
AMPL in the Cloud

Using Online Services to Develop and Deploy Optimization Applications through Algebraic Modeling

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Technology Tutorials — Monday, 2:10-3:00 pm

The Optimization Modeling Cycle

Steps

- Communicate with problem owner
- Build model
- Prepare data
- Generate optimization problem
- Submit problem to solver
 - * Gurobi, Knitro, CPLEX, Xpress, CONOPT, MINOS, . . .
- Report & analyze results
- *Repeat until you get it right!*

Goals for optimization software

- Do this quickly and reliably
- Get results before client loses interest
- Deploy for application

Optimization Modeling Languages

Two forms of an optimization problem

- Modeler's form
 - * Mathematical description, easy for people to work with
- Solver's form
 - * Explicit data structure, easy for solvers to compute with

Idea of a modeling language

- **A computer-readable modeler's form**
 - * You write optimization problems in a modeling language
 - * Computers translate to algorithm's form for solution

Advantages of a modeling language

- Faster modeling cycles
- More reliable modeling
- More maintainable applications

Algebraic Modeling Languages

Formulation concept

- Define data in terms of sets & parameters
 - * Analogous to database keys & records
- Define decision variables
- Minimize or maximize a function of decision variables
- Subject to equations or inequalities that constrain the values of the variables

Advantages

- Familiar
- Powerful
- Proven



Features

- Algebraic modeling language
- Built specially for optimization
- Designed to support many solvers

Design goals

- Powerful, general expressions
- Natural, easy-to-learn modeling principles
- Efficient processing that scales well with problem size

3 ways to use . . .

3 Ways to Use AMPL

Command language

- Browse results & debug model interactively
- Make changes and re-run

Scripting language

- Bring the programmer to the modeling language

Programming interface (API)

- Bring the modeling language to the programmer

Example: Roll Cutting

Motivation

- Fill orders for rolls of various widths
 - * by cutting raw rolls of one (large) fixed width
 - * using a variety of cutting patterns

Optimization model

- Decision variables
 - * number of raw rolls to cut according to each pattern
- Objective
 - * minimize number of raw rolls used
- Constraints
 - * meet demands for each ordered width

Roll cutting

Mathematical Formulation

Given

W set of ordered widths

n number of patterns considered

and

a_{ij} occurrences of width i in pattern j ,
for each $i \in W$ and $j = 1, \dots, n$

b_i orders for width i , for each $i \in W$

Roll cutting

Mathematical Formulation (*cont'd*)

Determine

X_j number of rolls to cut using pattern j ,
for each $j = 1, \dots, n$

to minimize

$$\sum_{j=1}^n X_j$$

total number of rolls cut

subject to

$$\sum_{j=1}^n a_{ij} X_j \geq b_i, \text{ for all } i \in W$$

number of rolls of width i cut
must be at least the number ordered

AMPL Formulation

Symbolic model

```
set WIDTHS;
param orders {WIDTHS} > 0;
param nPAT integer >= 0;
param nbr {WIDTHS,1..nPAT} integer >= 0;

var Cut {1..nPAT} integer >= 0;

minimize Number:
    sum {j in 1..nPAT} Cut[j];

subj to Fulfill {i in WIDTHS}:
    sum {j in 1..nPAT} nbr[i,j] * Cut[j] >= orders[i];
```

$$\sum_{j=1}^n a_{ij} X_j \geq b_i$$

Roll Cutting

AMPL Formulation (*cont'd*)

Explicit data (independent of model)

```
param: WIDTHS: orders :=  
       6.77      10  
       7.56      40  
      17.46     33  
      18.76     10 ;  
  
param nPAT := 9 ;  
  
param nbr:  1   2   3   4   5   6   7   8   9 :=  
      6.77    0   1   1   0   3   2   0   1   4  
      7.56    1   0   2   1   1   4   6   5   2  
     17.46    0   1   0   2   1   0   1   1   1  
     18.76    3   2   2   1   1   1   0   0   0 ;
```

Command Language

Model + data = problem instance to be solved

```
ampl: model cut.mod;
ampl: data cut.dat;
ampl: option solver cplex;
ampl: solve;
CPLEX 12.7.0.0: optimal integer solution; objective 20
3 MIP simplex iterations
ampl: option omit_zero_rows 1;
ampl: option display_1col 0;
ampl: display Cut;
4 13    7 4    9 3
```

Command Language (*cont'd*)

Solver choice independent of model and data

```
ampl: model cut.mod;
ampl: data cut.dat;
ampl: option solver gurobi;
ampl: solve;
Gurobi 7.0.0: optimal solution; objective 20
3 simplex iterations
ampl: option omit_zero_rows 1;
ampl: option display_1col 0;
ampl: display Cut;
4 13    7 4    9 3
```

Command Language (*cont'd*)

Solver choice independent of model and data

```
ampl: model cut.mod;
ampl: data cut.dat;
ampl: option solver gurobi;
ampl: solve;

Xpress 29.01: Best integer solution found 20
3 integer solutions have been found; 1 branch and bound node

ampl: option omit_zero_rows 1;
ampl: option display_1col 0;
ampl: display Cut;
4 13    7 4    9 3
```

Command Language (*cont'd*)

Results available for browsing

```
ampl: display {j in 1..nPAT, i in WIDTHS: Cut[j] > 0} nbr[i,j];  
:  
       4   7   9  :=                                     # patterns used  
6.77   0   0   4  
7.56   1   6   2  
17.46  2   1   1  
18.76  1   0   0  
  
ampl: display {j in 1..nPAT} sum {i in WIDTHS} i * nbr[i,j];  
1 63.84   3 59.41   5 64.09   7 62.82   9 59.66      # pattern  
2 61.75   4 61.24   6 62.54   8 62.0                  # total widths  
  
ampl: display Fulfill.slack;  
       6.77  2                                         # overruns  
       7.56  3  
      17.46  0  
      18.76  3
```

IDE for Command Language

The screenshot shows the AMPL IDE interface. On the left is a file explorer window titled "Current Directory" showing files in the directory C:\Users\Robert\Desktop\FILES\T1. The central area contains a "Console" window displaying the output of an AMPL session. The right side features two code editors: one for "cut.mod" and one for "cut.dat".

Console Output:

```
AMPL
ampl: model cut.mod;
ampl: data cut.dat;
ampl: option solver gurobi;
ampl: solve;
Gurobi 6.0.4: optimal solution; objective 20
3 simplex iterations
ampl: option omit_zero_rows 1;
ampl: option display_1col 0;
ampl: option display_transpose 100;
ampl: display Cut;
Cut [*] :=
4 13    7 4    9 3
;

ampl: display {j in 1..nPAT, i in WIDTHS: Cut[j] > 0} nbr[i,j];
nbr[i,j] [*,*] (tr)
:      4    7    9    :=
6.77  0    0    4
7.56  1    6    2
17.46 2    1    1
18.76 1    0    0
;

ampl: |
```

cut.mod Content:

```
set WIDTHS;
param orders {WIDTHS} > 0;

param nPAT integer >= 0;
param nbr {WIDTHS,1..nPAT} integer >= 0;

var Cut {1..nPAT} integer >= 0;

minimize Number:
  sum {j in 1..nPAT} Cut[j];

subj to Fulfill {i in WIDTHS}:
  sum {j in 1..nPAT} nbr[i,j] * Cut[j] >= orders[i];
```

cut.dat Content:

```
param: WIDTHS: orders :=
       6.77    10
       7.56    40
      17.46    33
      18.76    10 ;

param nPAT := 9 ;

param nbr: 1 2 3 4 5 6 7 8 9 :=
       6.77  0 1 1 0 3 2 0 1 4
       7.56  1 0 2 1 4 6 5 2
      17.46  0 1 0 2 1 0 1 1 1
      18.76  3 2 2 1 1 0 0 0 0 ;
```

Computing in the Cloud

Client side

- Local computing device owned by the user
 - * Company, organization, university, individual
- Client application run by the user on the local device

Server side

- Remote computing facility owned by a provider
 - * Company, organization, university
- Service running automatically at the remote facility

AMPL

Optimization in the Cloud

Optimization on demand

- NEOS Server

Optimization by subscription

- Gurobi Instant Cloud

Building optimization apps

- QuanDec

. . . more AMPL alternatives on the way!

