \end{cases}$$

T — solving time in seconds
Preferences: time, auditoriums

	Greedy	Annealing	ILP
Loss function	6	7	2
T,[seconds]	10.31	5.28	0.82
Prefer.='-1'	0, 0	0, 0	0, 0
Prefer.= '0'	0, 0	0, 0	0, 0
Prefer.= '1'	time-4,audit.-2	time-7,audit.-0	time-2,audit.-0

	9.00 -12.00	12.30 - 15.30	16.00 - 19.00	9.00 - 11.00	11.30 - 13.30	14.00 - 16.00	16. 30 - 18.30
402	Energy Systems (Physics) & Technology 402		Methods for Enhanced Oil Recovery 402				
403	Robotics 403	Structural Analysis and Design 403					
404				Functional Genomics 404	Mathematical Modeling in Biology 404		
407	History and Philosophy of Science 407	Optimization Methods 407	Ideas to Impact / Technology Commercialization 407			Bioinformatics Lab Course 407	
408	Material Structure Characterization Methods 408						
423							
422							
Space CREI Lab							
Venue: Institute of Gene Biology							

Рис.: on Monday

	9.00 -12.00	12.30 - 15.30	16.00 - 19.00	9.00 - 11.00	11.30 - 13.30	14.00 - 16.00	16. 30 - 18.30
402	Material Structure Characterization Methods 402		Energy Colloquium 402 (16-17)				
403	Photonics Review 403	Robotics 403					
404	Computational Chemistry and Materials Modelling 404	Introduction to Solid State Physics 404					
407	Pedagogy of Higher Education 407	Numerical Linear Algebra 407	Ideas to Impact / Technology Commercialization 407				
408	Optimization Methods 408						
423							
422							
Space CREI Lab							
Venue: Institute of Gene Biology							

Рис.: on Tuesday

	9.00 -12.00	12.30 - 15.30	16.00 - 19.00	9.00 - 11.00	11.30 - 13.30	14.00 - 16.00	16. 30 - 18.30
402	Computational Chemistry and Materials Modelling 402						
403	Material Structure Characterization Methods 403		Methods for Enhanced Oil Recovery 403				
404		Introduction to Solid State Physics 404					
407		Numerical Linear Algebra 407	Selected Topics in Energy: 407				
408							
423							
422							
Space CREI Lab	Spacecraft and Mission Design Space CREI Lab						
Venue: Institute of Gene Biology	Basic Molecular Biology Techniques+Seminar Venue: Institute of Gene Biology	Basic Molecular Biology Techniques+Seminar Venue: Institute of Gene Biology	Basic Molecular Biology Techniques+Seminar Venue: Institute of Gene Biology				

Рис.: on Wednesday

Best Schedule

	9.00 -12.00	12.30 - 15.30	16.00 - 19.00	9.00 - 11.00	11.30 - 13.30	14.00 - 16.00	16. 30 - 18.30
402	History and Philosophy of Science 402		Skoltech Colloquium 402 (16-17)				
403	Energy Systems (Physics) & Technology 403		Convex Optimization for Data Science 403				
404		Photonics Review 404	Petrophysics and Reservoir Engineering 404	Imaging in Biology 404			
407	Structural Analysis and Design 407	Ideas to Impact / Technology Commercialization 407					
408		Numerical Linear Algebra 408					
423							
422	Advanced Solid State Physics 422						
Space CREI Lab	Spacecraft and Mission Design Space CREI Lab						
Venue: Institute of Gene Biology							

Рис.: on Thursday

	9.00 -12.00	12.30 - 15.30	16.00 - 19.00	9.00 - 11.00	11.30 - 13.30	14.00 - 16.00	16. 30 - 18.30
402	Photonics Review 402	Robotics 402					
403	Computational Chemistry and Materials Modelling 403	Advanced Solid State Physics 403					
404	Pedagogy of Higher Education 404	Introduction to Solid State Physics 404				Mathematical Modeling in Biology 404	
407	Energy Systems (Physics) & Technology 407	Optimization Methods 407					Imaging in Biology 407
408			History and Philosophy of Science 408	Bioinformatics Lab Course 408	Functional Genomics 408		
423							
422							
Space CREI Lab			Spacecraft and Mission Design Space CREI Lab				
Venue: Institute of Gene Biology							

Рис.: on Friday

Conclusion

We learned:

- chose methods for solving the problem, compared
- handle big data and apply methods (sometimes with modification)
- share work
- work in teams and help each other

Our results:

- distributed objects on suitable auditoriums and suitable time slots, considering all having constraint
- the best schedule maximize all subject's preferences except Ideas to Impact and Optimization Methods