



JuMP + HiGHS

Oscar Dowson

HiGHS workshop 2025

Outline

What is JuMP

HiGHS.jl

Who's using HiGHS.jl

MIP reformulations

Wish list

What is JuMP?

Part of the zoo of algebraic modeling languages



CMPL, CPLEX Concert, GNU MathProg, Gurobi C++/Python API, linopy, MATLAB, Mosek Fusion, MOSEL, ompr, OPTMODEL, PuLP, PyOptInterface, Python-MIP, YALMIP, ZIMPL,

...

What is JuMP?

An open-source algebraic modeling language in Julia

```
using JuMP, HiGHS
function solve_knapsack(; w::Vector, c::Vector, W::Float64)
    model = Model(HiGHS.Optimizer)
    @variable(model, 0 <= x[1:length(c)] <= 1, Bin)
    @constraint(model, sum(wi * xi for (wi, xi) in zip(w, x)) <= W)
    @objective(model, Min, c' * x)
    optimize!(model)
    return value.(x)
end
x = solve_knapsack(; w = rand(30), c = rand(30), W = 10)
```

What is JuMP?

Statistics of the github.com/jump-dev organization

- Under development since 2013
- Supports all major problem types, including MIP, NLP, SDP
- > 50 connected solvers
- > 60 repositories in github.com/jump-dev

In the last year

- > 10,000 downloads/month
- > 1,000 pull requests
- > 300 issues opened
- > 50 contributors

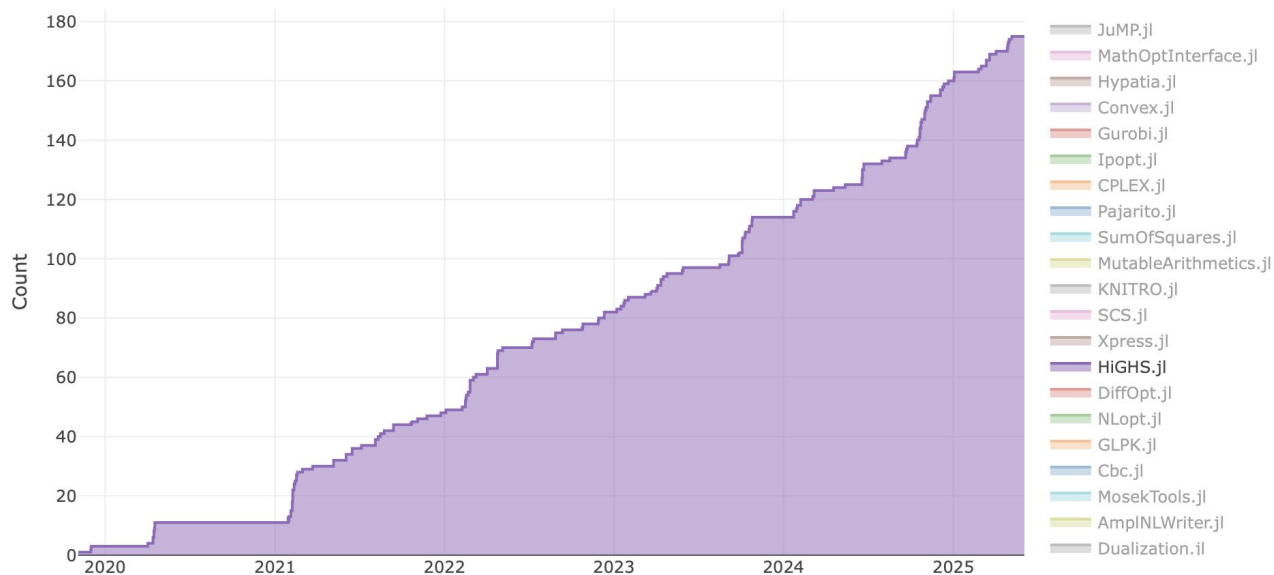
What is HiGHS.jl

The Julia interface to HiGHS

- github.com/jump-dev/HiGHS.jl
- A Julia package
- Wraps the complete C API. It can do anything C can do
- Provides an interface to JuMP
- Under development since 2019
- 12 contributors
- ~6,000 lines of Julia code

