



COIN-OR
Status Report

Matthew
Saltzman,
François
Margot

What

Why and How

COIN-OR
Foundation

Recent and
Current News

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

Matthew Saltzman, François Margot

Associate Professor of Mathematical Sciences, Clemson University
President, COIN-OR Foundation

Tepper School of Business, Carnegie Mellon University
Member, Technical Leadership Council

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



Outline

COIN-OR
Status Report

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Recent and
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- ▶ 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
 - ▶ Structure
- ▶ Recent and Current News
- ▶ Future Challenges



What is COIN-OR?

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Recent and
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► Computational INfrastructure for Operations Research



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Recent and
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- ▶ COmputational INfrastructure for Operations Research
- ▶ a **repository** of source code, examples, models, data



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- ▶ available for use and modification at no cost



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- ▶ Multi-platform (Linux, Unix, Windows, ...)



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- ▶ Multi-platform (Linux, Unix, Windows, ...)
- ▶ under open-source licenses



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- ▶ a **community** of users, contributors, volunteers



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- ▶ Multi-platform (Linux, Unix, Windows, ...)
- ▶ under open-source licenses
- ▶ a **community** of users, contributors, volunteers
- ▶ a **non-profit foundation** with elected leadership



Source Code – Linear Optimization

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Recent and
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- ▶ Linear Programming
 - ▶ Clp, DyLP, Vol



Source Code – Linear Optimization

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- ▶ Linear Programming
 - ▶ Clp, DyLP, Vol
- ▶ Integer Linear Programming
 - ▶ ALPS, BCP, Cbc, COPS, SYMPHONY



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 - ▶ Clp, DyLP, Vol
- ▶ Integer Linear Programming
 - ▶ ALPS, BCP, Cbc, COPS, SYMPHONY
- ▶ Stochastic Linear Programming
 - ▶ SMI



Source Code – Non Linear Optimization

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- ▶ Semidefinite Programming
 - ▶ CSDP



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- ▶ Semidefinite Programming
 - ▶ CSDP
- ▶ Non Linear Programming
 - ▶ DFO, Ipopt, SVM-QP



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- ▶ Non Linear Programming
 - ▶ DFO, Ipopt, SVM-QP
- ▶ Non Linear Integer Programming
 - ▶ Bonmin



Source Code – Utilities

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Source Code – Utilities

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Recent and
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- ▶ Graph representation
 - ▶ CGC



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- ▶ Graph representation
 - ▶ CGC
- ▶ Metaheuristics
 - ▶ OTS



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 - ▶ OTS
- ▶ Modeling Language
 - ▶ FLOPC++, NLPAPI



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 - ▶ FLOPC++, NLPAPI
- ▶ Interface with solvers
 - ▶ OSI



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 - ▶ OSI
- ▶ Cut generators
 - ▶ CGL



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- ▶ Cut generators
 - ▶ CGL
- ▶ Data structures, linear algebra
 - ▶ CoinUtils



Source Code – Utilities

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 - ▶ CGL
- ▶ Data structures, linear algebra
 - ▶ CoinUtils
- ▶ Differentiation
 - ▶ CppAD



Additions in the Works

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Recent and
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- ▶ Lagrangian Optimization
 - ▶ LaGO
- ▶ K -shortest paths
 - ▶ KshortestPaths
- ▶ Repository for problem instances
 - ▶ RPX



Historical Perspective

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Current News

Year	Projects	OSI	CGL
2000	4	3	2
2001	6	4	3
2002	9	7	6
2003	13	8	6
2004	16	11	9
2005	22	12	15
2006	28	12	17



Projects Features

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Recent and
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- ▶ 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” ?

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Current News

- ▶ 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

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Recent and
Current News

- ▶ Open-source software (OSS)
- ▶ Free and Open-Source Software (FOSS)
- ▶ Free/Libre and Open-Source Software (FLOSS)
- ▶ Free Software



Common Misconceptions about Open Source

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Recent and
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- ▶ All open-source licenses are the same.



Common Misconceptions about Open Source

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Recent and
Current News

- ▶ All open-source licenses are the same.
 - ▶ False. There are a variety of licenses with different specific requirements.



Common Misconceptions about Open Source

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- ▶ All open-source licenses are the same.
 - ▶ False. There are a variety of licenses with different specific requirements.
- ▶ “Free for academic use only” is open source.



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 - ▶ False. Open-source licenses must have the same conditions for any user.



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- ▶ “Free for academic use only” is open source.
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- ▶ Open source is the same as freeware/shareware.



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 - ▶ False. There are a variety of licenses with different specific requirements.
- ▶ “Free for academic use only” is open source.
 - ▶ False. Open-source licenses must have the same conditions for any user.
- ▶ Open source is the same as freeware/shareware.
 - ▶ False. The source code must be available for use, modification, and redistribution.



Examples of Open-Source Software

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Operating Systems	GNU/Linux FreeBSD
System Tools	Apache BIND (DNS) gcc/g++/...
Middleware	MySQL
Applications	Firefox OpenOffice.org TEX/L ^A T _E X Emacs



Other Open-source Tools for OR

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Recent and
Current News

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 ?