NEOS Server www.neos-server.org

Network Enabled Optimization System

- Originated 1995 at Argonne National Laboratory
 - * U.S. Department of Energy
- Since 2011 at Wisconsin Institutes for Discovery
 - * University of Wisconsin, Madison

Free “optimization on demand”

- Over 40 solvers
- Several optimization modeling languages

Architecture

Distributed workstations

- Offer varied inputs & solvers
- Process submissions on demand
- Contributed by varied organizations

Central scheduler

- Receives and queues submissions
- Sends submissions to appropriate workstations
- Returns results

Minimal hands-on management

- *Distributed*: Install NEOS software on workstations
- *Central*: Update server database
of workstation locations and abilities

Original Facilities

Local submission clients

- Email
- Website
- NEOS submission tool

Problem description formats

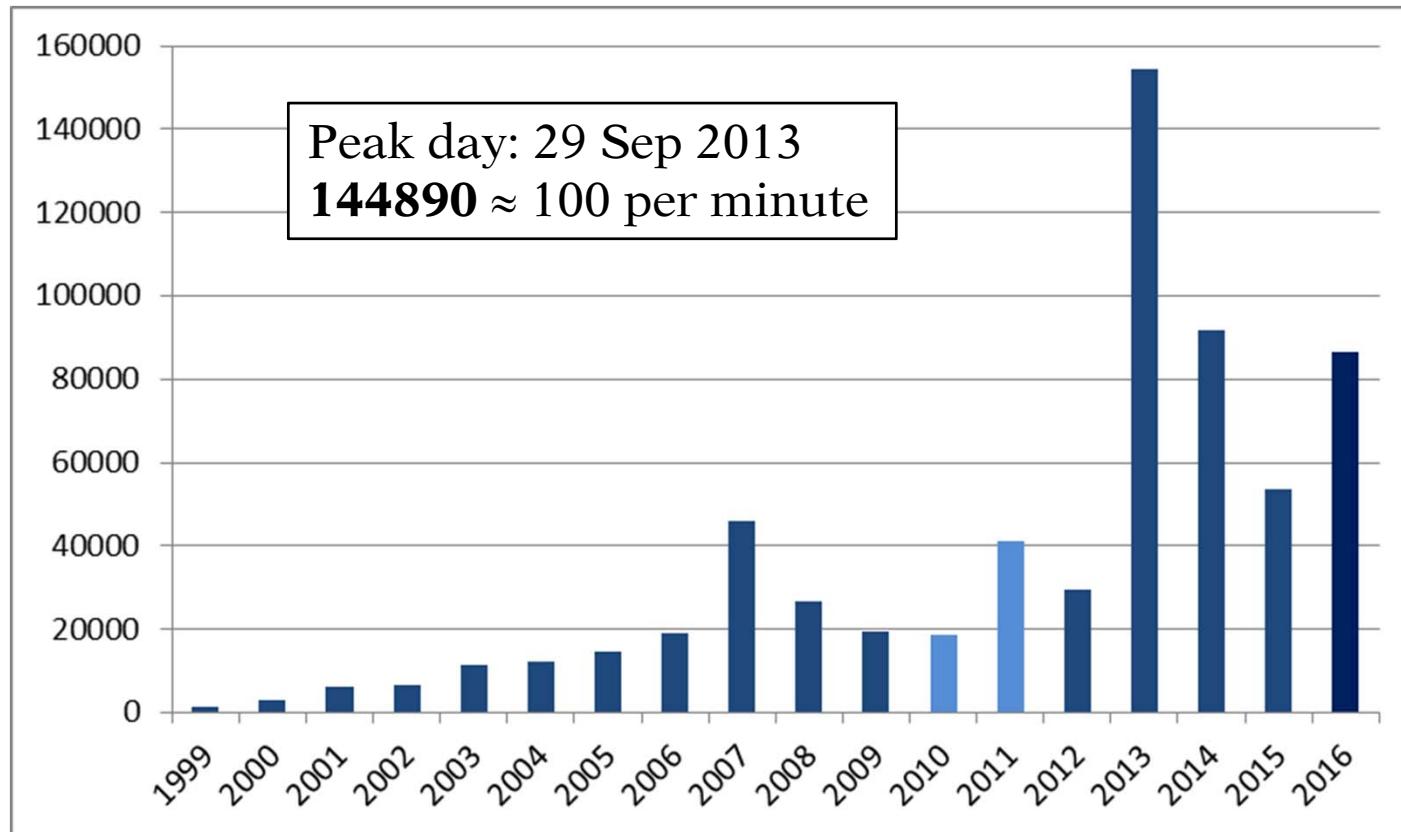
- Linear: MPS and other solver files
- Nonlinear: Fortran or C programs
 - * automatic differentiation of programs

W. Gropp and J.J. Moré, 1997. **Optimization Environments and the NEOS Server.** *Approximation Theory and Optimization*, M. D. Buhmann and A. Iserles, eds., Cambridge University Press, 167-182.

J. Czyzyk, M.P. Mesnier and J.J. Moré, 1998. **The NEOS Server.** *IEEE Journal on Computational Science and Engineering* 5(3), 68-75.

Impact: Total Submissions

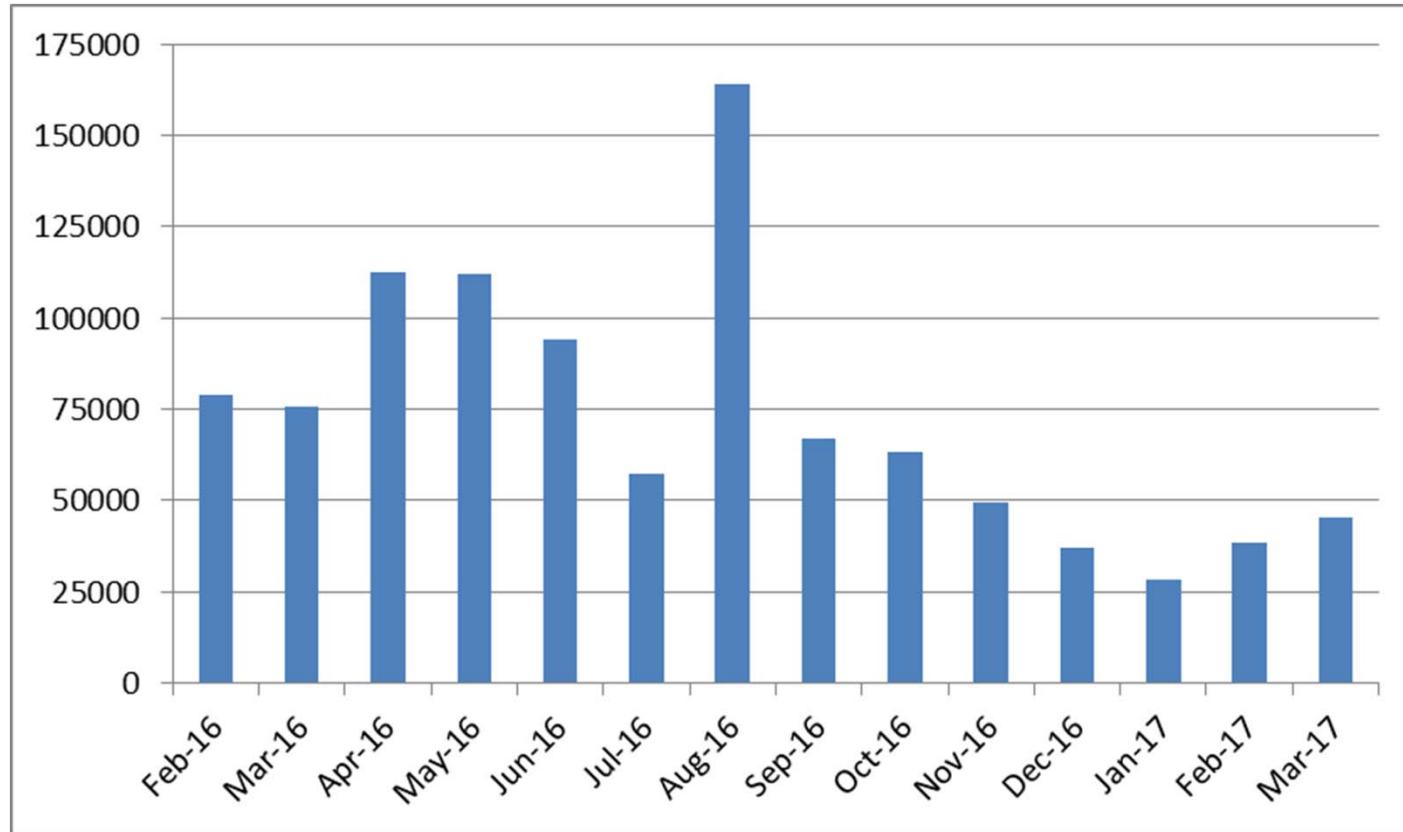
Monthly rates since 1999



45000/month \approx one per minute

Impact: Recent Submissions

Monthly rates for past year



45000/month \approx one per minute

Assessment

Strengths

- Free
- Choice of solvers
 - * Every popular solver available
- Easy to use
 - * No account setup
 - * No advance scheduling

Weaknesses

- Stand-alone focus: submission of “solve jobs”
- Non-profit management
 - * Limited support & development
 - * No guarantee of confidentiality
 - * No guarantee of performance

Modeling Languages in NEOS

Modeling language inputs

- AMPL model, data, commands files
- GAMS model, options, gdx files

Modeling language operation

- User chooses a solver and a language
- NEOS scheduler finds a compatible workstation
- NEOS workstation invokes modeling language system with given inputs
- Modeling language system invokes solver

E.D. Dolan, R. Fourer, J.J. Moré and T.S. Munson,
Optimization on the NEOS Server. *SIAM News* **35**:6
(July/August 2002) 4, 8–9. www.siam.org/pdf/news/457.pdf

Solver & Language Listing

The screenshot shows a web browser window titled "NEOS Solvers" with the URL <https://neos-server.org/neos/solvers/index.html>. The page lists solvers categorized by type:

- Linear Programming**
 - BDMLP [GAMS Input]
 - bmpmpd [AMPL Input][LP Input][MPS Input][QPS Input]
 - Clp [MPS Input]
 - CPLEX [AMPL Input][GAMS Input][LP Input][MPS Input]
 - FICO-Xpress [AMPL Input][GAMS Input][MOSEL Input][MPS Input]
 - Gurobi [AMPL Input][GAMS Input][MPS Input]
 - MOSEK [AMPL Input][GAMS Input][LP Input][MPS Input]
 - OOQP [AMPL Input]
 - SoPlex80bit [LP Input][MPS Input]
- Mathematical Programs with Equilibrium Constraints**
 - filterMPEC [AMPL Input]
 - Knitro [GAMS Input]
 - NLPEC [GAMS Input]
- Mixed Integer Linear Programming**
 - Cbc [AMPL Input][GAMS Input][MPS Input]
 - CPLEX [AMPL Input][GAMS Input][LP Input][MPS Input]
 - feaspump [AMPL Input][CPLEX Input][MPS Input]
 - FICO-Xpress [AMPL Input][GAMS Input][MOSEL Input][MPS Input]
 - Gurobi [AMPL Input][GAMS Input][MPS Input]
 - MINTO [AMPL Input]
 - MOSEK [AMPL Input][GAMS Input][LP Input][MPS Input]
 - proxy [CPLEX Input][MPS Input]
 - qsopt_ex [AMPL Input][LP Input][MPS Input]
 - scip [AMPL Input][CPLEX Input][GAMS Input][MPS Input][OSIL Input][ZIMPL Input]
 - SYMPHONY [MPS Input]
- Mixed Integer Nonlinearly Constrained Optimization**
 - AlphaECP [GAMS Input]
 - BARON [AMPL Input][GAMS Input]
 - Bonmin [AMPL Input][GAMS Input]