HiGHS.jl

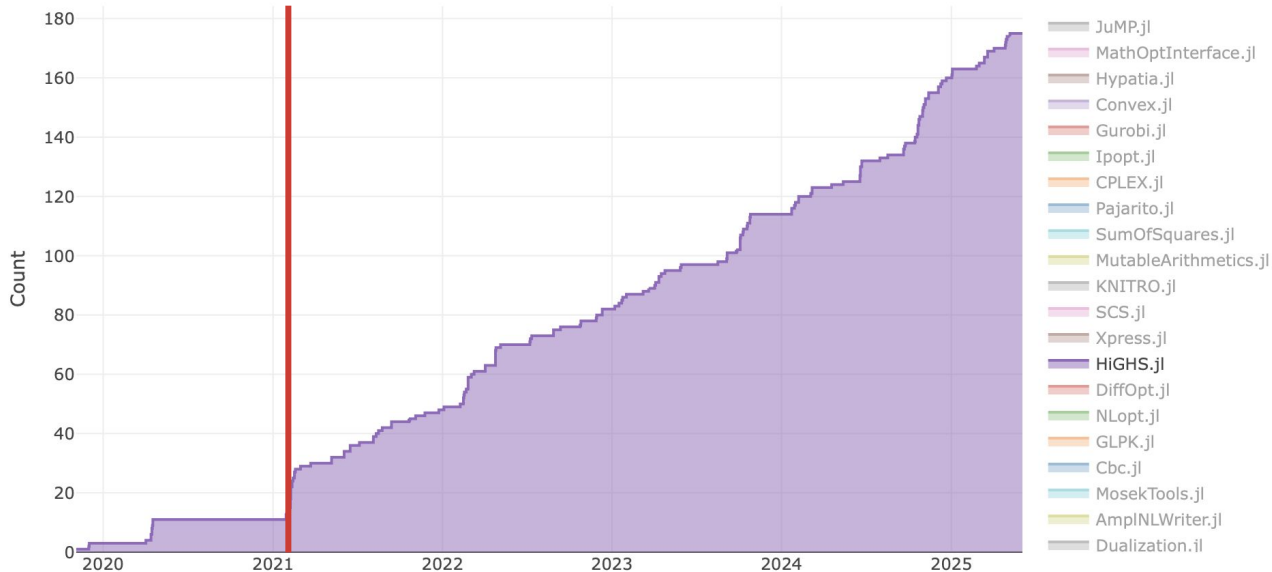
A history



HiGHS.jl

A history

Official Julia release



Mathieu Besançon
matbesancon · he/him

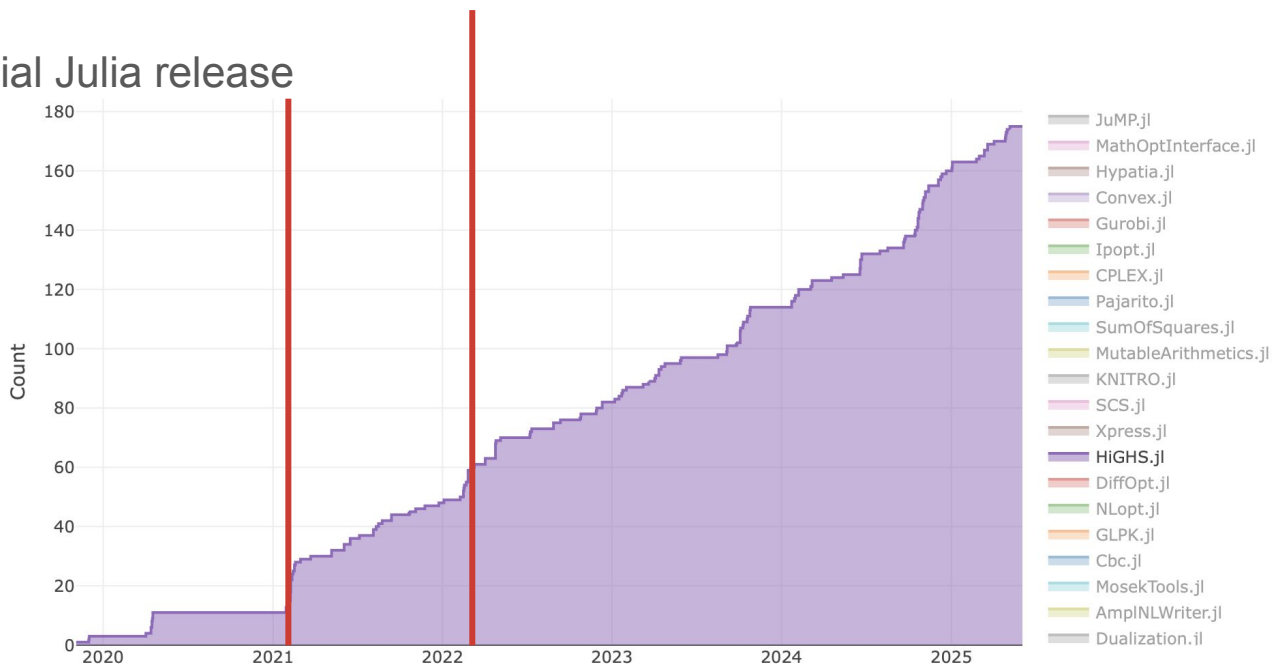
HiGHS.jl

A history

[HiGHS.jl](#) v1.0 release

Started using HiGHS in JuMP documentation