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Recent and
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- ▶ The price is right



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Recent and
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- ▶ The price is right
- ▶ Reuse rather than reinvent



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Recent and
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- ▶ Reuse rather than reinvent
- ▶ Can modify code



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Recent and
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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Can modify code
- ▶ Build on high-quality code



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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Can modify code
- ▶ Build on high-quality code
- ▶ Leverage support of the community



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- ▶ Build on high-quality code
- ▶ Leverage support of the community
- ▶ Researchers and industry can participate



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- ▶ Build on high-quality code
- ▶ Leverage support of the community
- ▶ Researchers and industry can participate
- ▶ Easier, fairer, faster comparison



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- ▶ Build on high-quality code
- ▶ Leverage support of the community
- ▶ Researchers and industry can participate
- ▶ Easier, fairer, faster comparison
- ▶ Distributed computing without licensing



Testing COIN-OR Software

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Recent and
Current News

- ▶ Binaries from `www.coin-or.org` (in progress)
- ▶ Tar and zip balls from `www.coin-or.org`
- ▶ NEOS server (Bonmin, Clp, Cbc, csdp, Ipopt)



Why Submitting to COIN-OR ?

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Recent and
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- ▶ Allow for easier comparison



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Recent and
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- ▶ Allow for easier comparison
- ▶ Exposure



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Recent and
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- ▶ Allow for easier comparison
- ▶ Exposure
- ▶ Promote standard



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- ▶ Promote standard
- ▶ Foster collaboration



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- ▶ Allow for easier comparison
- ▶ Exposure
- ▶ Promote standard
- ▶ Foster collaboration
- ▶ Peer review for code, “publication” of code



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- ▶ Paper description of algorithms usually not enough to reimplement



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- ▶ Foster collaboration
- ▶ 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

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Recent and
Current News

- ▶ Build system (autoconf, automake)
- ▶ Multiple platform distribution
- ▶ Trac pages
- ▶ Bug reporting system
- ▶ Mailing lists



Submitting a New Project

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Recent and
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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

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- ▶ 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



COIN-OR Community

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Individuals





Corporate Relations

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



▶ Sandia National Labs

▶ GAMS

▶ Frontline Systems

▶ (more)



Corporate Relations

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▶ Sandia National Labs

▶ GAMS

▶ Frontline Systems

▶ (more)

▶ Statistic from 2005: industry accounts for 37% of coin-discuss email list posts



Many Academic Institutions Are Represented

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- ▶ 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

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- ▶ 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

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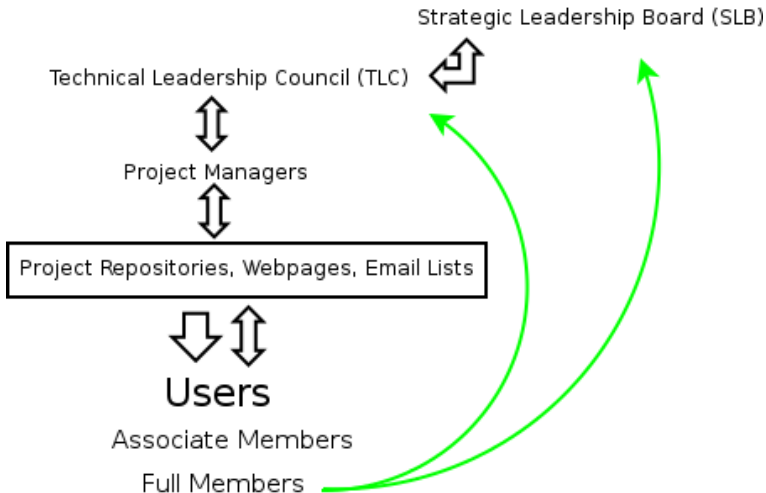
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Current Leadership of COIN-OR

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Technical Leadership Council (TLC)

- ▶ JP Fasano, IBM
- ▶ Laszlo Ladanyi, IBM
- ▶ Leo Lopes, U of Arizona
- ▶ François Margot, Carnegie Mellon U
- ▶ Kipp Martin, U of Chicago
- ▶ Ted Ralphs, Lehigh U
- ▶ Andreas Wächter, IBM



Current Leadership of COIN-OR

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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



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Current News

- ▶ Design contest held in summer 2006. Full and Associate Members voted for the winner. (65 entries)
- ▶ Winning design by Seprian Damayanto.



DIMACS Workshop on COIN-OR

COIN-OR
Status Report

Matthew
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Margot

What

Why and How

COIN-OR
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Recent and
Current News

- ▶ 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:
 - ▶ Jonathan Eckstein
 - ▶ Jeff Linderoth
 - ▶ Robin Lougee-Heimer
 - ▶ Francois Margot



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- ▶ Thanks to the organizers:
 - ▶ Jonathan Eckstein
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 - ▶ Robin Lougee-Heimer
 - ▶ Francois Margot
- ▶ A key issue discussed: **We need to make projects easier for users to acquire, configure, and use.**



Recent Work: Development Tools

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- ▶ 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

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- ▶ 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 GPL model parser integration with Cbc).



Challenges

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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.



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- ▶ Releases, binaries, packages



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- ▶ Releases, binaries, packages
- ▶ More work with standards for instances and models



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- ▶ More work with standards for instances and models
- ▶ Taking care of growing pains



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- ▶ Wiki documentation efforts



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- ▶ Wiki documentation efforts
- ▶ Analog for peer-review (??)



Helping COIN-OR

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- ▶ Use COIN-OR resources



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- ▶ Use COIN-OR resources
- ▶ Send feedback through email lists and issue-tracking system



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For More Info

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