COIN-OR: Open-source Software for Operations Research
A Status Report

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Thanks to Robin Lougee-Heimer, Brenda Dietrich, Brady Hunsaker, et al.
Outline

- What
  - What is COIN-OR?
  - What is available in COIN-OR?
  - What is open-source software?

- Why and How
  - Why use COIN-OR?
  - How to add to COIN-OR?

- COIN-OR Foundation
  - History
  - Stucture

- Recent and Current News

- Future Challenges
What is COIN-OR?

- COnputational INfrastructure for Operations Research
What is COIN-OR?

- COnfigurable Optimization Infrastructure for Operations Research
- a repository of source code, examples, models, data
What is COIN-OR?

- COnputational INfrastructure for Operations Research
- a repository of source code, examples, models, data
- available for use and modification at no cost
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- Multi-platform (Linux, Unix, Windows, ...)

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- a repository of source code, examples, models, data
- available for use and modification at no cost
- Multi-platform (Linux, Unix, Windows, ...)
- under open-source licenses
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- A repository of source code, examples, models, data
- Available for use and modification at no cost
- Multi-platform (Linux, Unix, Windows, ...)
- Under open-source licenses
- A community of users, contributors, volunteers
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- a community of users, contributors, volunteers
- a non-profit foundation with elected leadership
Source Code – Linear Optimization

- Linear Programming
  - Clp, DyLP, Vol
Source Code – Linear Optimization

- Linear Programming
  - Clp, DyLP, Vol
- Integer Linear Programming
  - ALPS, BCP, Cbc, COPS, SYMPHONY
Source Code – Linear Optimization

- Linear Programming
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- Integer Linear Programming
  - ALPS, BCP, Cbc, COPS, SYMPHONY
- Stochastic Linear Programming
  - SMI
Source Code – Non Linear Optimization
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- Semidefinite Programming
  - CSDP
Source Code – Non Linear Optimization

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  - DFO, Ipopt, SVM-QP
Source Code – Non Linear Optimization

- Semidefinite Programming
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- Non Linear Programming
  - DFO, Ipopt, SVM-QP
- Non Linear Integer Programming
  - Bonmin
Source Code – Utilities

- Graph representation
  - CGC
Source Code – Utilities

- Graph representation
  - CGC
- Metaheuristics
  - OTS
Source Code – Utilities

- **Graph representation**
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- **Modeling Language**
  - FLOPC++, NLPAPI
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- Data structures, linear algebra
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- Differentiation
  - CppAD
Additions in the Works

- Lagrangian Optimization
  - LaGO
- K-shortest paths
  - KshortestPaths
- Repository for problem instances
  - RPX
## Historical Perspective

<table>
<thead>
<tr>
<th>Year</th>
<th>Projects</th>
<th>OSI</th>
<th>CGL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2001</td>
<td>6</td>
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<td>3</td>
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<td>2002</td>
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<td>6</td>
</tr>
<tr>
<td>2003</td>
<td>13</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>2004</td>
<td>16</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>2005</td>
<td>22</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>2006</td>
<td>28</td>
<td>12</td>
<td>17</td>
</tr>
</tbody>
</table>
Projects Features

- different states of maturity, robustness, and documentation
- May depend on other projects
- Each project has a project manager
- May use different licenses
- Most use the Common Public License (CPL).
What is “Open Source”? 

- A category of software licenses
  - Must allow code to be used, shared, modified, and redistributed
  - Usually available for free download

- A philosophy
  - Healthy community of users and contributors
  - Helps to debug, enhance, and support the code
  - Similar to academic research
Other Names for Open Source

- Open-source software (OSS)
- Free and Open-Source Software (FOSS)
- Free/Libre and Open-Source Software (FLOSS)
- Free Software
Common Misconceptions about Open Source

- All open-source licenses are the same.

False. There are a variety of licenses with different specific requirements.

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### Examples of Open-Source Software

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<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Systems</td>
<td>GNU/Linux, FreeBSD</td>
</tr>
<tr>
<td>System Tools</td>
<td>Apache, BIND (DNS), gcc/g++/...</td>
</tr>
<tr>
<td>Middleware</td>
<td>MySQL</td>
</tr>
<tr>
<td>Applications</td>
<td>Firefox, OpenOffice.org, \TeX/\LaTeX, Emacs</td>
</tr>
</tbody>
</table>
Many other open-source tools for OR.

- R
- Octave
- GOBLIN
- LEMON
- Fast Artificial Neural Network
- GNU Linear Programming Kit (GLPK)
- Cliquer
Why Using COIN-OR Software?