Official Julia release



Mathieu Besançon
matbesancon · he/him

HiGHS.jl

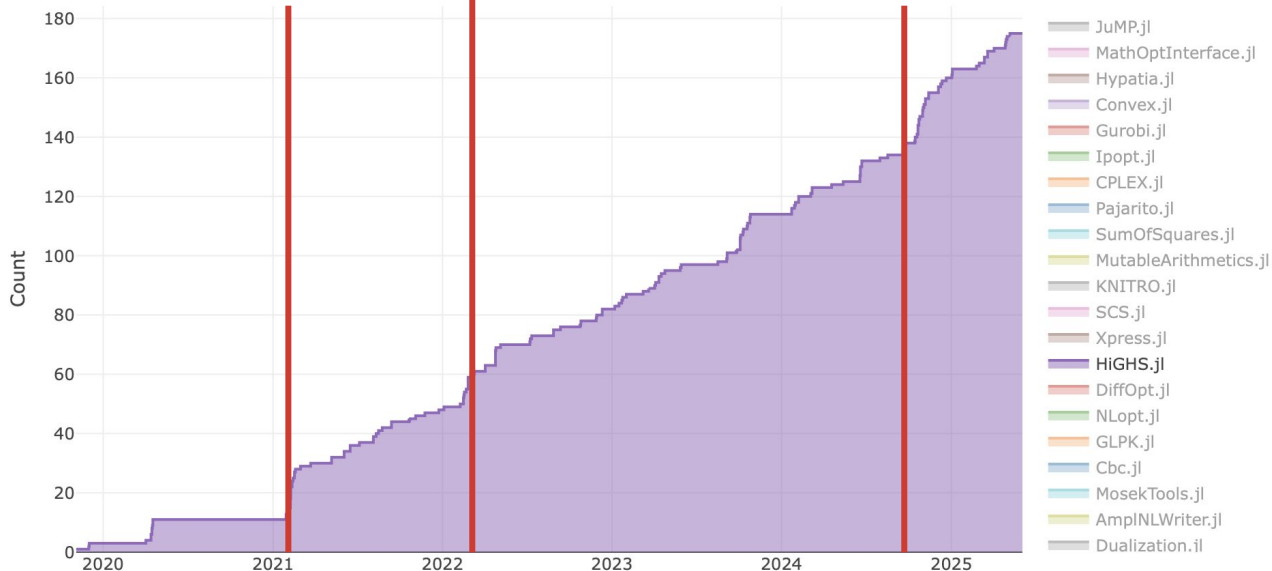
A history

[HiGHS.jl](#) v1.0 release

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HiGHS+JuMP Breakthrough grant



