There are many available resources for optimization.

- Optimization solvers
- Benchmark / test collections
- Software for reading and writing optimization problems
- ...
Extensible optimization infrastructure

Package ROI
- Manages extensions
  - Provides functions to create / solve / read / write optimization problems

Extensions
- Add solvers to ROI (ROI.plugin.*)
- Add reader / writer of different formats to ROI
- Add predefined optimization problems (ROI.models.*)
ROI for UseR

- Simple modeling language following the principles of R.

- Since optimization problems are stored in a single object they can be easily shared.

- Exploit different solver options by just changing the solver name.
ROI for Developer

- Removes dependence on a specific solver
- Increases portability
- Allows the use of a new solver with minimal (or no) code changes
- Eases access to test (benchmark) collections
What’s new?

ROI is on CRAN since 2011-10-06

- Conic optimization
- New solver plugins
- ROI manages reformulations
- Multiple solutions
- New models (ROI.models.*)
- ...

...
ROIs can Model

- **Objective**
  - Linear (L\_objective)
  - Quadratic (Q\_objective)
  - Functional (F\_objective)

- **Constraints**
  - Linear (L\_constraint)
  - Quadratic (Q\_constraint)
  - Conic (C\_constraint)
  - Functional (F\_constraint)
ROI can Model

- **Types**
  - "B"  binary
  - "I"  integer
  - "C"  continuous

- **Bounds**
  - $V_{\text{bound}}$

- **Minimum / Maximum**
Plugins are Available for

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>linear</td>
</tr>
<tr>
<td>no</td>
<td></td>
</tr>
<tr>
<td>box</td>
<td></td>
</tr>
<tr>
<td>linear</td>
<td>4, 4, 5</td>
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<tr>
<td>quadratic</td>
<td>1, 1, 3</td>
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<tr>
<td>conic</td>
<td>1, 1, 2</td>
</tr>
<tr>
<td>general nonlinear</td>
<td></td>
</tr>
</tbody>
</table>

binary, integer, continuous
Define Binary Linear Problem

R> m <- OP(L_objective(c(-1, -1, -1, -1, -99)),
+       L_constraint(L = rbind(c(1, 1, 0, 0, 0),
+                               c(0, 0, 1, 1, 0),
+                               c(0, 0, 0, 1, 1)),
+       dir = leq(3), rhs = rep.int(1, 3)),
+       types = rep("B", 5L))
R> m

ROI Optimization Problem:

Minimize a linear objective function of length 5 with
- 5 binary objective variables,

subject to
- 3 constraints of type linear.
- 0 lower and 0 upper non-standard variable bounds.
R> x <- ROI_solve(m, solver = "msbinlp", nsol_max = 2L)
R> x

2 optimal solutions found.
The objective value is: -1.010000e+02

R> solution(x)

[[1]]
[1] 0 1 1 0 1

[[2]]
[1] 1 0 1 0 1

R> solution(x, "status_code")

[[1]]
[1] 0

[[2]]
[1] 0
Reformulate

Reformulations are typically hidden within the optimization software. ROI allows register new reformulations and to work with them directly.

```r
R> bq <- OP(Q_objective(Q = rbind(c(0, 3, 0),
+       c(3, 0, 1),
+       c(0, 1, 0)),
+       L = c(-1, -4, -1)),
+       types = rep("B", 3))
R> milp <- ROI_reformulate(x = bq,
+       to = ROI_solver_signature("glpk"))
R> ROI_solve(milp)

Optimal solution found.
The objective value is: -4.000000e+00
```
Obtain Information

- List all registered (installed and loaded) solver plugins.
  R> names(ROI_registered_solvers())

  [1] "nlminb" "alabama" "cbc" "clp" "cplex"
  [6] "deoptim" "ecos" "glpk" "gurobi" "ipop"
  [11] "lpsolve" "mosek" "msbinlp" "nloptr" "optimx"
  [16] "quadprog" "scs" "symphony"

- List all registered (installed) solver plugins applicable.
  R> ROI_applicable_solvers(m)

  [1] "cbc" "cplex" "ecos" "glpk" "gurobi"
  [6] "lpsolve" "mosek" "msbinlp" "symphony"

- List all available solver plugins.
  R> ROI_available_solvers()[i, c("Package", "Repository")]

    Package Repository
    4 ROI.plugin.ecos https://cran.r-project.org/src/contrib
    12 ROI.plugin.scs https://cran.r-project.org/src/contrib
    29 ROI.plugin.cbc https://github.com/dirkschumach
Outlook and Future Work

- Add solvers (qpOASES, Couenne, ...)
- Add reader / writer
- Add benchmark collections (QPLIB, ...)
- Extend modeling capabilities of ROI
- ...
- ...
Thank you for your Attention

More information can be found at

http://roi.r-forge.r-project.org/

https://r-forge.r-project.org/projects/roi/

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