



COIN-OR  
Triennial  
Update

Brady  
Hunsaker

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Recent and  
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Future

# COIN-OR: Open-source Software for Operations Research Triennial Update

Brady Hunsaker

Assistant Professor, University of Pittsburgh  
Secretary, COIN-OR Foundation

Thanks to Robin Lougee-Heimer and Brenda Dietrich

ISMP 2006



# Outline

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- ▶ What
  - ▶ What is COIN-OR?
  - ▶ What is open-source software?
- ▶ Why and How
  - ▶ Why should I participate in COIN-OR?
  - ▶ How can I participate in COIN-OR?
- ▶ Recent and Current News
- ▶ Future Challenges



# What is COIN-OR?

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- ▶ COmputational INfrastructure for Operations Research



# What is COIN-OR?

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





# What is COIN-OR?

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- ▶ Computational INFrastructure for Operations Research
- ▶ a **repository** of source code, examples, models, data
- ▶ available for use and modification at no cost



# What is COIN-OR?

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- ▶ COmputational INfrastructure for Operations Research
- ▶ a **repository** of source code, examples, models, data
- ▶ available for use and modification at no cost
- ▶ under open-source licenses



# What is COIN-OR?

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- ▶ COmputational INfrastructure for Operations Research
- ▶ a **repository** of source code, examples, models, data
- ▶ available for use and modification at no cost
- ▶ under open-source licenses
- ▶ a **community** of users, contributors, volunteers



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- ▶ COmputational INfrastructure for Operations Research
- ▶ a **repository** of source code, examples, models, data
- ▶ available for use and modification at no cost
- ▶ under open-source licenses
- ▶ a **community** of users, contributors, volunteers
- ▶ a **non-profit foundation** with elected leadership



# What is “Open Source”?

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



# Other Names for Open Source

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- ▶ Open-source software
- ▶ Free/Libre and Open-Source Software (FLOSS)
- ▶ Free and Open-Source Software (FOSS)
- ▶ Free Software
- ▶ Brady's opinion: These names reflect the speaker's philosophy, but all apply to the same software.



# Common Misconceptions about Open Source

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- ▶ All open-source licenses are the same.

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# 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.



# 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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- ▶ All open-source licenses are the same.
  - ▶ False. There are a variety of licenses with different specific requirements.
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  - ▶ False. Open-source licenses must have the same conditions for any user.



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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.



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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.
  - ▶ 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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# Examples of Open-Source Software

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Operating Systems	GNU/Linux FreeBSD
System Tools	Apache Bind (DNS)
Middleware	MySQL
Applications	Firefox OpenOffice TeX/LaTeX Emacs



# Other Open-source Tools for OR

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There are plenty of other open-source tools for OR.

- ▶ R
- ▶ Octave
- ▶ GOBLIN
- ▶ LEMON
- ▶ Fast Artificial Neural Network
- ▶ GNU Linear Programming Kit (GLPK)
- ▶ Cliquer





# 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



# Current Projects: Stand-alone Solvers/tools

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- ▶ LP solvers: COIN-OR LP (CLP), Dynamic LP (dylp), Volume Algorithm (VOL)
- ▶ MILP solvers: COIN-OR Branch-and-Cut (CBC), SYMPHONY
- ▶ Nonlinear solver: Interior-Point Optimizer (IPOPT) (not quite stand-alone)
- ▶ Nonlinear integer solver: Basic Open-source Nonlinear Mixed INteger programming (BONMIN)
- ▶ Semidefinite programming: CSDP
- ▶ Derivative-Free Optimization (DFO)
- ▶ Support Vector Machine Quadratic Programming (SVM-QP)



# Current Projects: Frameworks

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- ▶ Abstract Library for Parallel Search (ALPS)
- ▶ Branch-Cut-Price (BCP)
- ▶ Open Tabu Search (OTS)



# Current Projects: Interfaces/APIs/Modeling

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- ▶ Open Solver Interface (OSI): for LP/MILP (11 solvers supported)
- ▶ Non-Linear Programming API (NLPAPI)
- ▶ Stochastic Modeling Interface (SMI)
- ▶ FLOPC++: algebraic modeling language embedded in C++
- ▶ CoinMP: easy-to-use C API for CLP, CBC, and CGL (Windows DLL and Unix)



# Current Projects: Other

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- ▶ Cut Generator Library (CGL)
- ▶ CppAD: differentiation of C++ function
- ▶ Multifario: computing implicitly-defined manifolds
- ▶ CoinUtils: utilities such as sparse matrix manipulation and I/O



# Projects Are Separate

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- ▶ Projects have different states of maturity, robustness, and documentation.
- ▶ Some projects depend on other projects.
- ▶ Many projects develop their own user community.
- ▶ Each project has a project manager.
- ▶ Projects may use different licenses, but each project is completely under one license.
- ▶ Most current projects use the Common Public License (CPL).
- ▶ New project submissions are welcome.