Mathieu Besançon
matbesancon · he/him

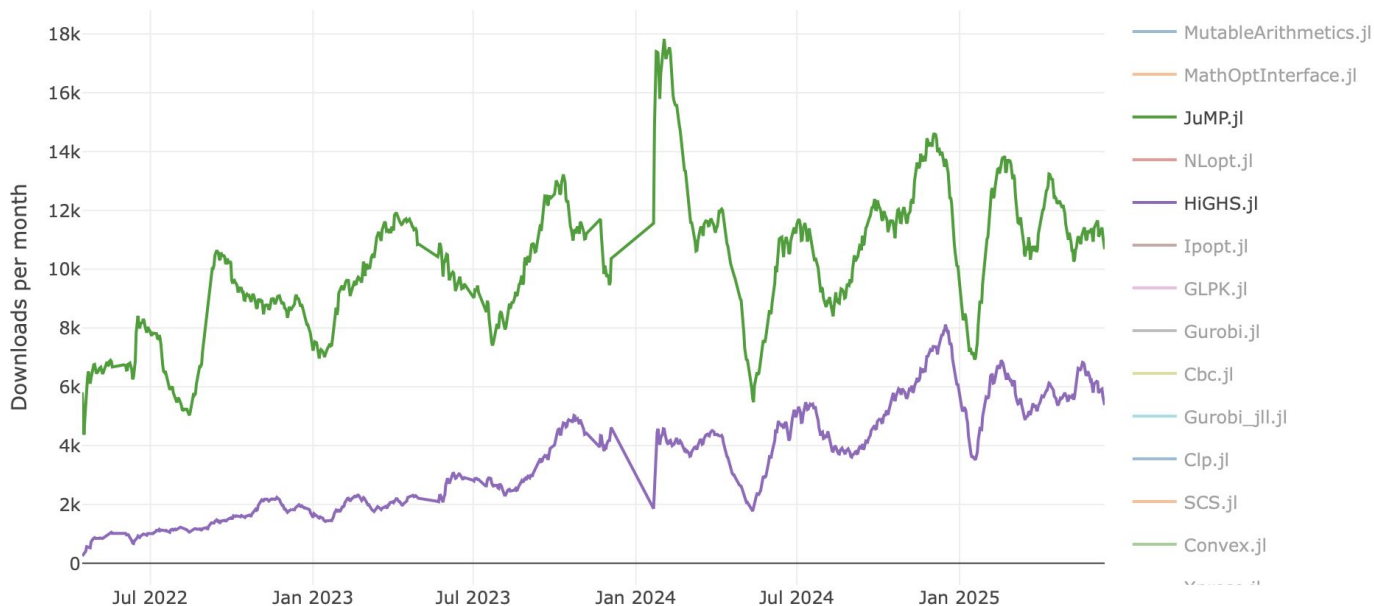
Who's using HiGHS.jl

Who's using HiGHS.jl

***we don't collect identifiable statistics. Look at trend, not absolute**

User downloads by package

A chart of 28-day moving average of approximate monthly download statistics from Julia's package servers.



Who's using HiGHS.jl

>1k projects on GitHub

github.com/search?q=87dc4568-4c63-4d18-b0c0-bb2238e4078b

Filter by

- <> Code 1k
- Repositories 0
- Issues 7
- Pull requests 3
- Discussions 0
- Users 0
- Commits 180
- Packages 0
- Wikis 0
- Topics 0
- Marketplace 0

Languages

- TOML
- Julia
- Text
- More languages...