NEOS Server

AMPL Input Page

The screenshot shows a web browser window titled "NEOS Server: CPLEX". The URL in the address bar is <https://neos-server.org/neos/solvers/milp:CPLEX/AMPL.html>. The page header includes the NEOS logo, a "Contact" link, a "Help" link, and "Sign In" and "Sign Up" buttons. A sidebar on the right lists "NEOS Interfaces to CPLEX" with links for "WWW Form & Sample Submissions", "Email", and "XML-RPC". The main content area features a large banner with the word "optimization" and mathematical expressions: $0 = \nabla_x \mathcal{L}(x, u) \perp x \text{ free}$ and $0 < -\nabla_u \mathcal{L}(x, y) \perp y > 0$. Below the banner, a section titled "CPLEX" describes the solver and provides links to IBM Decision Optimization and the IBM Academic Initiative. A final section titled "Using the NEOS Server with AMPL/CPLEX" explains the submission process and solver options.

CPLEX

The NEOS Server offers the IBM ILOG CPLEX Optimizer for the solution of mixed-integer linear programming (MILP) problems that can be modeled in [AMPL](#) format.

For information on IBM Decision Optimization products, including the CPLEX Optimizer, visit [IBM Decision Optimization](#).

For information on all IBM software available to academics, visit the [IBM Academic Initiative](#).

Using the NEOS Server with AMPL/CPLEX

The user must submit a model in [AMPL](#) format to solve a mixed-integer linear program. The [examples section](#) of the AMPL website provides examples of models in AMPL format.

The MILP problem must be specified by a model file with the options of a data file and a commands file. If the commands file is specified, it must contain the AMPL solve command. However, the command file must *not* contain the model or data commands. The model and data files are renamed internally by NEOS.

The commands file may include option settings for CPLEX. To specify solver options, add

NEOS Server

AMPL Input Page

The screenshot shows a web browser window titled "NEOS Server: CPLEX". The URL in the address bar is <https://neos-server.org/neos/solvers/milp:CPLEX/AMPL.html>. The page has a dark header with "NEOS", "Contact", "Help", "Sign In", and "Sign Up" buttons. The main content area is titled "Web Submission Form". It contains four sections: "Model File" (with a "Choose File" button set to "cut.mod"), "Data File" (with a "Choose File" button set to "cut.dat"), "Commands File" (with a "Choose File" button set to "No file chosen"), and "Comments" (an empty text area). At the bottom is an "Additional Settings" section with two checkboxes: "Dry run: generate job XML instead of submitting it to NEOS" and "Short Priority: submit to higher priority queue with maximum CPU time of 5 minutes".

Model File
Enter the location of the AMPL model (local file)
 cut.mod

Data File
Enter the location of the AMPL data file (local file)
 cut.dat

Commands File
Enter the location of the AMPL commands file (local file)
 No file chosen

Comments

Additional Settings

Dry run: generate job XML instead of submitting it to NEOS

Short Priority: submit to higher priority queue with maximum CPU time of 5 minutes

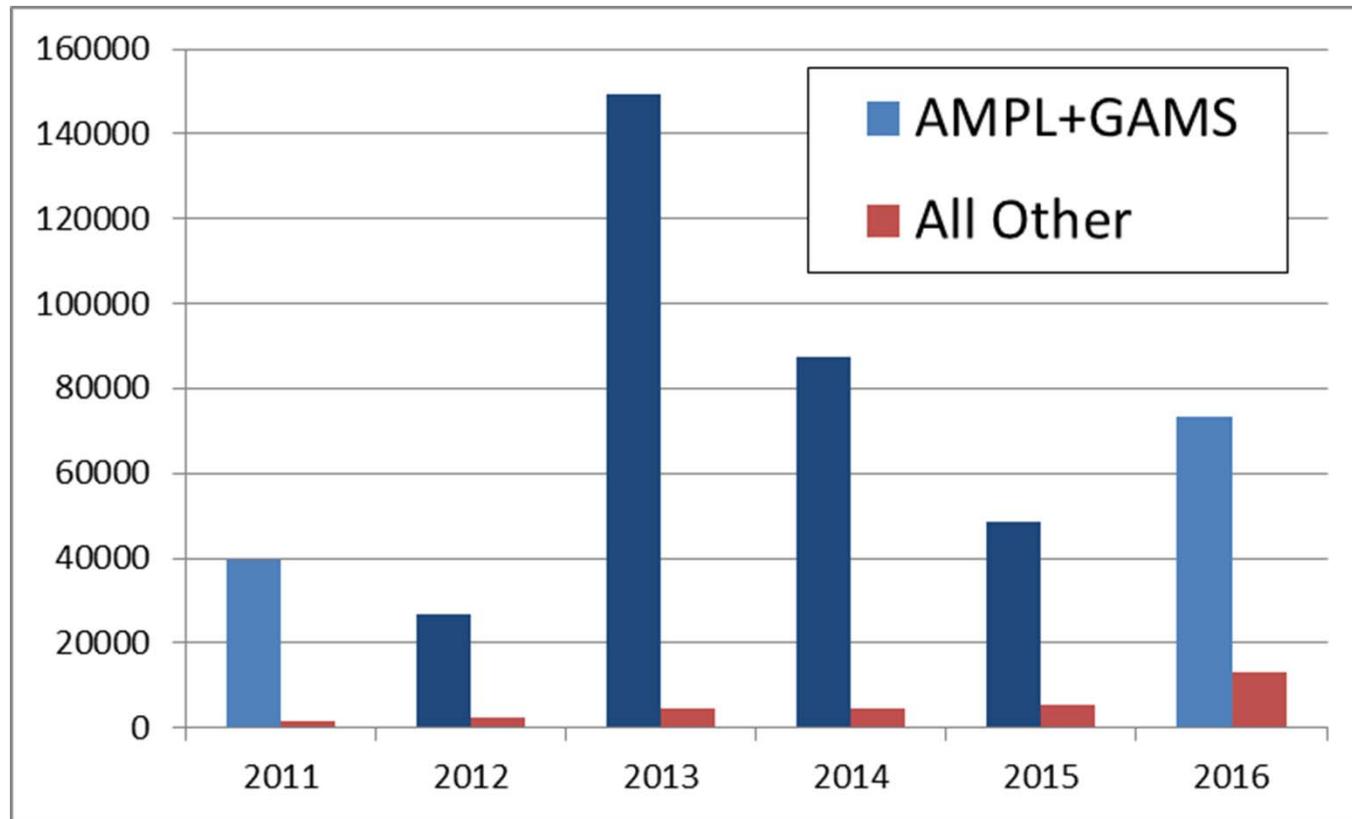
NEOS Server

AMPL Input Page

The screenshot shows a web browser window titled "NEOS Server: CPLEX". The URL in the address bar is <https://neos-server.org/neos/solvers/milp:CPLEX/AMPL.html>. The page has a dark header with "NEOS" and navigation links for "Contact" and "Help". On the right, there are "Sign In" and "Sign Up" buttons. The main content area includes a "Comments" section with a large empty text box. Below it is an "Additional Settings" section containing three checkboxes: "Dry run: generate job XML instead of submitting it to NEOS", "Short Priority: submit to higher priority queue with maximum CPU time of 5 minutes", and an "E-Mail address:" field with a placeholder. A note at the bottom of this section says, "Please do not click the 'Submit to NEOS' button more than once." There are two buttons: "Submit to NEOS" (blue) and "Clear this Form". A blue banner at the bottom states, "By submitting a job, you have accepted the [Terms of Use](#)". At the bottom of the page, there are logos for "WISCONSIN UNIVERSITY OF WISCONSIN-MADISON" and "WISCONSIN INSTITUTES FOR DISCOVERY". Copyright information at the bottom reads: "Copyright © 2017, Wisconsin Institutes for Discovery at the University of Wisconsin, Madison · [Terms of Use](#) · [Questions and Comments](#)".

