

TD #1

Advanced Mathematical Programming

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Software

Modelling

Implementation

Section 1

Software

Structured and flat formulations

- ▶ Mathematical Programs (MP) describing *problems* involve sets and parameters
e.g. $\min\{c^\top x \mid Ax \geq b\}$
- ▶ For each set of values assigned to the parameters, MP describes a different *instance*
e.g. $\min\{x_1 + 2x_2 \mid x_1 + x_2 \geq 1\}$

Structured and flat formulations

- ▶ Mathematical Programs (MP) describing *problems* involve sets and parameters
e.g. $\min\{c^T x \mid Ax \geq b\}$
- ▶ For each set of values assigned to the parameters, MP describes a different *instance*
e.g. $\min\{x_1 + 2x_2 \mid x_1 + x_2 \geq 1\}$
- ▶ Humans reason in terms of problems (*structured formulations*)
- ▶ **Solvers provide solutions for instances** (*flat formulations*)
- ▶ Need a translation from problems to instances: modelling languages
(e.g. AMPL, Python+PyOMO, Matlab+YALMIP, Julia+JuMP, ...)

AMPL vs. Python

- ▶ AMPL
 - ▶ wonderful syntax close to mathematics
 - ▶ interfaces with lots of solvers, including MINLP (but little **SDP**)
 - ▶ imperative sub-language: poor (no function calls, no libraries)
 - ▶ good for rapid prototyping or “just use the solver”
- ▶ Python
 - ▶ mixture of declarative (PyOMO) and imperative (Python)
 - ▶ interfaces with many solvers, including SDP (but little MINLP)
 - ▶ excellent imperative sub-language (Python itself)
 - ▶ good for “doing further stuff with the solution”

Installing AMPL

- ▶ Windows (64bit)

1. make directory C:\ampl
2. copy `ampl_mswin64.zip` inside C:\ampl and unzip it
3. insert C:\ampl in the PATH environment variable
*System Properties dialog/Advanced tab/Environment Variables
button/Path field/Edit button/add C:\ampl to the string,
separated by semicolons*

- ▶ MacOS X: open terminal, and type

```
cd ; mkdir ampl ; cd ampl
unzip ~/Downloads/ampl_macosx64.zip
cd ; echo "export PATH=$PATH:~/ampl" >> ~/.bash_profile
source ~/.bash_profile
```

- ▶ Linux (64bit): as for MacOS X

but replace `ampl_macosx64.zip` by `ampl_linux-intel64.zip`

Testing AMPL

1. open a command prompt / terminal window
2. Save the following to `test.run`

```
set M := 1..50;  
set N := 1..10;  
param c{N} default Uniform01();  
param A{M,N} default Uniform(0,1);  
param b{M} default Uniform(1,2);  
var x{N} >= 0;  
minimize f: sum{j in N} c[j]*x[j];  
subject to C{i in M}:  
    sum{j in N} A[i,j]*x[j] >= b[i];  
option solver cplex;  
solve;  
display x,f,solve_result;
```

3. type `ampl < test.run`
4. optimal objective function value is $f = 1.34199$