Repositories

- datejada/rolling-horizon-example

1k files (532 ms)

jump-dev/JuMP.jl · docs/Project.toml TOML · master

```
16 ForwardDiff = "f6369f11-7733-5829-9624-2563aa707210"
17 Gurobi = "2e9cd046-0924-5485-92f1-d5272153d98b"
18 HTTP = "cd3eb016-35fb-5094-929b-558a96fad6f3"
19 HiGHS = "87dc4568-4c63-4d18-b0c0-bb2238e4078b"
20 Images = "916415d5-f1e6-5110-898d-aaa5f9f070e0"
21 Interpolations = "a98d9a8b-a2ab-59e6-89dd-64a1c18fca59"
22 Ipopt = "b6b21f68-93f8-5de0-b562-5493be1d77c9"
```

jbrema/MCcourse · extras/transfer_learning.jl Julia · main

```
935 [[deps.HiGHS]]
936 deps = ["HiGHS_jll", "MathOptInterface", "PrecompileTools", "SparseArrays"]
937 git-tree-sha1 = "fce13308f09771b160232983cad57be39a8a0ebb"
938 uuid = "87dc4568-4c63-4d18-b0c0-bb2238e4078b"
939 version = "1.7.5"
940
941 [[deps.HiGHS_jll]]
```

plasmio-dev/Plasmio.jl · examples/Manifest.toml TOML · main

```
116 [[deps.HiGHS]]
117 deps = ["HiGHS_jll", "MathOptInterface", "PrecompileTools", "SparseArrays"]
118 git-tree-sha1 = "a216e32299172b83abfe699604584f413ffbb045"
119 uuid = "87dc4568-4c63-4d18-b0c0-bb2238e4078b"
120 version = "1.9.0"
121
```

Who's using HiGHS.jl

Julia packages



Thomas Christensen
thchr

Follow

45 followers · 2 following

Technical University of Denmark

thomas@dtu.dk

<https://thchr.github.io/>

README MIT license

PresentationScheduling.jl

CI: passing codecov: 87%

Schedule a list of meetings, distributing research and journal club presentations so as to maximize the time-separation between presentations by the same individual.

Example

```
using PresentationScheduling

dates = Date("2024-08-28"):Week(2):Date("2024-12-18")
individuals = ["John", "Jane", "Bob", "Alice", "Sven", "Luis", "Jean", "Malcolm"]

presentations_modify = Dict{"Malcolm" => 1, "Alice" => 3}
journals_modify = Dict{"Malcolm" => 0, "Alice" => 0, "Sven" => 0}
cannot_attend = Dict{"Malcolm" => dates[3:end]}

schedule = optimize_presentation_schedule(
    individuals, dates, presentations_modify, journals_modify, cannot_attend;
    default_presentations=2,
    min_total=2,
    max_total=3,
    min_presentations=1,
    max_presentations=3,
    min_journals=0,
    max_journals=1,
    time_limit=20)


```

Which returns a `PresentationSchedule` that displays as a time-table:

```
julia> schedule
+ research presentation  journal club  cannot attend

  
```

	28/8	11/9	25/9	9/10	23/10	6/11	20/11	4/12	18/12
John	■			■		■	■		■
Jane		■							
Bob	■			■				■	■
Alice			■			■	■		■
Sven									
Luis		■			■				■
Jean	■							■	
Malcolm		■	■	■	■	■	■	■	■

objective value (total badness): 0.3443877551028488

Who's using HiGHS.jl

Julia packages



Neel Smith

neelsmith

Follow

53 followers · 3 following

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MiseEnPage.jl

Analyze the layout of manuscript pages edited following the conventions of the Homer Multitext project.

See the [documentation](#).

