Model Deployment in GAMS

GAMS Jupyter / GAMS MIRO

Agenda

1. Motivation
2. GAMS Jupyter
3. GAMS MIRO
    1. Overview
    2. Hands-on
    3. How-to
    4. Scenario runs and sensitivity analysis
    5. Summary

Motivation

Motivation

- AMLs are powerful tools for developing solver-independent optimization models

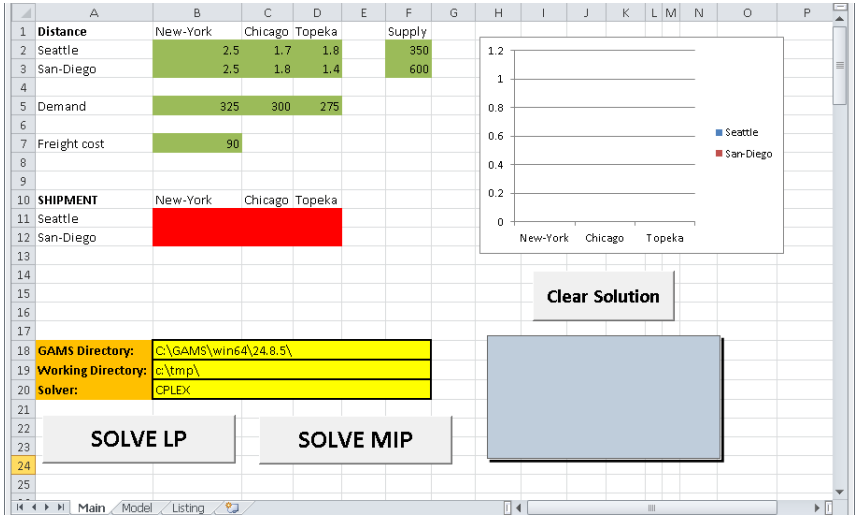
- Intuitive deployment and visualization are becoming increasingly important
  - → End-users of optimization software are very often not modeling experts
  - → Need for easy-to-use tool to visualize data and compare results

- Current deployment possibilities are not satisfactory for everyone

Deployment of GAMS models
current possibilities

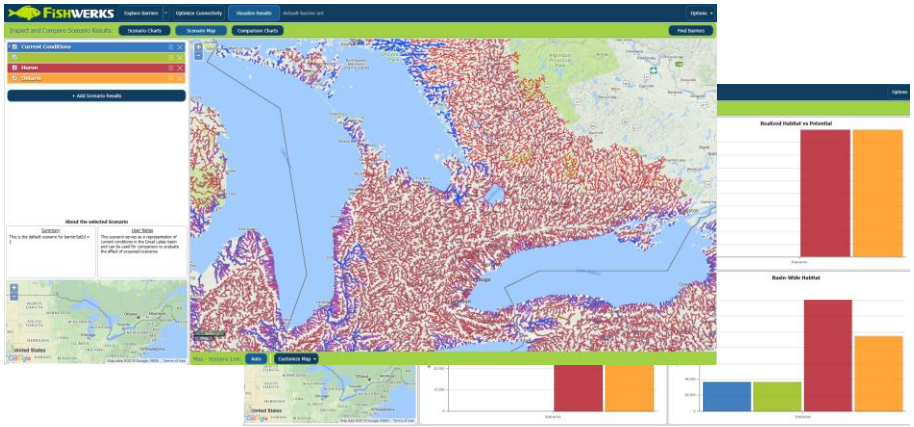
Expert level APIs

- GDX, OPT, GAMSX, GMO, …
- High performance and flexibility
- Automatically generated imperative APIs for several languages (C, C++, C#, Delphi, Java, Python, VBA, …)



