

# PA163 Constraint Programming 2024

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# Base information

**Course website:** interactive syllabus at IS MU

- <https://is.muni.cz/auth/el/fi/podzim2024/PA163/index.qwarp>
- slides and lecture videos added during semester

**Two sample exams from the last years**

**Materials in Czech**

- lecture slides from the past years
- homework examples with solutions

**Final exam and homeworks:** language

- can be written in Czech/Slovak (English terminology must be used)

# Evaluation

**Final exam:** 80 points

- 40 points at least
- theoretical part: 55 points  
overview questions, examples, comparisons, terminology, algorithms
- programming part on computers: 25 points  
Optimization Programming Language

**2 homeworks:** 20 points

- 8 points at least
- one homework for up to 10 points

**Bonus points:** up to 1 points per lecture

- for active participation in the lecture  
responding questions, discussions including asking the questions

**Total:** A 90 and more, B 80-89, C 70-79, D 60-69, E 55-59

- Dechter, R. [Constraint processing](#). Morgan Kaufmann Publishers, 2003. <http://www.ics.uci.edu/~dechter/books/>
- [Handbook of Constraint Programming](#), Elsevier, 2006
- Barták, R. [On-line guide to constraint programming](#).  
<http://ktilinux.ms.mff.cuni.cz/~bartak/constraints/>
- Barták, R. [Contstraint programming](#), course at MFF UK, Prague (both in English and Czech).  
<http://kti.ms.mff.cuni.cz/~bartak/podminky/index.html>
- [Constraint Programming online](#) (community web)  
<http://www.cp-online.org/>
- Additional Internet resource available from the course website

# Outline of lectures

- Introduction
- Arc and path consistency
- Propagation for non-binary constraints
- Global constraints
- Directional consistency, graph width
- Look-ahead algorithms, branch & bound
- Look-back algorithms
- Scheduling: propagation and search
- Incomplete search
- Local search

## Seminars are obligatory

- One absence acceptable
- Absence at two seminars: additional homeworks
- Missed half (three) of the seminars: not possible

## Goals

- Getting programming practice with the constraint programming

## Contents

- Introduction to the Optimization Programming Language (OPL)
- Global constraints
- Modeling
- Scheduling
- Search

# Software: IBM ILOG CPLEX Optimization Studio

## Download at IS MU Study Materials

- MS Windows, Linux, MacOS
- no-cost academic edition
- free version not recommended

## Software availability at FI MU

- computer hall, aisa
- Windows, Linux and MacOS

## Optimization Programming Language (OPL)

- a natural mathematical description of optimization models
- high-level syntax with simpler and shorter code
- for mathematical programming and constraint programming
- <https://www.ibm.com/analytics/optimization-modeling>

# Optimization Programming Language (OPL)

Volsay produces the compounds  $\text{NH}_3$  (ammonia) and  $\text{NH}_4\text{Cl}$  (ammonium chloride). Volsay has 50 units of nitrogen (N), 180 units of hydrogen (H) and 40 units of chlorine (Cl).

Volsay makes a profit of 40 Eur per unit of  $\text{NH}_3$ , and 50 Eur per unit of  $\text{NH}_4\text{Cl}$  sold. How does Volsay maximize profit based on inventory?

using CP;

```
dvar int+ nh3;  
dvar int+ nh4cl;  
maximize  
    40 * nh3 + 50 * nh4cl  
subject to {  
    nh3 + nh4cl <= 50;  
    3 * nh3 + 4 * nh4cl <= 180;  
    nh4cl <= 40;  
};
```