JuMP: open-source algebraic modeling in Julia
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What do we want in a modeling language?
- User friendliness
- Performance
- Low-level access to solver
- Solver independence
- Extensibility
- Ease of embedding
- Stability

Many modeling languages available, but no satisfying combination of features.

Typical trade-offs:
- User friendliness/performance
- Low-level access/solver independence

Julia opens a new space in the user friendliness/performance trade-off for programming languages.

What does this mean for:
- the practice of OR? See
- modeling languages?

JuMP
Optimization modeling language embedded in Julia

User friendliness
- Embedded in a high-level language
- Familiar syntax
- Complete documentation

Performance
- User’s algebraic statements translated to efficient matrix generator code by using Julia’s metaprogramming functionality

For example,
```julia
@addConstraint(m, sum(weight[i] * x[i], i=1:N) + s == capacity)
```
calls a Julia “macro” which generates the following code:
```julia
aff = AffExpr()
sizeshint!(aff, coerce, sumlen)
for i = 1:N
    addToExpression(aff, 1.0 * weight[i], x[i])
end
addToExpression(aff, -1.0, capacity)
addConstraint(m, Constraint(aff, "=="))
```

Solver independence
- Change solver = GurobiSolver() to solver = CplexSolver().
- Currently supports Cbc/Clp, CPLEX, GLPK, Mosek, and Gurobi
- Callbacks for CPLEX, Gurobi, GLPK

Nonlinear modeling
- Convex and nonconvex nonlinear objectives and constraints.
- Exact second derivatives computed by reverse-mode automatic differentiation, no dependency on AMPL
- Exploit sparsity via state-of-the-art graph coloring techniques
- Solution with Ipopt
- Expression trees available for MINLP solvers (none connected yet)

Future work
- More supported MIP solvers (SCIP)
- MINLP (SCIP/Couenne/...)
- Branching callbacks
- Algebraic support for disjunctive models

Who’s using JuMP?
- “Integer Programming” and “OR Software Tools” courses at MIT
- Intro. to Multidisplinary Design Optimization” at Stanford
- Los Alamos and Argonne Natl. Labs
- Gadfly.jl plotting package (MIP for optimal graphical layouts!)

http://juliaopt.org