Object Oriented APIs

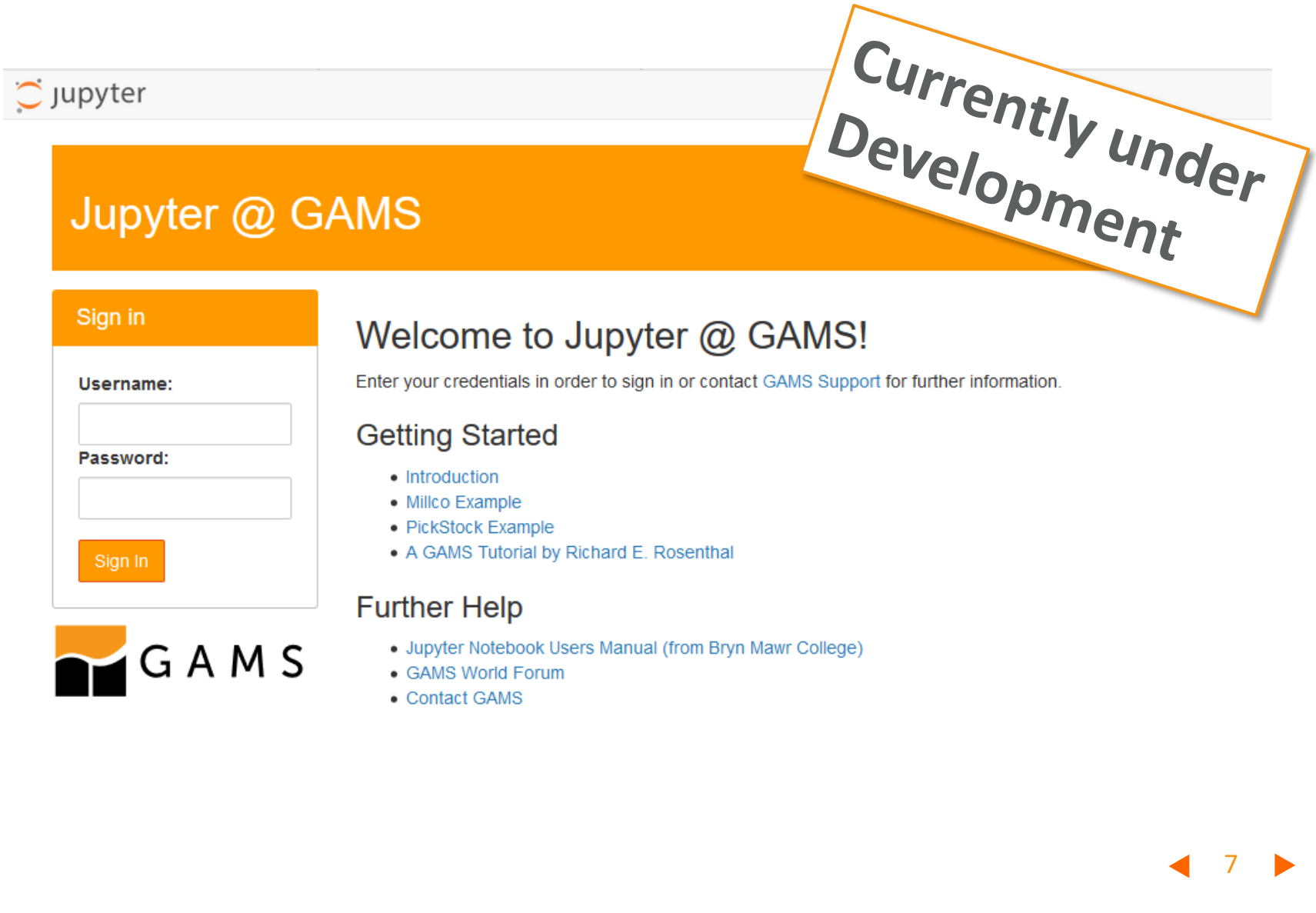
- GAMS comes with several OO APIs (Python, Java, C++, C#, …) to develop applications



→ Programming required to build your applications

GAMS Jupyter

Welcome to Jupyter @ GAMS!



GAMS Jupyter Example

jupyter nbviewer

JUPYTER FAQ

In [17]:
```
%%gams
Parameter fund(date) 'Index fund report parameter'; fund(d) = sum(s, price(d, s)*w.l(s));
Parameter error(date) 'Absolute error'; error(d) = abs(index(d)-fund(d));
```

Plotting of the results

In [18]:
```
%gams_pull -d fund error
fig, ax = plt.subplots()
index.plot(y="value", ax=ax, xticks=[0, trainingDays, len(date)], yticks=[], label="Dow Jones")
fund.plot(y="value", ax=ax, xticks=[0, trainingDays, len(date)], yticks=[], label="Index Fund")
```

Using GAMS Jupyter Notebooks to tell "optimization stories"

- Runs in a browser / on a server
  → No local installation needed
- Allows to use notebook technology in combination with GAMS
- Notebooks allow to combine GAMS and Python
  - GAMS works great with well structured data and optimization models
  - Python is very rich in features to retrieve, manipulate, and visualize data that comes in all sort of ways
  - ➔ Combining GAMS and Python in a notebook it is relatively easy to tell an optimization story with text, data, graphs, math, and models

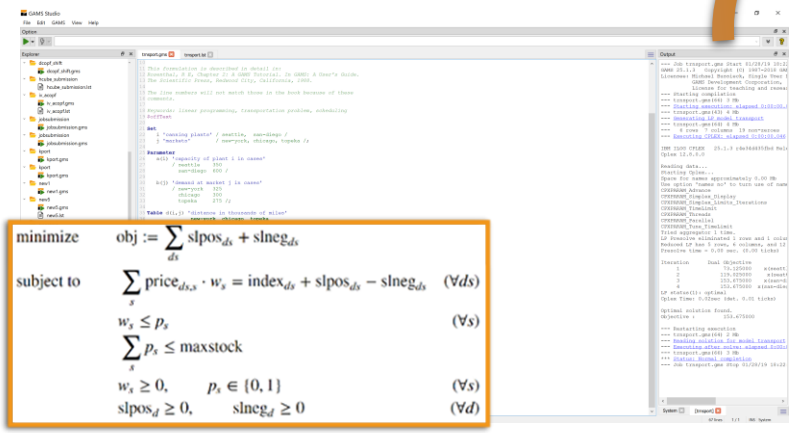
- This "product" is currently under development.
  Give it a try at https://jupyterhub.gams.com/hub/login