Impact: Modeling Languages

Monthly rates since 2011



APIs

Application programming interfaces

- Access NEOS from a local program

Implementations

- Version 1: XML-RPC remote procedure call
- Version 5: full Python API

Uses

- NEOS submission tool
- NEOS option in Solver Studio for Excel
- **NEOS as a “solver” for modeling systems**

Modeling Systems as NEOS Clients

New “solvers”

- Kestrel for AMPL
- Kestrel for GAMS

Familiar operation

- Choose Kestrel as the local “solver”
- Set an option to choose a real solver on NEOS
- Initiate a solve and wait for results

E.D. Dolan, R. Fourer, J.-P. Goux, T.S. Munson and J. Sarich,
**Kestrel: An Interface from Optimization Modeling Systems
to the NEOS Server.** *INFORMS Journal on Computing* **20**
(2008) 525–538. dx.doi.org/10.1287/ijoc.1080.0264

AMPL Interactive Session

```
ampl: model sched1.mod;
ampl: data sched.dat;

ampl: let least_assign := 16;

ampl: option solver kestrel;
ampl: option kestrel_options 'solver=cplex';

ampl: solve;

Connecting to: neos-server.org:3332
Job 4679195 submitted to NEOS, password='JMNRQoTD'

Check the following URL for progress report :

http://neos-server.org/neos/cgi-bin/nph-neos-
solver.cgi?admin=results&jobnumber=4679195&pass=JMNRQoTD

Job 4679195 dispatched
password: JMNRQoTD

----- Begin Solver Output -----

Job submitted to NEOS HTCondor pool.
```

AMPL Interactive Session

```
----- Begin Solver Output -----
```

```
Job submitted to NEOS HTCondor pool.
```

```
CPLEX 12.6.2.0: optimal integer solution; objective 265.9999999999943  
135348 MIP simplex iterations  
17430 branch-and-bound nodes
```

```
ampl: option omit_zero_rows 1, display_1col 0;
```

```
ampl: display Work;
```

```
Work [*] :=
```

```
 1 16    11 16    36 19    72 20    82 20    106 16   114 20   125 20  
 3 16    29 16    66 17    79 19    104 19   112 16   121 16  
;
```

```
ampl:
```

Kestrel Impact

Some success

- 2013 and 2014:
Peaked at over 500,000 submissions
- 2015:
Dropped to only about 30,000 submissions
- 2016:
Back up to 100,000 submissions

Kestrel Assessment

Strengths

- Powerful local client for modeling
- NEOS facilities for solving

Weaknesses

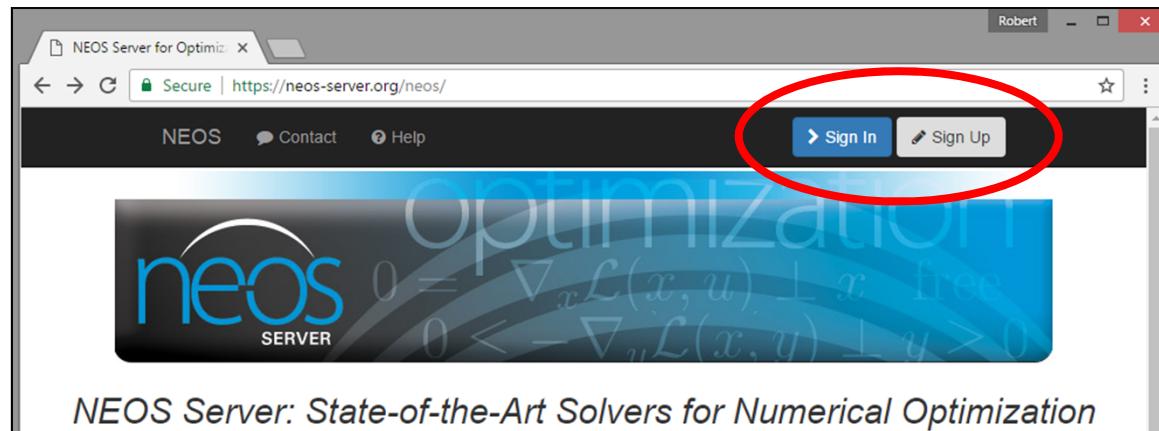
- Not all NEOS solvers available
- Local solver software is strong competition . . .
 - * Bundled with modeling languages
 - * Free for trial use
 - * Free for course and academic use
- Limited support & development

Recent Developments

Intensified support

- Shift to HTCondor “high-throughput” platforms
- Updated Kestrel client
- Updated solver offerings

User accounts



- Higher priority for job scheduling
- “My Jobs” tab listing recent jobs & links to results

Other Offerings Like NEOS

IBM Decision Optimization on Cloud

- “DropSolve” service similar to NEOS
- “DOcplexcloud API” like NEOS API

Satalia

- Chooses a solver for you
- Pays royalties to clients and to solvers
- Currently sold on subscription . . .



Gurobi 7.0 Instant Cloud cloud.gurobi.com

Client side

- Standard Gurobi installation
- Cloud license

Server side

- Compute server for Gurobi solver
 - * Single-machine solves
 - * Distributed MIP solves
 - * Distributed tuning
- Server pools with load balancing

... hosted on Amazon Web Services

*"Cloud computing technology is changing quickly.
Please check these documents periodically to ensure
you have the latest instructions for the Gurobi Cloud."*

Gurobi Instant Cloud for AMPL

Client side

- AMPL installation (command-line or IDE)
- Standard Gurobi-for-AMPL installation

Server side

- Gurobi compute server
- Gurobi optimizer

Gurobi Instant Cloud for AMPL

www.gurobi.com

The screenshot shows the Gurobi Optimization website at www.gurobi.com. The page features a dark blue header with the Gurobi logo and navigation links for PRODUCTS, DOWNLOADS, RESOURCES, ACADEMIA, SUPPORT, and ABOUT. A search bar and language selection are also present. The main content area has a blue background with a world map pattern. It features a large white text banner: "An easier way to make better decisions". Below this, a subtext reads: "The state-of-the-art mathematical programming solver for prescriptive analytics". Three main sections are highlighted: "Learn About" (with a magnifying glass icon), "Get Gurobi" (with a hand icon), and "Use Gurobi" (with a wrench and screwdriver icon). Each section contains a brief description and a red call-to-action button. To the right, a box highlights "Gurobi Optimizer 6.5" with a bulleted list of features: Faster times to feasibility and optimality, No-surprises pricing, Intuitive interfaces, and Easy-to-reach technical support. Buttons for "Get Started Today!" and "See what's new in v6.5!" are also shown. At the bottom, a box promotes free training events.

An easier way to make better decisions

The state-of-the-art mathematical programming solver for prescriptive analytics

Learn About

Get Gurobi

Use Gurobi

Gurobi Optimizer 6.5

- Faster times to feasibility and optimality
- No-surprises pricing
- Intuitive interfaces
- Easy-to-reach technical support

Get Started Today!

See what's new in v6.5!

Join us for your choice of free, two-day, in-person training events

We are offering two free training events for commercial users, one presented in English and another presented in German.

In these hands-on and interactive training events you will:

- build your modeling skills across three modeling workshops ranging from beginner to advanced

Gurobi Instant Cloud for AMPL

www.gurobi.com

The screenshot shows the Gurobi Optimization website. At the top, there's a navigation bar with the Gurobi logo, a search bar, and links for Products, Downloads, Resources, Academia, Support, About, Login, and Register. Below the header, a large blue banner features the text "An easier way to make better decisions" over a world map background, followed by "The state-of-the-art mathematical programming solver for prescriptive analytics". To the right of this banner, a section for "Gurobi Optimizer 6.5" lists four bullet points: "Faster times to feasibility and optimality", "No-surprises pricing", "Intuitive interfaces", and "Easy-to-reach technical support". It includes two red buttons: "Get Started Today!" and "See what's new in v6.5!". Below the banner, three white cards provide links: "Learn About" (with a magnifying glass icon), "Get Gurobi" (with a hand icon), and "Use Gurobi" (with a wrench and screwdriver icon). A callout box at the bottom left contains text about training events, mentioning English and German presentations, hands-on training, and modeling workshops.

An easier way to make better decisions

The state-of-the-art mathematical programming solver for prescriptive analytics

Gurobi Optimizer 6.5

- Faster times to feasibility and optimality
- No-surprises pricing
- Intuitive interfaces
- Easy-to-reach technical support

[Get Started Today!](#)

[See what's new in v6.5!](#)

Learn About

Gurobi builds and supports the best math programming solvers available for all major problem types. It's all we do...

Get Gurobi

We offer versions designed specifically for the needs of commercial, ISV, and academic users...

Use Gurobi

We've worked hard to make it easier to get started with or switch to Gurobi than you may have thought possible...

