

ROI - R Optimization Infrastructure

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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.*)

- ▶ 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.

- ▶ 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

ROI is on CRAN since 2011-10-06

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

- ▶ Objective
 - ▶ Linear (L_objective)
 - ▶ Quadratic (Q_objective)
 - ▶ Functional (F_objective)

- ▶ Constraints
 - ▶ Linear (L_constraint)
 - ▶ Quadratic (Q_constraint)
 - ▶ Conic (C_constraint)
 - ▶ Functional (F_constraint)

- ▶ Types

- ▶ "B" binary
- ▶ "I" integer
- ▶ "C" continuous

- ▶ Bounds

- ▶ V_bound

- ▶ Minimum / Maximum

Constraints	Objective		
	linear	quadratic	general nonlinear
no			
box			0, 0, 1
linear	4, 4, 5		
quadratic	1, 1, 3	2, 2, 2	
conic	1, 1, 2		
general nonlinear			0, 0, 4

binary, integer, continuous

```
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
```

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

```
R> bqp <- 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 = bqp,  
+                          to = ROI_solver_signature("glpk"))  
R> ROI_solve(milp)
```

Optimal solution found.

The objective value is: -4.000000e+00

- ▶ 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/dirkschumacher

- ▶ Add solvers (qpOASES, Couenne, ...)
- ▶ Add reader / writer
- ▶ Add benchmark collections (QPLIB, ...)
- ▶ Extend modeling capabilities of ROI
- ▶ ...

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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