GAMS MIRO

Overview

Click to deploy

Develop GAMS model



$$\text{minimize} \quad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

$$\text{subject to} \quad \sum_{s} \text{price}_{ds,s} \cdot w_s = \text{index}_{ds} + \text{slpos}_{ds} - \text{slneg}_{ds} \quad (\forall ds)$$

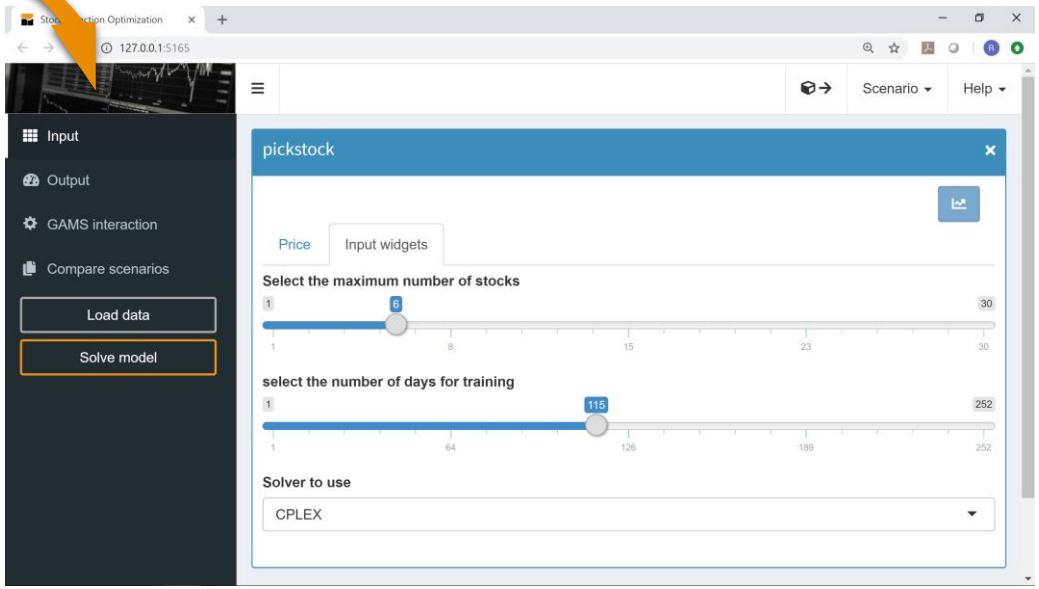
$$w_s \le p_s \quad (\forall s)$$

$$\sum_{s} p_s \le \text{maxstock}$$

$$w_s \ge 0, \qquad p_s \in \{0,1\} \quad (\forall s)$$

$$\text{slpos}_d \ge 0, \qquad \text{slneg}_d \ge 0 \quad (\forall d)$$

Web browser

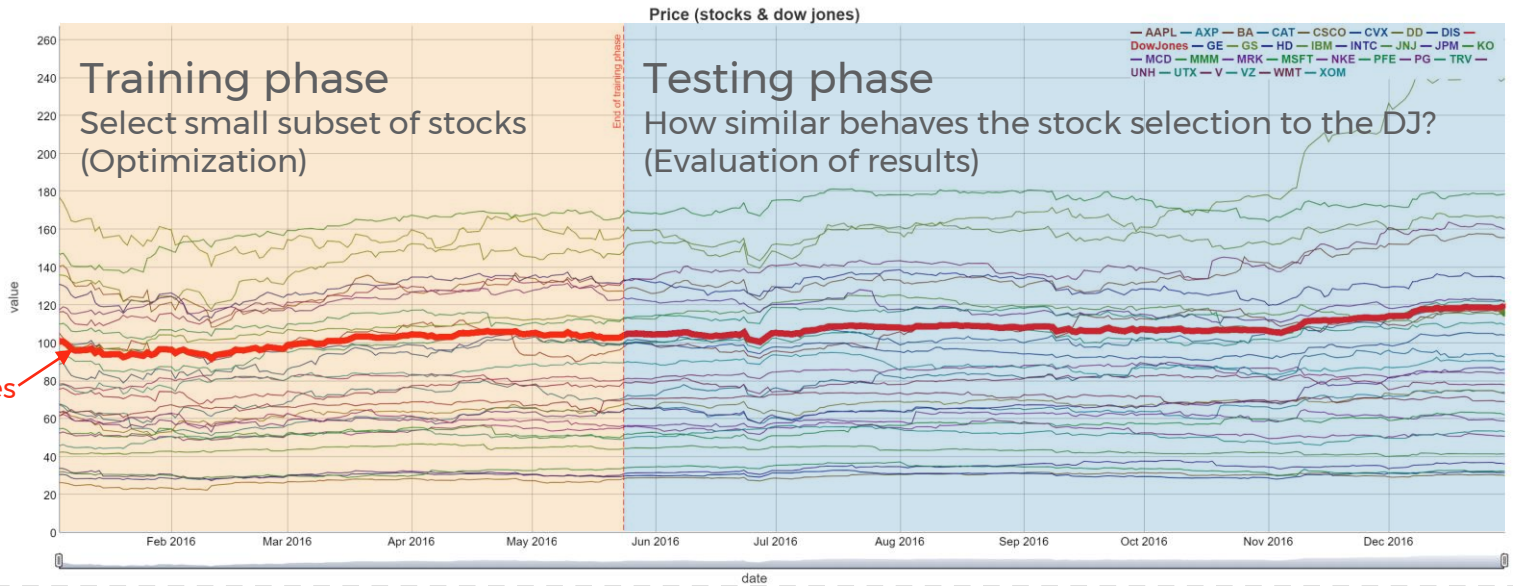


- ✓ Web interface for GAMS models
- ✓ Usage via web browser

Hands-on

Model: Pickstock

Model: *Pickstock*



- **Data**: Performance of all shares of the Dow Jones index over a period of 1 year
- **Goal**: Find a small selection of stocks that follows the Dow Jones as closely as possible
- **Optimization model**: Select a subset (≤ `maxstock`) of Dow Jones stocks, along with weights, so that this portfolio behaves similarly to the overall index (in the training phase)