Join us for your choice of free, two-day, in-person training events

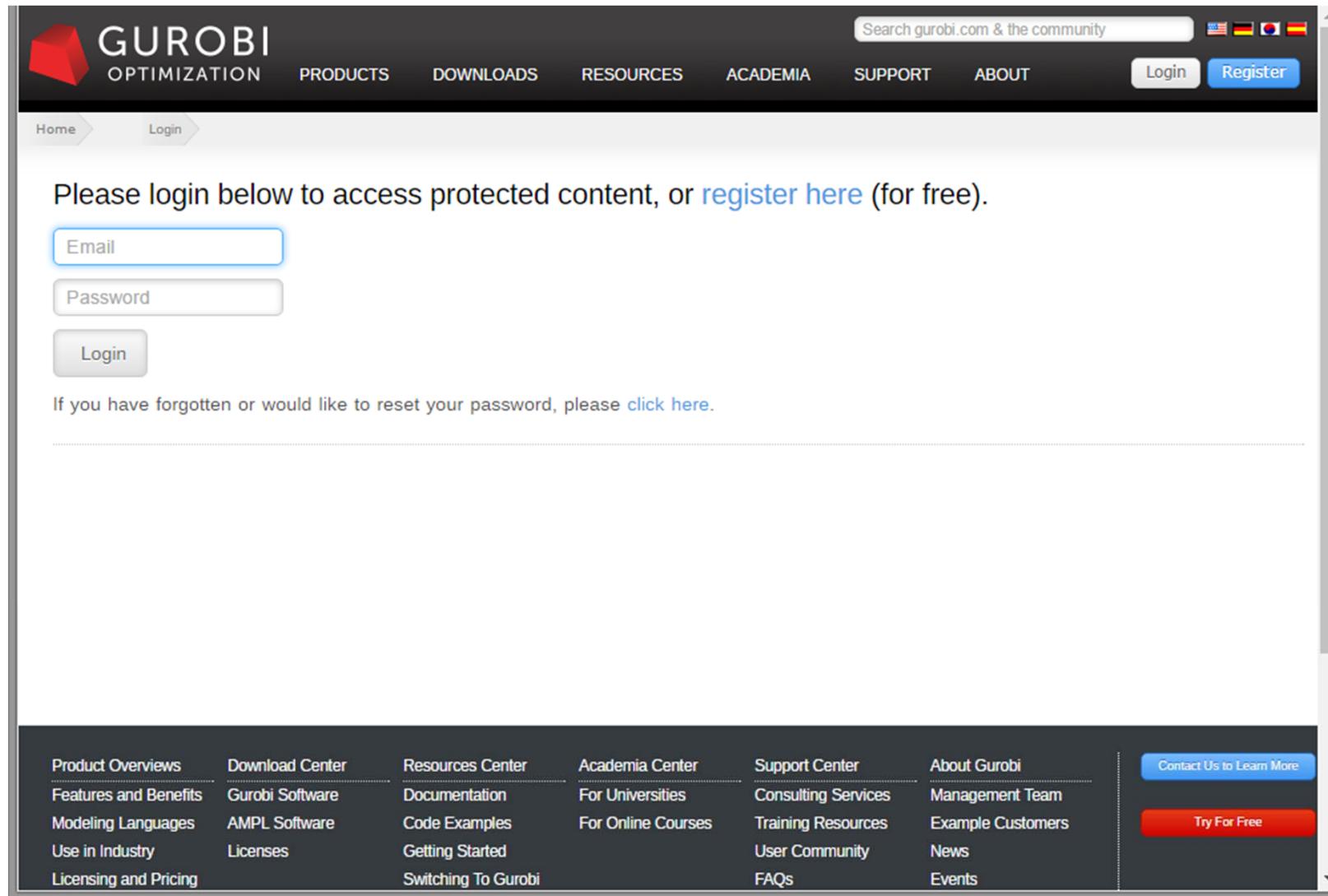
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In these hands-on and interactive training events you will:

- build your modeling skills across three modeling workshops ranging from beginner to advanced

Gurobi Instant Cloud for AMPL

www.gurobi.com



The screenshot shows the Gurobi website's login page. At the top, there is a dark header bar with the Gurobi logo, navigation links for PRODUCTS, DOWNLOADS, RESOURCES, ACADEMIA, SUPPORT, and ABOUT, and buttons for Login and Register. Below the header, a search bar and language selection icons are visible. The main content area has a breadcrumb trail showing Home > Login. It displays a message: "Please login below to access protected content, or register here (for free)". There are input fields for Email and Password, and a Login button. Below these fields, a link "click here" is provided for password recovery. At the bottom of the page, there is a footer navigation bar with links for Product Overviews, Features and Benefits, Modeling Languages, Use in Industry, Licensing and Pricing, Download Center, Gurobi Software, AMPL Software, Licenses, Resources Center, Documentation, Code Examples, Getting Started, Switching To Gurobi, Academia Center, For Universities, For Online Courses, Support Center, Consulting Services, Training Resources, User Community, FAQs, About Gurobi, Management Team, Example Customers, News, and Events. On the right side of the footer, there are two buttons: "Contact Us to Learn More" and "Try For Free".

Gurobi Instant Cloud for AMPL

ngcloud.gurobi.com

The screenshot shows the Gurobi Instant Cloud homepage. At the top, there's a dark header with the Gurobi logo, navigation links (PRODUCTS, DOWNLOADS, RESOURCES, ACADEMIA, SUPPORT, ABOUT), a user icon, and a "Get Gurobi" button. Below the header is a large blue banner featuring a world map composed of dots and the text "Gurobi Instant Cloud" and "Instant access to powerful optimization software and fast machines". To the right of the banner are two red buttons: "Open Cloud Manager" and "Discuss Your Needs". The main content area is divided into three columns: "Great for...", "Easy and Robust", and "Cost Effective", each with a list of bullet points. At the bottom, there are three blue buttons: "Learn more", "Cloud Guide", and "Pricing".

Great for...

- Handling spikes in demand
- Solving challenging models
- Meeting periodic optimization needs
- Delivering cloud-based solutions
- Providing cloud-based failover

Easy and Robust

- Automatically start, manage and stop multiple machines
- Access from your existing applications
- Select dedicated machines from a data center near you
- Stay secure with built-in 256-bit AES encryption

Cost Effective

- Use and pay for only what you need
- Reduce or eliminate local data center costs
- Support Windows, Linux and Mac clients
- Access includes Gurobi Support

View Available Licenses

The screenshot shows a web-based interface for managing licenses. At the top, a blue header bar contains the title "Licenses". To the right of the title are three icons: a question mark, a refresh symbol, and a share symbol. Below the header, there is a search bar labeled "Search:" with a placeholder text input field. On the left side of the main content area, there is a dropdown menu labeled "Show 10 licenses". To the right of this, there is a search bar with a placeholder "Search:" and a clear button. The main content area displays a table of available licenses. The table has columns: "License", "Active Machines", "Rate Plan", "Credit (US Dollar)", and "Expiration Time". Each row in the table represents a license entry. The first row (License 142032) has a green status icon. The second row (License 121420) has a red warning icon. Each row also includes a set of three circular icons for search, download, and more options. At the bottom of the table, there is a message "Showing 1 to 2 of 2 licenses" and a navigation bar with buttons for "First", "Previous", a page number "1" (which is highlighted), "Next", and "Last". Below the table, there are three blue buttons: "CONTACT SALES", "SUPPORT CENTER", and "GETTING STARTED".

License	Active Machines	Rate Plan	Credit (US Dollar)	Expiration Time
142032	0	No Charge	\$25	10/30/2016 7:00:00 PM
121420	0	No Charge	\$24.12	4/28/2016 7:00:00 PM

Get Gurobi License File

```
# This is a license file created by the Gurobi Instant Cloud
# Created on Mon, 17 Oct 2016 20:46:26 GMT
# License Id: 142032
# Place this file in your home directory or one of the following
# locations where XXX is the Gurobi Optimizer version you are using:
#     * C:\gurobi\ or C:\gurobiXXX\ on Windows
#     * /opt/gurobi/ or /opt/gurobiXXX/ on Linux
#     * /Library/gurobi/ or /Library/gurobiXXX/ on Mac OS X
# Or set environment variable GRB_LICENSE_FILE to point to this file
# Do not share this license file because it contains your secret key
```

CLOUDACCESSID=fedf3901-04f1-44d7-9725-e36c1c3f70f6

CLOUDKEY=0v9XdWrDQLiE3EiAAEKtFw

CLOUDHOST=ngcloud.gurobi.com

Use with AMPL: Setup

```
ampl: model multmip3.mod;
ampl: data multmip3.dat;

ampl: option solver gurobi;

ampl: option gurobi_options
ampl?  'cloudid=fedf3901-04f1-44d7-9725-e36c1c3f70f6' \
ampl?  'cloudkey=0v9XdWrDQLiE3EiAAEktFw';

ampl:
```

Use with AMPL: *Startup*

```
ampl: model multmip3.mod;
ampl: data multmip3.dat;

ampl: option solver gurobi;

ampl: option gurobi_options
ampl?  'cloudid=fedf3901-04f1-44d7-9725-e36c1c3f70f6 \
ampl?  cloudkey=0v9XdWrDQLiE3EiAAEktFw';

ampl: solve;

Gurobi 7.0.0: cloudid=fedf3901-04f1-44d7-9725-e36c1c3f70f6
cloudkey=0v9XdWrDQLiE3EiAAEktFw

Waiting for cloud server to start.....
```

Use with AMPL: *Solve*

```
ampl: model multmip3.mod;
ampl: data multmip3.dat;

ampl: option solver gurobi;

ampl: option gurobi_options
ampl?  'cloudid=fedf3901-04f1-44d7-9725-e36c1c3f70f6' \
ampl?  'cloudkey=0v9XdWrDQLiE3EiAAEktFw';

ampl: solve;

Gurobi 7.0.0: cloudid=fedf3901-04f1-44d7-9725-e36c1c3f70f6
cloudkey=0v9XdWrDQLiE3EiAAEktFw

Waiting for cloud server to start.....
Capacity available on 'default' cloud pool - connecting...
Established 256-bit AES encrypted connection

Gurobi 7.0.0: optimal solution; objective 235625
289 simplex iterations
25 branch-and-cut nodes
plus 35 simplex iterations for intbasis

ampl:
```

Use with AMPL: *Continue*

```
ampl: display {i in ORIG, j in DEST} sum {p in PROD} Trans[i,j,p];  
:  
DET    FRA    FRE    LAF    LAN    STL    WIN    :=  
CLEV   625    375    550    0      500    550    0  
GARY     0      0      0      400    0      625    375  
PITT   525    525    625    600    0      625    0  
;  
  
ampl: reset data;  
ampl: data multmip3a.dat;  
  
ampl: solve;  
  
Gurobi 7.0.0: clouddid=fedf3901-04f1-44d7-9725-e36c1c3f70f6  
cloudkey=0v9XdWrDQLiE3EiAAEkFw  
  
Capacity available on 'default' cloud pool - connecting...  
Established 256-bit AES encrypted connection  
  
Gurobi 7.0.0: optimal solution; objective 238450  
163 simplex iterations  
plus 33 simplex iterations for intbasis  
  
ampl:
```