What

Why and How

COIN-OR Foundation

Recent and Current News
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- Researchers and industry can participate
- Easier, fairer, faster comparison
- Distributed computing without licensing
Testing COIN-OR Software

- Binaries from www.coin-or.org (in progress)
- Tar and zip balls from www.coin-or.org
- NEOS server (Bonmin, Clp, Cbc, csdp, Ipopt)
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- Peer review for code, “publication” of code
- Paper description of algorithms usually not enough to reimplement
- Community help in debugging and maintaining the code
COIN-OR Facilities

- Build system (autoconf, automake)
- Multiple platform distribution
- Trac pages
- Bug reporting system
- Mailing lists
Submitting a New Project

Acceptance Terms:

- Useful to other OR professionals
- Promotes development of OR software
- Open source License (any OSI-approved)
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Technical requirements:
- “Development” or “Production” project
- README, INSTALL, AUTHORS, LICENSE
- Build and run on at least one platform
- Test for successful installation
- Willingness to maintain the code for a while
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Legal requirements:
- Intellectual Property related issues
- Open Source Initiative approved license
Brief History of COIN-OR

- Initiative started in 2000
- Announced at ISMP 2000 Atlanta
- Originally hosted by IBM (no longer true)
- Originally only for optimization (no longer true)
- Scope broadened to include all of operations research around 2002-2003
- COIN-OR Foundation established in 2004 to manage the initiative
- DIMACS Workshop on COIN-OR 2006
Corporate Relations

A number of corporations use and/or contribute to COIN-OR:

- IBM
- Maximal Software
- Schneider National
- Sandia National Labs
- GAMS
- Frontline Systems
- (more)
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Statistic from 2005: industry accounts for 37% of coin-discuss email list posts
Many Academic Institutions Are Represented

- Brunel
- Carl von Ossitzky U, Oldenburg
- Carnegie Mellon
- Clemson
- Cornell
- Konrad Zuse Zentrum Berlin
- Lehigh
- New Mexico Tech
- Northwestern
- Politecnico di Milano
- Rutgers
- Simon Fraser
- U de Geneve
- U of Arizona
- U of Chicago
- U of Pittsburgh
- U of São Paulo
- U of Washington
- U.S. Air Force Academy
- (probably others)
Incorporation in 2004

- Managed by the COIN-OR Foundation, Inc.
- Incorporated in the U.S. in 2004
- Recognized as a tax-exempt, educational foundation by the IRS
- Elected leadership
- Similar to other professional societies
- Repository hosted by INFORMS for a nominal fee
Structure of COIN-OR

- Strategic Leadership Board (SLB)
- Technical Leadership Council (TLC)
- Project Managers
- Project Repositories, Webpages, Email Lists
- Users
  - Associate Members
  - Full Members
Current Leadership of COIN-OR

Technical Leadership Council (TLC)

- JP Fasano, IBM
- Laszlo Ladanyi, IBM
- Leo Lopes, U of Arizona
- Francois Margot, Carnegie Mellon U
- Kipp Martin, U of Chicago
- Ted Ralphs, Lehigh U
- Andreas Wächter, IBM
Current Leadership of COIN-OR

Strategic Leadership Board (SLB)

- Bob Fourer, Northwestern U
- Lou Hafer, Simon Fraser U
- Brady Hunsaker, U of Pittsburgh, Secretary
- Randy Kiefer, INFORMS
- Kevin Furman, Exxon Mobil
- Robin Lougee-Heimer, IBM
- Matt Saltzman, Clemson U, President
- A representative of the Technical Leadership Council
Recent News: Logo

- Design contest held in summer 2006. Full and Associate Members voted for the winner. (65 entries)
- Winning design by Seprian Damayanto.
Held July 2006 at DIMACS in New Jersey, USA

Four-day workshop sponsored by DIMACS and IBM Research

Over 50 participants

Over 25 presentations, tutorials, and panel discussions

Thanks to the organizers:

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- A key issue discussed: We need to make projects easier for users to acquire, configure, and use.
Recent Work: Development Tools

- Move repository from cvs to subversion
- Trac system
- To ease configuration and installation, most projects now use Automake/Autoconf.
  - ./configure
  - make
  - make install
- Version numbering, stable releases
Work in Progress: Precompiled Binaries

- Creating binaries for download.
- Planned platforms: Windows, GNU/Linux, Mac OS X
- Some projects are not amenable to binaries
- Due to license incompatibilities, a few features may not be distributed in binaries (such as GMPL model parser integration with Cbc).
Challenges

General goals:
- Ease-of-use (downloading, building, user interface)
- Documentation
- Recognition/awareness
- Research “credit” (analog for peer-review)

Technical:
- Testing
- Supporting multiple platforms
- Stability
- rpms for popular GNU/Linux distributions.
On the Horizon

- Releases, binaries, packages
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- Analog for peer-review (??)
Helping COIN-OR

- Use COIN-OR resources
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- Send feedback through email lists and issue-tracking system
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For More Info

www.coin-or.org