$$\text{minimize} \quad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

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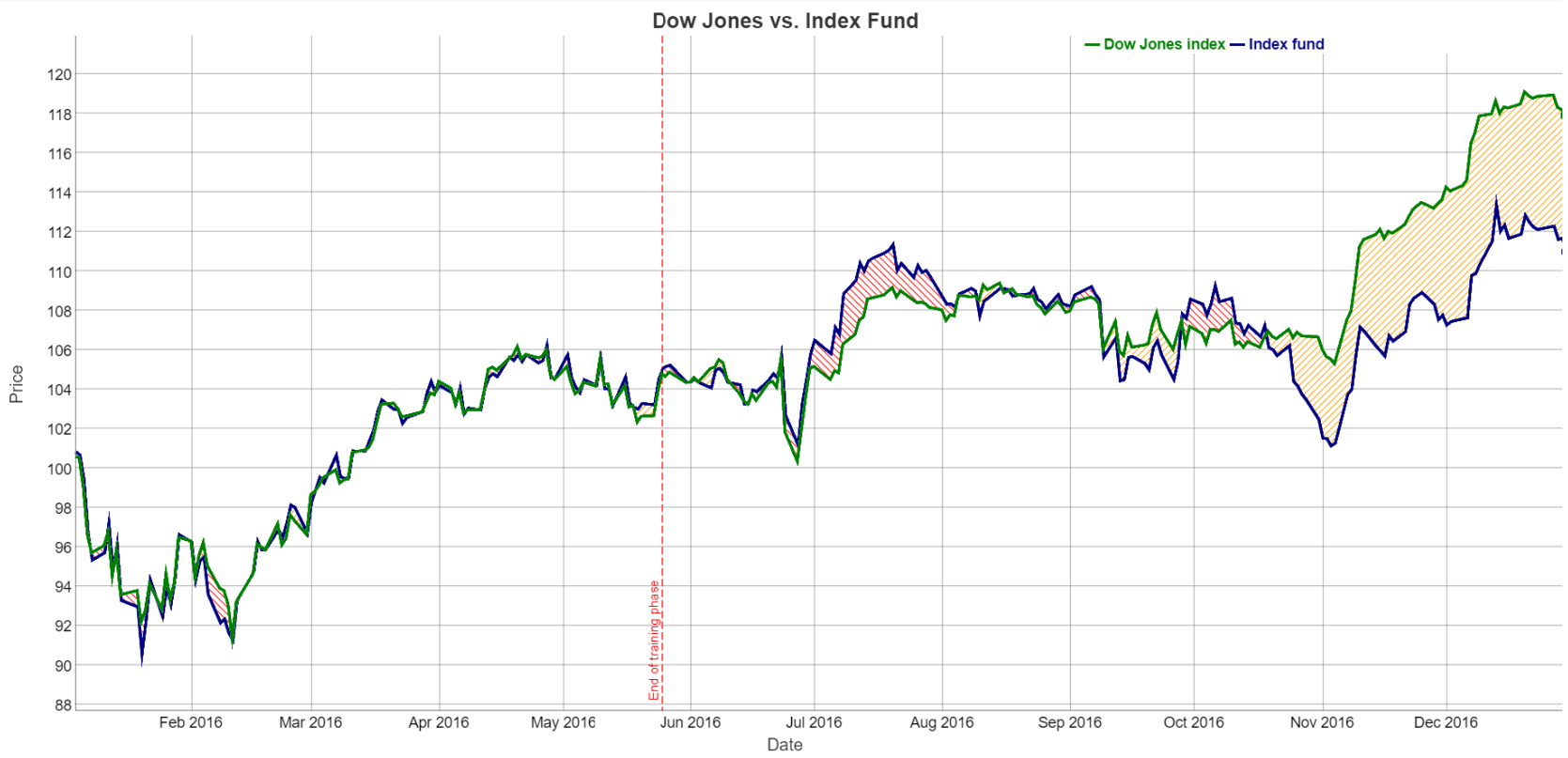