Gurobi Instant Cloud for AMPL

Manage Server Configuration

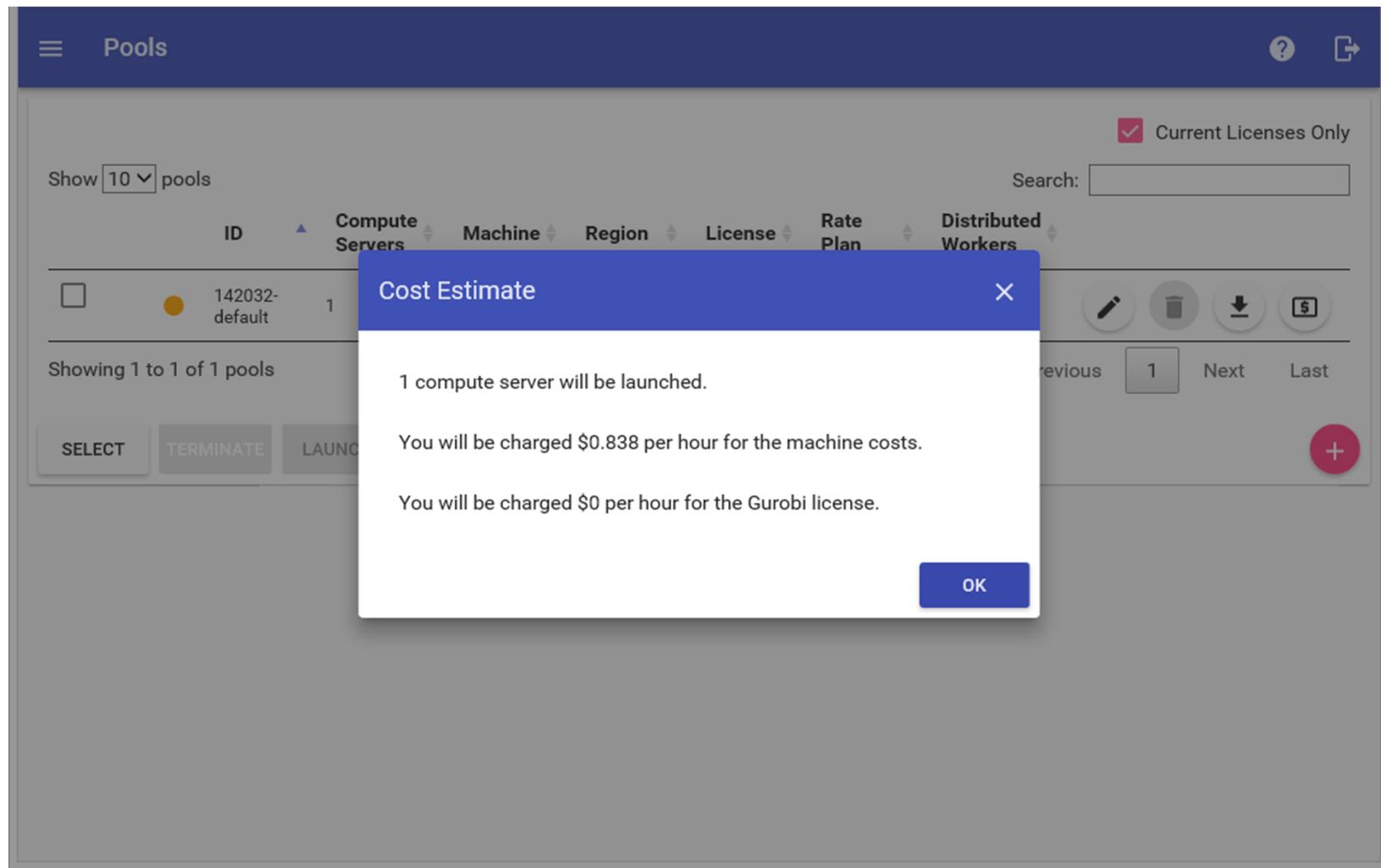
The screenshot shows the Gurobi Instant Cloud for AMPL web interface. On the left, a sidebar menu lists options: Instant Cloud (selected), LICENSES (highlighted in blue), POOLS, MACHINES, MANUAL LAUNCH, HISTORY, and SETTINGS. At the bottom of the sidebar are buttons for LOG IN and GETTING STARTED. The main content area displays a table of server configurations. The columns are: Name, Type, Rate Plan, Credit (US Dollar), and Expiration Time. Two rows are visible:

Name	Type	Rate Plan	Credit (US Dollar)	Expiration Time
4er@ampl.com	Machine	No Charge	\$19.75	10/30/2016 7:00:00 PM
	Pool	No Charge	\$24.12	4/28/2016 7:00:00 PM

Below the table are navigation buttons: First, Previous, Next, and Last, with the page number set to 1.

Gurobi Instant Cloud for AMPL

Check Costs



Gurobi Cloud Costs

Commercial plans

- Annual subscription fee, *plus*
- Hourly rates for use:
 - * Gurobi rate for compute servers
 - * Amazon rate for distributed workers

Trials, academic use, special grants

- Amazon rate only
 - . . . *set up through sales rep*

Gurobi Cloud for AMPL: Assessment

Strengths

- Security
- Reliability (via Amazon)
- Support for multi-server and/or multi-worker pools
- Support for local modeling clients

Drawbacks (compared to NEOS)

- Not free
 - * Budgeting can be complicated
- Solver-specific
- Not quite “optimization on demand”

QuanDec

Server side

- AMPL model and data
- Standard AMPL-solver installations

Client side

- Interactive tool for collaboration & decision-making
- Runs on any recent web browser
- Java-based implementation
 - * AMPL API for Java
 - * Eclipse Remote Application Platform

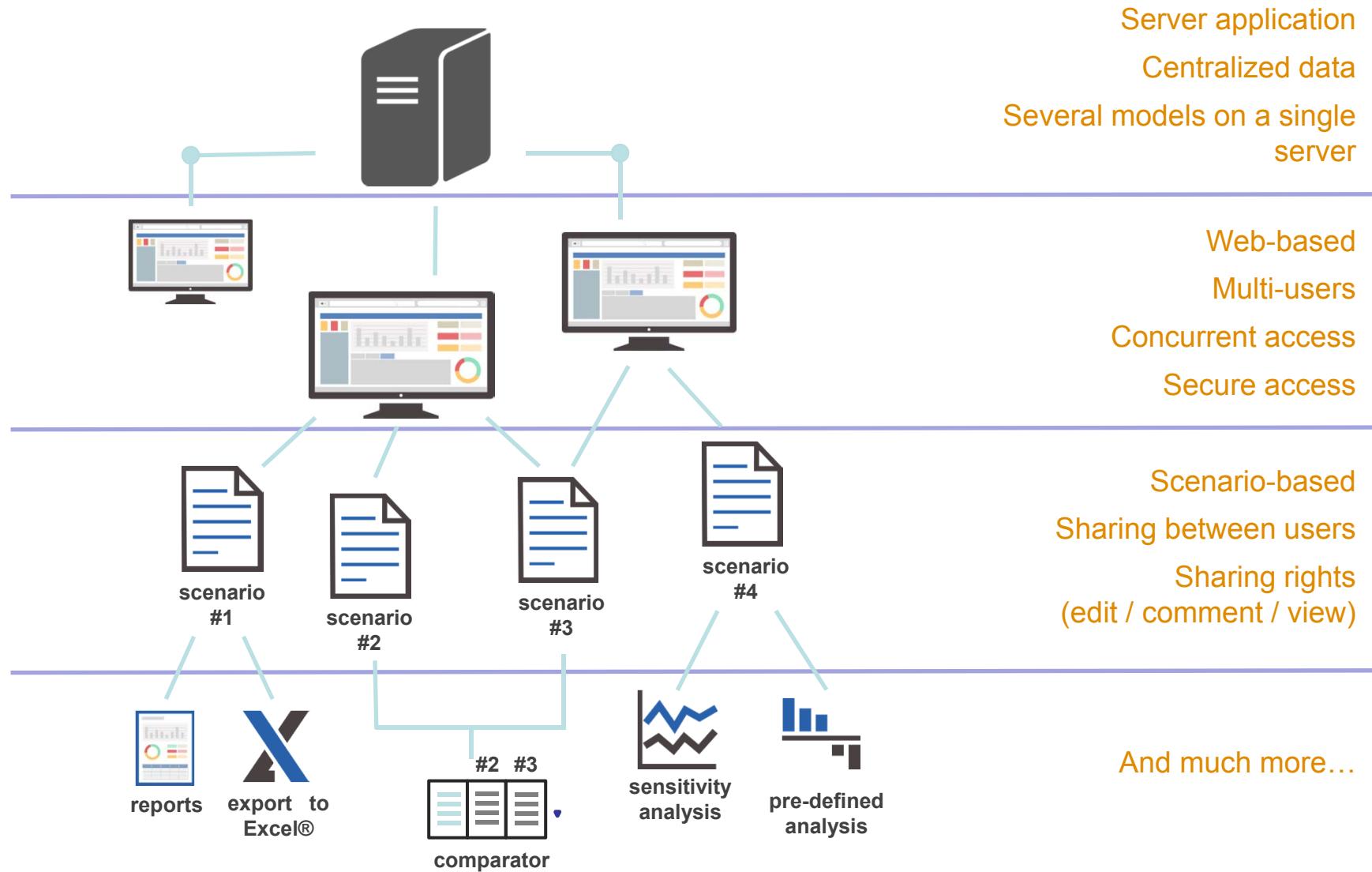
. . . developed / supported by Cassotis Consulting



The web-based graphical interface
that turns optimization models written
in AMPL into decision-making tools.