Visualizations

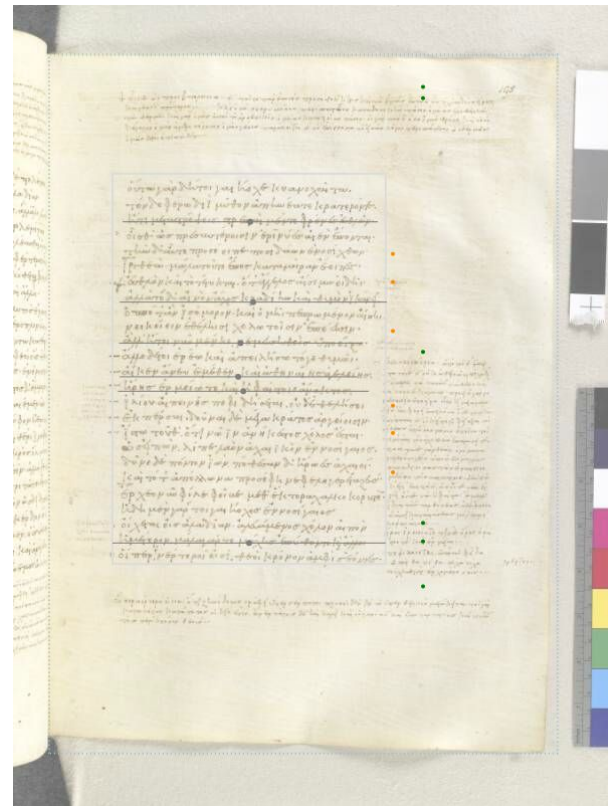
Interactive Pluto notebook: optimizing placement of *scholia* under the proximity hypothesis:

```
julia> [1, 0.12], [3, 0.09], [4, 0.09], [6, 0.04], [7, 0.1], [12, 0.09], [14, 0.12], [15, 0.09], [16, 0.04], [17, 0.1], [18, 0.09], [19, 0.12], [20, 0.09], [21, 0.12], [22, 0.09], [23, 0.12], [24, 0.09], [25, 0.12], [26, 0.09], [27, 0.12], [28, 0.09], [29, 0.12], [30, 0.09], [31, 0.12], [32, 0.09], [33, 0.12], [34, 0.09], [35, 0.12], [36, 0.09], [37, 0.12], [38, 0.09], [39, 0.12], [40, 0.09], [41, 0.12], [42, 0.09], [43, 0.12], [44, 0.09], [45, 0.12], [46, 0.09], [47, 0.12], [48, 0.09], [49, 0.12], [50, 0.09], [51, 0.12], [52, 0.09], [53, 0.12], [54, 0.09], [55, 0.12], [56, 0.09], [57, 0.12], [58, 0.09], [59, 0.12], [60, 0.09], [61, 0.12], [62, 0.09], [63, 0.12], [64, 0.09], [65, 0.12], [66, 0.09], [67, 0.12], [68, 0.09], [69, 0.12], [70, 0.09], [71, 0.12], [72, 0.09], [73, 0.12], [74, 0.09], [75, 0.12], [76, 0.09], [77, 0.12], [78, 0.09], [79, 0.12], [80, 0.09], [81, 0.12], [82, 0.09], [83, 0.12], [84, 0.09], [85, 0.12], [86, 0.09], [87, 0.12], [88, 0.09], [89, 0.12], [90, 0.09], [91, 0.12], [92, 0.09], [93, 0.12], [94, 0.09], [95, 0.12], [96, 0.09], [97, 0.12], [98, 0.09], [99, 0.12], [100, 0.09]
```

Page height: 350
Number of notes to plot: 6

IAIAZ

Results of analysis, Venetus A, folio 195 recto: theoretical y position under the proximity hypothesis versus actual y positions:



Who's using HiGHS.jl

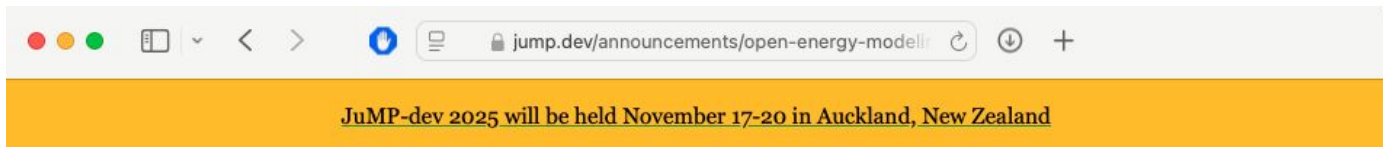
Energy system modellers

AnyMOD.jl, Dolphyn.jl, ElectricityEmissions.jl, EnergyModelsX, GenX.jl, IESopt.jl, MacroEnergy.jl, PowerModelsONM.jl, PowerModelsWildfire.jl, PowerSimulations.jl, SpineOpt.jl, TulipaEnergyModel.jl, UnitCommitment.jl, WaterModels.jl, ...