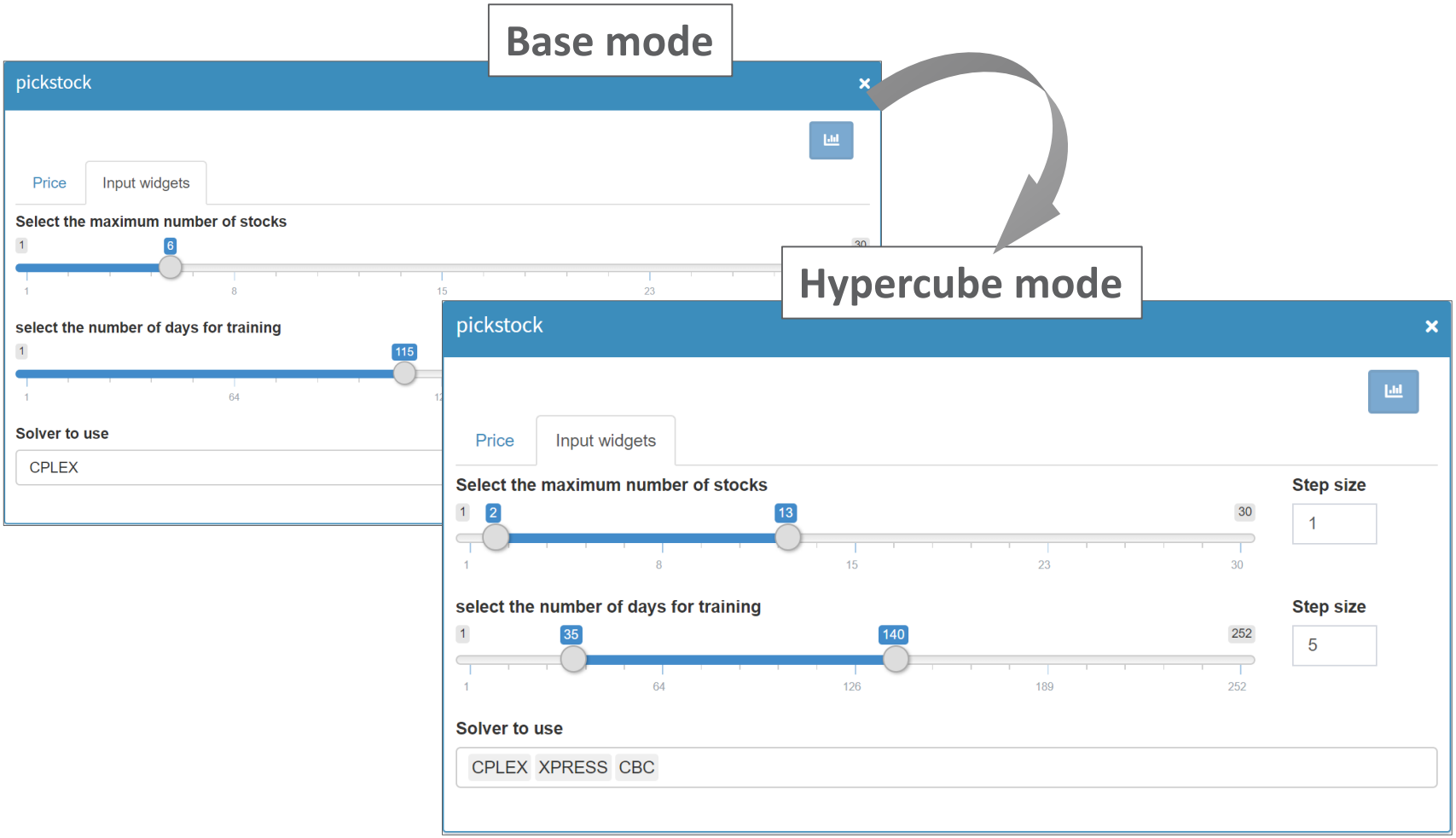


$$\text{minimize} \qquad \text{obj} := \sum_{ds} \text{slpos}_{ds} + \text{slneg}_{ds}$$