Features

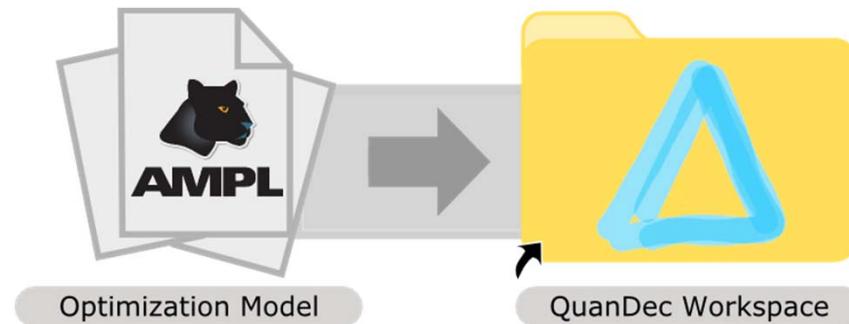


Getting started

step 1: install QuanDec on a server

step 2: copy & paste your model files (.mod and .dat) into
QuanDec's workspace

step 3: create AMPL tables and link them to QuanDec explorer





E-mail :

Password :

[Forgot?](#)

Enter your email to login

Version 2.3.1

CASSOTIS consulting

[Login](#)

Web-application

Multi-user

Secure access

Concurrent access

This week

Name	Owner	Last change
BUDGET 2016	Mary Torres	September 9, 2016 4:59 PM
My Scenario	Me	Today 10:54 AM

All

Name	Owner
BUDGET 2015	Mary Torres
BUDGET 2016	Mary Torres
My Scenario	Me
FORECAST 2017	Mary Torres

Share with others

Anyone can comment

People or groups

Robert Finn can edit X

OK

OK

Scenario-based environment

Sharing system

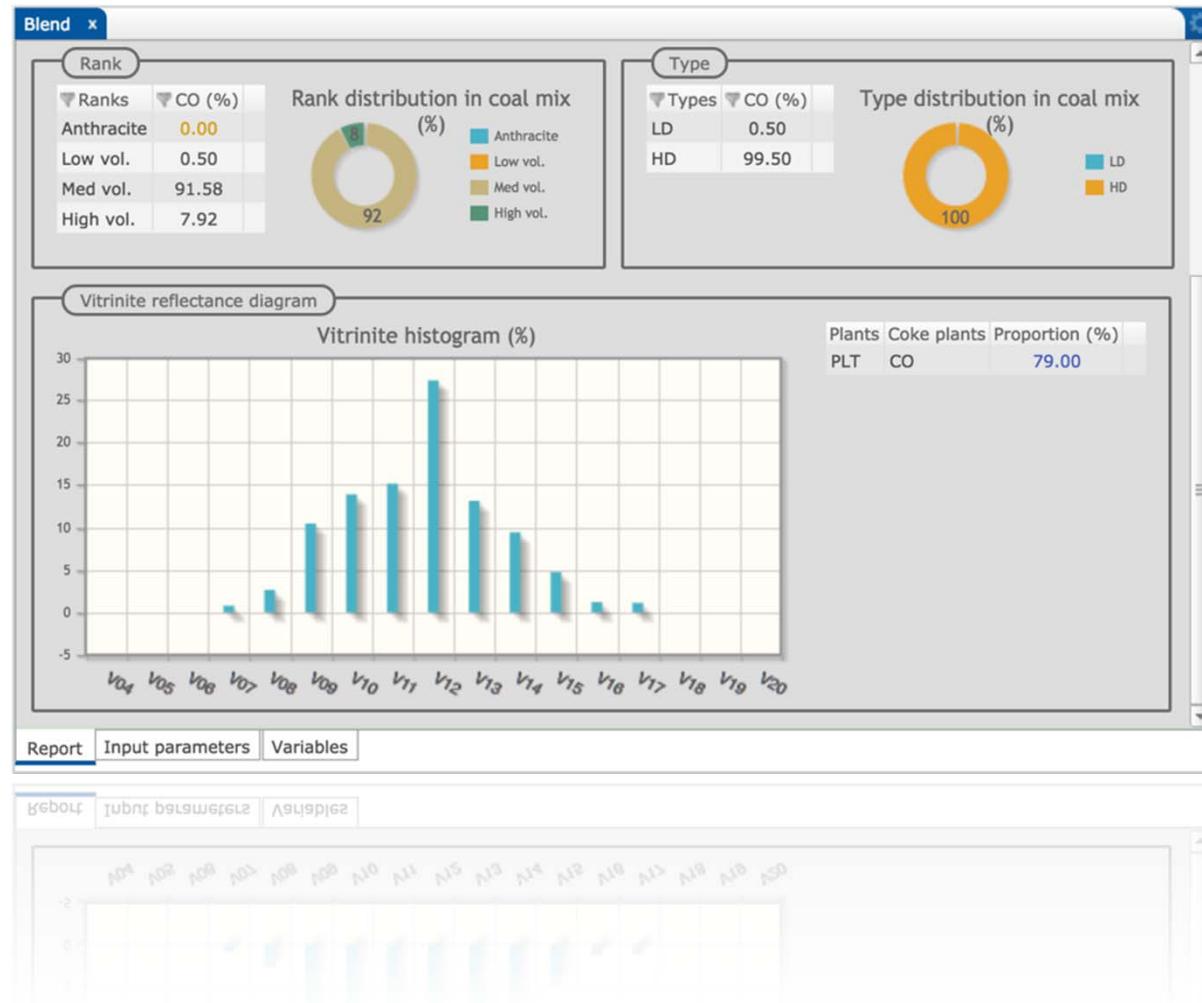
Permission:
Edit – Comment - View

- 3 levels:**
- Report
 - Input parameters
 - Variables

Chart and tables

Colored values
for easier analysis

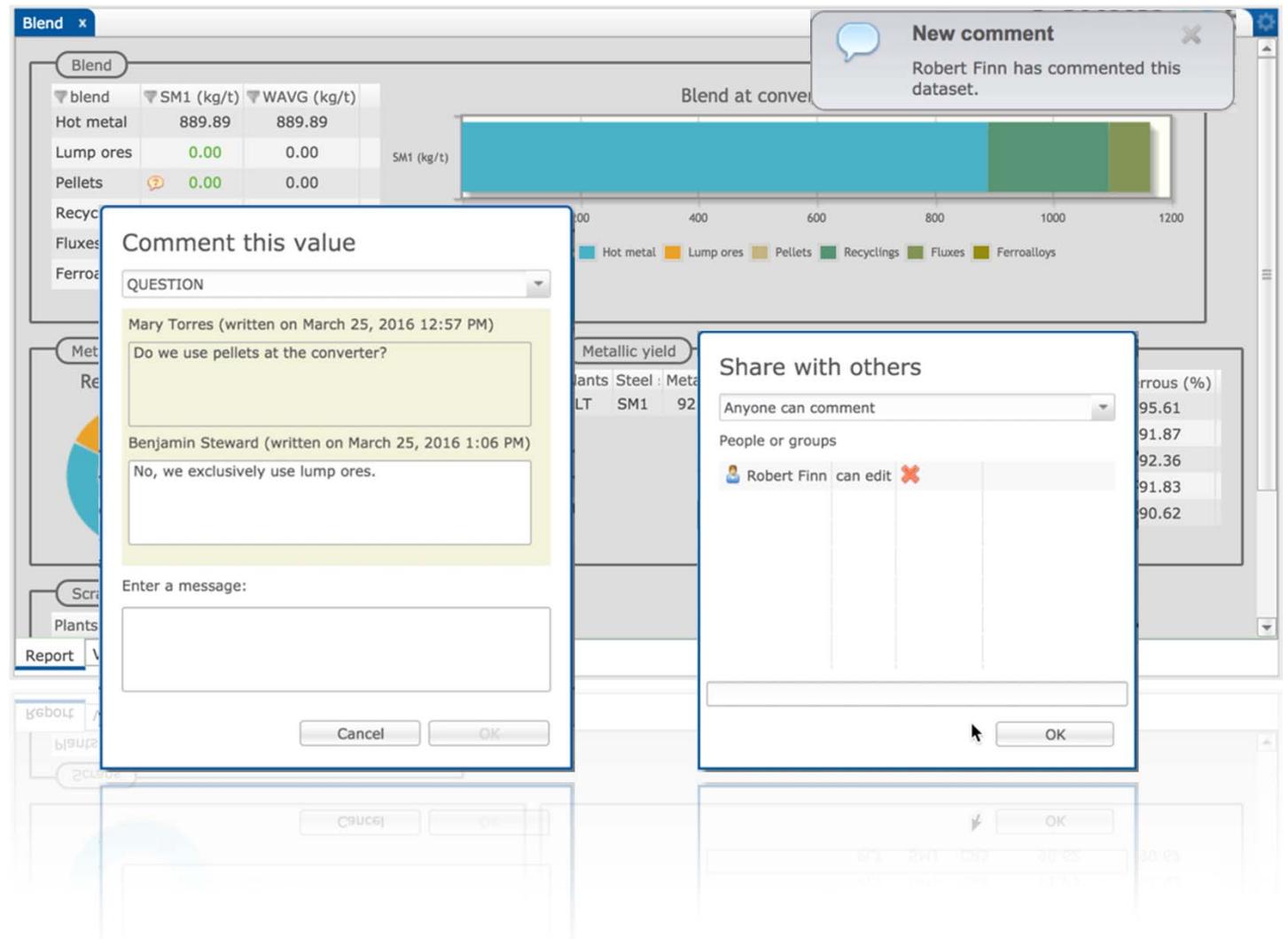
Constraint (min/max)
on any variable



Collaborative work

Notification system

Comments between users



Coke plants x

Operating costs

Plants	Coke plants	Costs	Fixed (MUS\$/year)	Variable (US\$/t)
PLT	CO	Maintenance	7.75	0.90
PLT	CO	Labour costs	3.95	0.00
PLT	CO	Utilities	0.05	0.11
PLT	CO	Water treatment	7.78	0.00
PLT	CO	Court yard	5.36	0.00
PLT	CO	Services	0.02	0.94
PLT	CO	Indirect costs	2.57	0.00
PLT	CO	Depreciation	4.92	0.00
PLT	CO	Electricity	0.00	0.03