# COIN-OR Community

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## Individuals





# Corporate Relations

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



▶ Sandia National Labs

▶ GAMS

▶ Frontline Systems

▶ (more)





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



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▶ (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)



# Why Use and Contribute to COIN-OR

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# Why Use and Contribute to COIN-OR

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► The price is right



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



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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Build on high-quality code



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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Build on high-quality code
- ▶ Promote standards



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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Build on high-quality code
- ▶ Promote standards
- ▶ Foster collaboration





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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Build on high-quality code
- ▶ Promote standards
- ▶ Foster collaboration
- ▶ Leverage support of the community



# Why Use and Contribute to COIN-OR

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- ▶ The price is right
- ▶ Reuse rather than reinvent
- ▶ Build on high-quality code
- ▶ Promote standards
- ▶ Foster collaboration
- ▶ Leverage support of the community
- ▶ Researchers and industry can participate



# Incorporation in 2004

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- ▶ The initiative is now managed by the COIN-OR Foundation, Inc.
- ▶ Incorporated in the U.S. in 2004
- ▶ Recognized as a tax-exempt corporation by the IRS
- ▶ Elected leadership
- ▶ Similar to other professional societies
- ▶ Repository now hosted by INFORMS for a nominal fee



# Structure of COIN-OR

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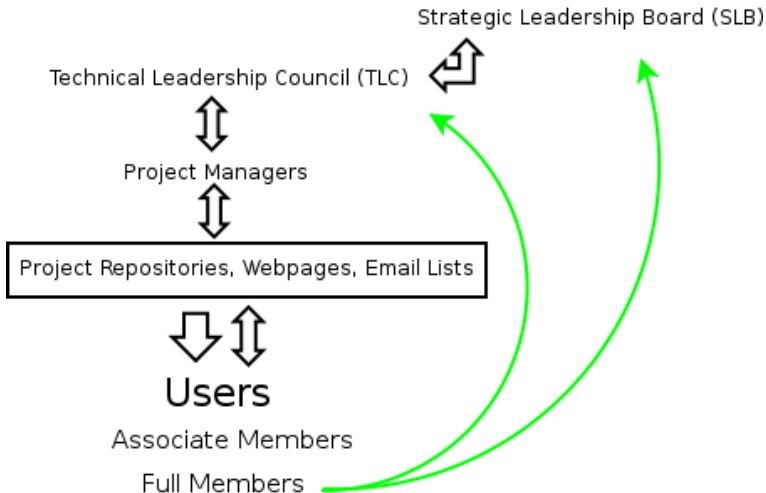
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# Current Leadership of COIN-OR

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## Technical Leadership Council (TLC)

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



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- ▶ Ted Ralphs, Lehigh U
- ▶ Andreas Wächter, IBM

Two seats are up for election this year.



# 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
- ▶ Bjarni Kristjansson, Maximal Software
- ▶ Robin Lougee-Heimer, IBM
- ▶ Matt Saltzman, Clemson U, President
- ▶ A representative of the Technical Leadership Council



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# Recent News: Logo

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



# Recent News: DIMACS Workshop on COIN-OR

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- ▶ Held two weeks ago 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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- ▶ 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
- ▶ 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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- ▶ To **ease configuration and installation**, most projects now use Automake/Autoconf.
- ▶ `./configure`  
`make`  
`make install`
- ▶ This change is very recent.
- ▶ Options when calling `configure` control the installation.



# Work in Progress: Numbered Releases

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- ▶ To **improve stability for users**, we are working to implement numbered releases for projects.
- ▶ These releases will have clearly specified dependencies.
- ▶ They will not change except for bug fixes.
- ▶ This will allow . . .



# Work in Progress: Precompiled Binaries

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- ▶ To **make life easier for users**, we have begun creating binaries for download.
- ▶ Planned platforms: Windows, GNU/Linux, Mac OS X
- ▶ Some projects are not amenable to binaries (such as OSI and BCP).
- ▶ Due to license incompatibilities, a few features may not be distributed in binaries (such as GPL model parser integration with CBC).
- ▶ We also hope to create packages for popular GNU/Linux distributions.



# Challenges

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- ▶ Ease-of-use (downloading, building, user interface)
- ▶ Documentation
- ▶ Supporting multiple platforms
- ▶ Stability
- ▶ Recognition/awareness
- ▶ Research “credit” (analog for peer-review)



# On the Horizon

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- ▶ Releases, binaries, packages





# On the Horizon

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



# On the Horizon

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- ▶ Releases, binaries, packages
- ▶ More work with standards for instances and models
- ▶ More data: Real Problem Exchange



# On the Horizon

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- ▶ Releases, binaries, packages
- ▶ More work with standards for instances and models
- ▶ More data: Real Problem Exchange
- ▶ Wiki documentation efforts



# On the Horizon

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- ▶ Releases, binaries, packages
- ▶ More work with standards for instances and models
- ▶ More data: Real Problem Exchange
- ▶ Wiki documentation efforts
- ▶ Analog for peer-review (??)



# Using COIN-OR

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- ▶ [www.coin-or.org](http://www.coin-or.org)
  - ▶ binaries for some projects
  - ▶ tarballs and Subversion/CVS
- ▶ NEOS: some COIN-OR solvers available
- ▶ Commercial Products: such as Frontline Systems
- ▶ Support
  - ▶ Free through email lists (see [www.coin-or.org](http://www.coin-or.org))



# Helping COIN-OR

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► Use COIN-OR resources

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# Helping COIN-OR

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



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- ▶ Use COIN-OR resources
- ▶ Send feedback through email lists and issue-tracking system
- ▶ Become an Associate Member (minimum donation of US\$10/5)





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- ▶ Join email lists; use your expertise to help other users



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- ▶ Convince your company to use/support COIN-OR



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- ▶ Write documentation!



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- ▶ Convince your company to use/support COIN-OR
- ▶ Write documentation!
- ▶ Volunteer to help with outreach: website, conferences



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- ▶ Contribute patches



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- ▶ Write documentation!
- ▶ Volunteer to help with outreach: website, conferences
- ▶ Contribute patches
- ▶ Improve existing projects



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- ▶ Contribute patches
- ▶ Improve existing projects
- ▶ Contribute a new project



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