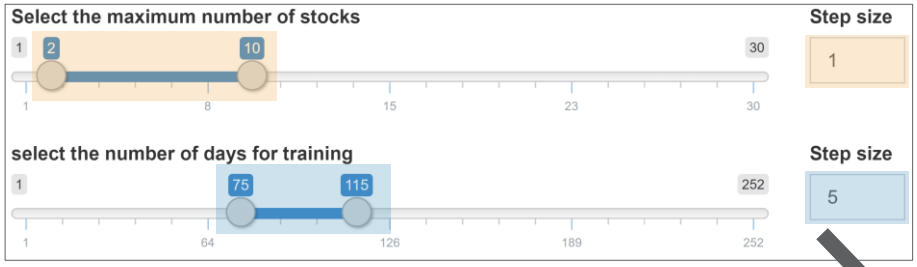
Scenario runs and sensitivity analysis

The GAMS MIRO Hypercube mode

Hypercube mode
scenario generation



Hypercube mode
scenario generation



+1

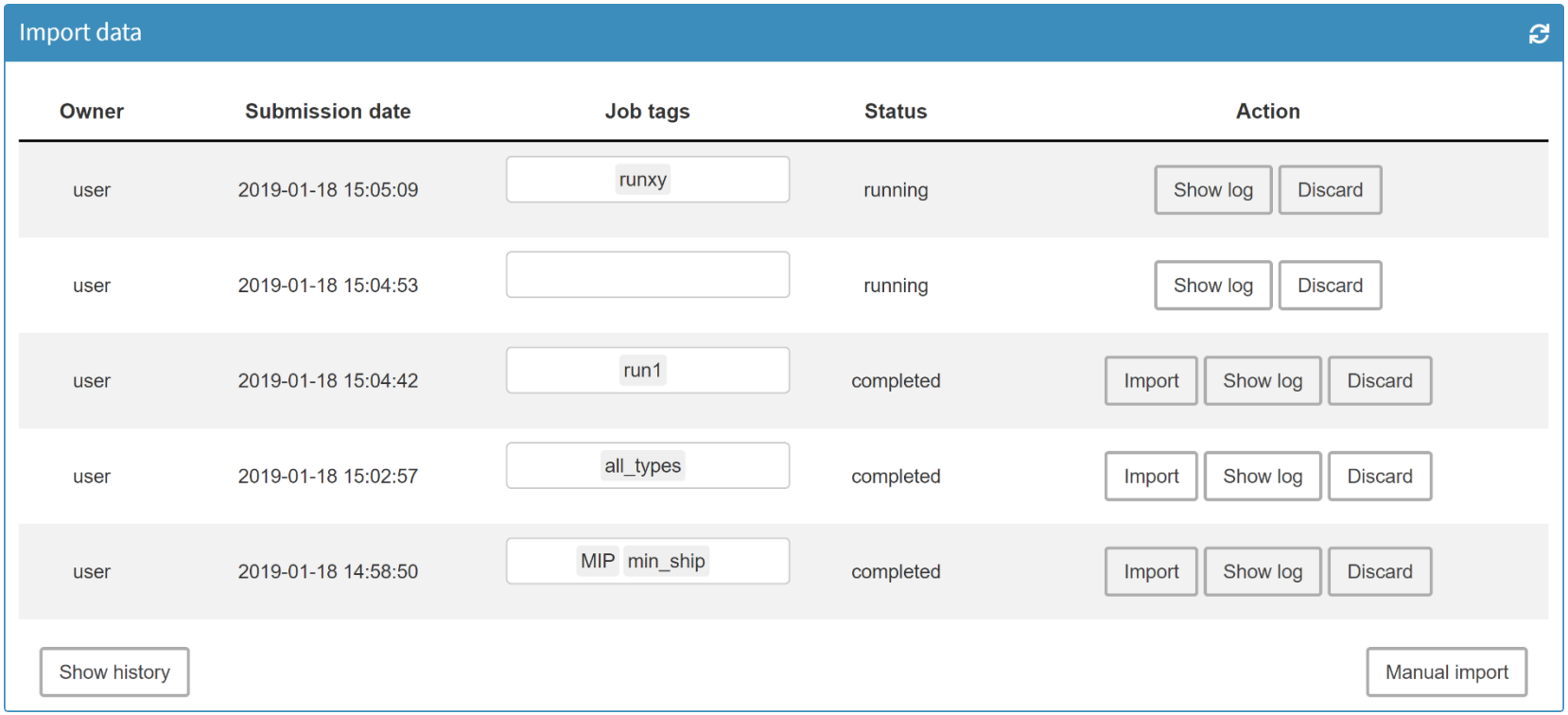
+5

	2	3	4	5	6	7	8	9	10
75	1	2	3	4	5	6	7	8	9
80	10	11		13	14	15	16	17	18
85	19	20					25	26	27
90	28	2						5	36
95	37							4	45
100	46							53	54
105	55	56	57					62	63
110	64	65	66	67	68	69		71	72
115	73	74	75	76	77	78	79	80	81