Report Input parameters Variables

Scenarios with changes history

Traceability and undo system

Journal Bounds Regressions Comments Error Log

Operating cost at coke plant PLT, CO1, co_elec, Variable 0.03 Today 11:26 AM by Arthur Turner

CO operational costs PLT, co_elec Electricity Today 11:26 AM by Arthur Turner

CO operational costs PLT co_elec Today 11:26 AM by Arthur Turner

Vitrinite reflectance inside of range at coke plant PLT, CO1 MAX 79.00 Today 10:49 AM by Arthur Turner

Arthur Turner QuanDec STEEL BUDGET 2016 My Scenario

Workspace Admin

New Report Show/Hide differences Export to Excel

Comparator

Variable	Unit	BUDGET 2016	My Scenario	Diff
Executive summaries				
Costs and Revenues				
Profit and Sales				
Production costs				
Absolute costs	MUS\$			
Detailed costs	US\$/t			
Internal price of intermediate	US\$/t			
Net production level	kt			
'PLT' 'CO'	kt	1763.98	1764.25	0.02%
'PLT' 'SI'	kt	4085.77	4084.46	-0.03%
'PLT' 'BF'	kt	5062.62	5060.91	-0.03%
'PLT' 'ST'	kt	5258.29	5256.75	-0.03%
'PLT' 'PO'				
Production cost of product				
Production level				
Material blends				
Coke plants				
Sinter plants				
Blast furnaces				
Steel shops				
Power plant				
Raw materials				
Steelmaking WFB				
Slag disposal				
Scrap sales				
Secondary steel				
Steelmaking				
Coated				
Hot rolled				

Select the scenarios to compare:

- BUDGET 2015
- BUDGET 2016
- My Scenario
- FORECAST 2017

Cancel OK

Economics and Production

Variable	Index	Unit	BUDGET 2016	My Scenario	Diff
Economics per int. plant	'PLT' 'costs'	MUS\$	1515.59	1515.20	-0.03%
Economics per int. plant	'PLT' 'revenues'	MUS\$	1762.23	1761.77	-0.03%
Economics per int. plant	'PLT' 'profit'	MUS\$	246.64	246.56	-0.03%
Economics per int. plant	'PLT' 'margin'	%	14.00	14.00	0.00%
Production cost of product	'PLT' 'coke'	US\$/t	164.48	164.54	0.04%
Production cost of product	'PLT' 'sinter'	US\$/t	77.55	77.50	-0.06%
Production cost of product	'PLT' 'hotmetal'	US\$/t	193.95	193.99	0.02%
Production cost of product	'PLT' 'slab'	US\$/t	286.27	286.28	0.00%
Production cost of product	'PLT' 'electricity'	US\$/MWh	125.75	125.75	0.00%
Production level of product	'PLT' 'coke'	kt	1818.54	1818.81	0.02%
Production level of product	'PLT' 'sinter'	kt	4085.77	4084.46	-0.03%

Reports

Name	User	Date	Action
Sulfur cycle	Benjamin Steward	March 18, 2016 3:45 PM	X
Metallic blend at CV	Me	February 21, 2016 4:51 PM	X
Raw material use at Reduction	Me	January 15, 2016 4:36 PM	X
Economics and Production	Mary Torres	September 13, 2016 4:53 PM	X
Flux consumption at Torpedo	Mary Torres	April 3, 2016 4:44 PM	X
Slab sales	Robert Finn	January 30, 2016 5:30 PM	X
Silicon cycle	Benjamin Steward	July 5, 2016 4:17 PM	X

Cancel OK

Scenario comparison

All variables can be compared

Display of relative difference

Custom reports

Sensitivity analysis

Parameter : Exchange rates

Index : 'brl'

From : 0.3

To : 1

#Pts : 3

Cancel OK

Sensitivity analysis

For both parameters
AND variables

Variable	Unit	0.30	0.65	Diff	1.00	Diff
Economics per int. plant	MUS\$					
'PLT' 'costs'	MUS\$	1515.39	1544.99	1.95%	1633.34	7.78%
'PLT' 'revenues'	MUS\$	1754.70	1679.96	-4.26%	1670.71	-4.79%
'PLT' 'profit'	MUS\$	239.31	134.97	-43.60%	37.37	-84.38%
'PLT' 'margin'	%	13.64	8.03	-41.09%	2.24	-83.60%

Variable	Index	Unit	0.30	0.65	Diff	1.00	Diff
Economics per int. plant	'PLT' 'costs'	MUS\$	1515.39	1544.99	1.95%	1633.34	7.78%
Economics per int. plant	'PLT' 'revenues'	MUS\$	1754.70	1679.96	-4.26%	1670.71	-4.79%
Economics per int. plant	'PLT' 'profit'	MUS\$	239.31	134.97	-43.60%	37.37	-84.38%
Economics per int. plant	'PLT' 'margin'	%	13.64	8.03	-41.09%	2.24	-83.60%

Production cost of product	'PLT' 'coke'	US\$/t	164.51	161.52	-1.82%	162.71	-1.10%
Production cost of product	'PLT' 'sinter'	US\$/t	77.68	83.23	7.15%	88.16	13.50%
Production cost of product	'PLT' 'hotmetal'	US\$/t	194.23	198.43	2.16%	202.93	4.48%
Production cost of product	'PLT' 'slab'	US\$/t	287.62	307.33	6.85%	326.85	13.64%
Production cost of product	'PLT' 'electricity'	US\$/MWh	125.62	125.73	0.08%	125.74	0.09%
Production level of product	'PLT' 'coke'	kt	1818.81	1815.95	-0.16%	1815.95	-0.16%
Production level of product	'PLT' 'sinter'	kt	4115.36	4007.25	-2.63%	4006.24	-2.65%
Production level of product	'PLT' 'hotmetal'	kt	5105.94	5051.71	-1.06%	5052.00	-1.06%
Production level of product	'PLT' 'trhotmetal'	kt	5025.36	4972.09	-1.06%	4972.37	-1.05%
Production level of product	'PLT' 'crudesteel'	kt	5657.39	5402.17	-4.51%	5372.49	-5.04%

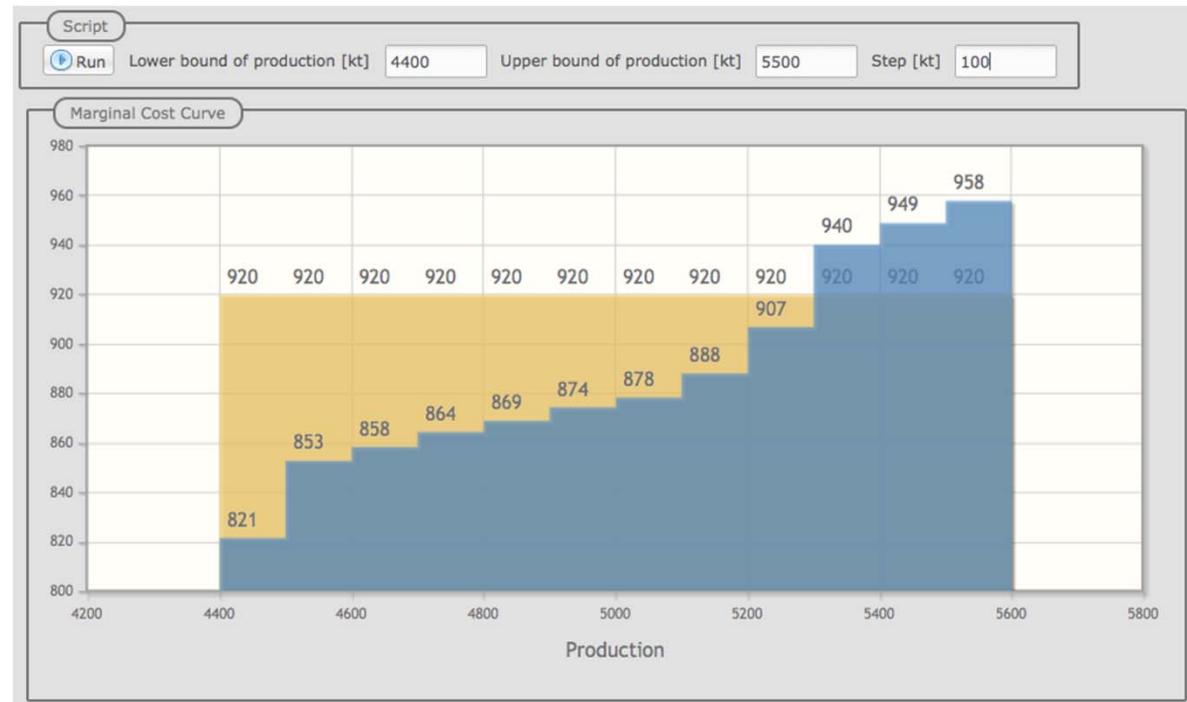
Reports			
Name	User	Date	Action
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Silicon cycle	Benjamin Steward	July 5, 2016 4:17 PM	X

All variables can be compared

Display of relative difference

Predefined analyses

Script parameters



QuanDec Availability

Ready now for commercial applications

- Free trials available
- Pricing keyed to number of models & users

First year's support included

- Tailored setup support from Cassotis Consulting
- Customizations possible

. . . contact sales@ampl.com for details