Number of scenarios
=
Cartesian product of scalar input combinations

Hypercube mode

Data import & monitoring of scenario runs



Hypercube mode

Scenario management

Load scenarios

Time created | between | 2019-02-01 | to | 2019-02-21 | -

Job tags | is | superman | -

AND

Time created | between | 2019-02-22 | to | 2019-03-04 | -

Job tags | is | wonder woman | -

-

AND

OR

Fetch results

Show 10 entries

Search:

Owner	Time created	Job tags	maximum number of stocks to select	MIP-Solver	number of days for training	Ratio between error test and error train	Absolute error in entire testing phase	Absolute error in entire training phase	last date of training period
user	2/15/2019, 2:53:55 PM	superman	8	CPLEX	99	13.7001401311091	170.448122203935	12.4413415171496	2016-05-24
user	2/15/2019, 2:53:55 PM	superman	3	CPLEX	99	5.13673004574033	229.061239845358	44.592812510229	2016-05-24
user	2/15/2019, 2:53:55 PM	superman	24	CPLEX	99	19.3422042295776	15.0432531197135	0.777742440373459	2016-05-24
All	All	All	All	All	All	All	All	All	

Showing 1 to 10 of 220 entries

Previous 1 2 3 4 5 … 22 Next

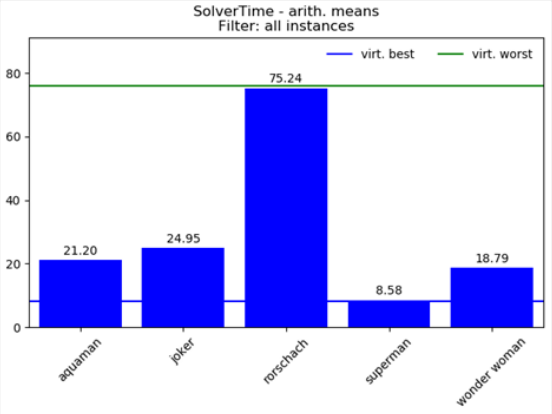
Choose selected scenarios | Choose current page | Choose all

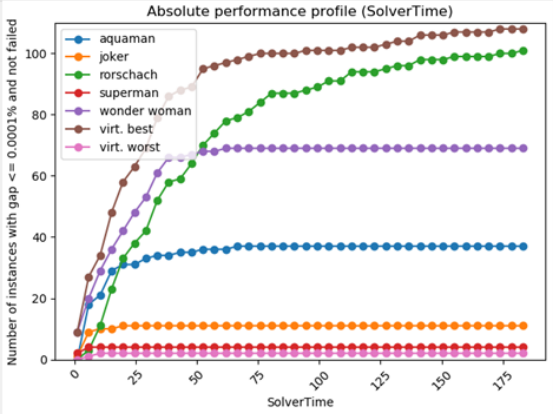
Show hash

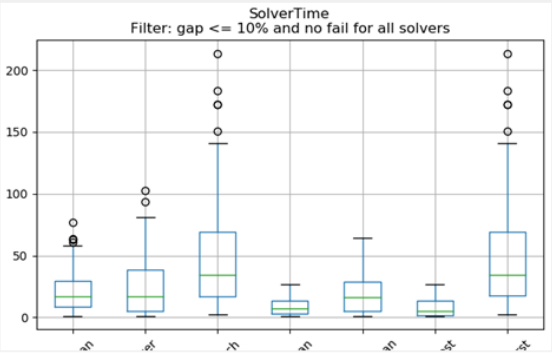
Hypercube mode
Analysis

Analyze Scenarios

Index | stat_Status | stat_Efficiency | stat_SolutionQuality | solvedata | documentation



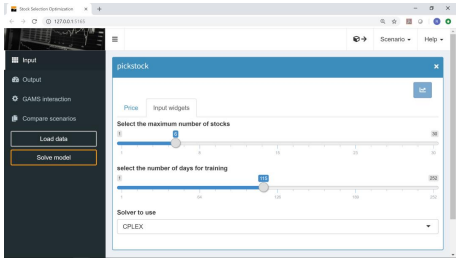




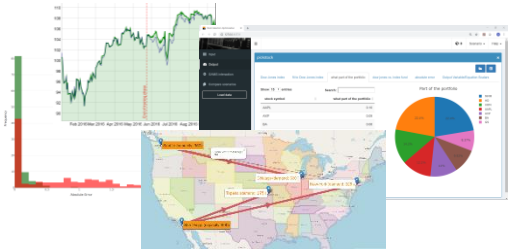
Summary

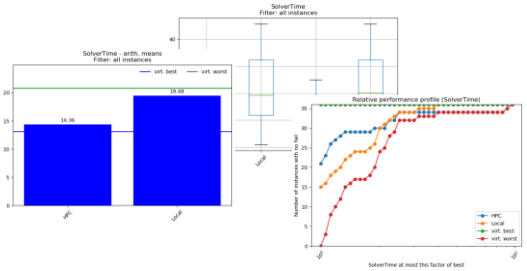
Key points

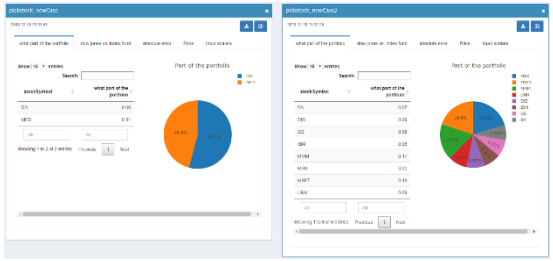
Summary
Key points



- Quick & automated deployment of GAMS models
- Data visualization with powerful charts / graphics
- Generation, processing and evaluation of scenario data
- Generation of performance statistics and sensitivity analyses
- Data export for external GAMS jobs and analyses
- Intuitive and structured work without GAMS knowledge
- Easy and convenient data management



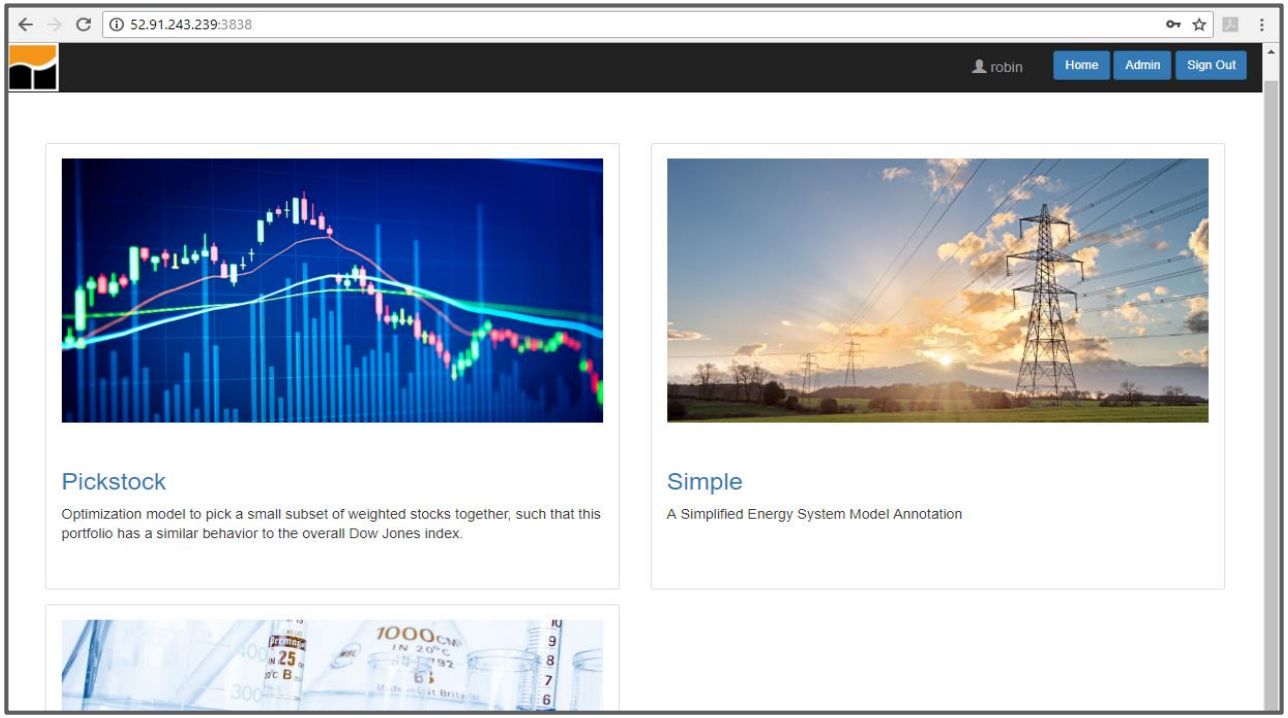




GAMS MIRO on a server

Based on docker technology

- Multi-user management
- Authentication: LDAP, OAuth 2.0, Google, GitHub, Facebook, …
- Multi-application support
- Load balancing
- Rolling updates



Conclusion

- Commercially supported GAMS product
- Currently a BETA version
- Installer for Windows, MacOS, Linux
- Used in commercial projects
- Already quite extensive documentation
- Configuration Generator

For more information visit:
www.gams.com/miro

Watch our YouTube video:
https://youtu.be/7pUrZ-u9ZcQ