tl;dr: HiGHS is used by many groups, all around the world, to solve energy related optimization problems from real-time operation of a battery through long-term planning of continental-scale systems

Who's using HiGHS.jl

Energy system modellers



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JuMP and HiGHS join forces to improve open energy modeling

[announcements](#), [open-energy-modeling](#) · 16 Sep 2024

Author: Miles Lubin, Carleton Coffrin, Oscar Dowson, Julian Hall, and Changhyun Kwon

The [JuMP Steering Committee](#) is pleased to announce that we, through [NumFOCUS](#), have received a large grant from the [Breakthrough Energy Foundation](#) to improve the performance of JuMP and [HiGHS](#) on open energy models.

In our recent post, [Steering Committee changes](#), we announced that Juan Pablo was stepping and Julian Hall (the lead developer of HiGHS) was joining the committee: this grant was the reason!

MIP reformulations

Bridging the gap between user formulations and the solver

MIP reformulations

Bridging the gap between user formulations and the solver

```
using JuMP, HiGHS
```

```
model = Model(HiGHS.Optimizer)
```

```
@variable(model, x[1:3], Bin)
```

```
@constraint(model, x in SOS2())
```

MIP reformulations

Bridging the gap between user formulations and the solver

using JuMP, HiGHS

```
model = Model(HiGHS.Optimizer)
```

```
@variable(model, x[1:3], Bin)
```

```
@constraint(model, x in SOS2())
```

```
julia> print(unsafe_backend(model))
```

Feasibility

Subject to:

VariableIndex-in-ZeroOne

$x[1] \in \{0, 1\}$

$x[2] \in \{0, 1\}$

$x[3] \in \{0, 1\}$

$v[4] \in \{0, 1\}$

$v[5] \in \{0, 1\}$

ScalarAffineFunction{Float64}-in-EqualTo{Float64}

$0.0 + 1.0 v[4] + 1.0 v[5] == 1.0$

ScalarAffineFunction{Float64}-in-LessThan{Float64}

$0.0 - 1.0 x[1] \leq 0.0$

$0.0 + 1.0 x[1] - 1.0 v[4] \leq 0.0$

$0.0 - 1.0 x[2] \leq 0.0$

$0.0 + 1.0 x[2] - 1.0 v[4] - 1.0 v[5] \leq 0.0$

$0.0 - 1.0 x[3] \leq 0.0$

$0.0 + 1.0 x[3] - 1.0 v[5] \leq 0.0$

MIP reformulations

Bridging the gap between user formulations and the solver

```
using JuMP, HiGHS
model = Model(HiGHS.Optimizer)
@variable(model, x[1:3], Bin)
@constraint(
    model,
    x[1] --> {x[2] + x[3] == 0},
)
```

MIP reformulations

Bridging the gap between user formulations and the solver

```
using JuMP, HiGHS
model = Model(HiGHS.Optimizer)
@variable(model, x[1:3], Bin)
@constraint(
    model,
    x[1] --> {x[2] + x[3] == 0},
)
```

```
julia> print(unsafe_backend(model))
Feasibility
Subject to:
VariableIndex-in-ZeroOne
  x[1] ∈ {0, 1}
  x[2] ∈ {0, 1}
  x[3] ∈ {0, 1}
ScalarAffineFunction{Float64}-in-EqualTo{Float64}
  0.0 + 1.0 x[2] + 1.0 x[3] + 1.0 v[4] == -0.0
ScalarAffineFunction{Float64}-in-LessThan{Float64}
  0.0 + 2.0 x[1] - 1.0 v[4] <= 2.0
  0.0 + 1.0 v[4] <= 0.0
```

Wishlist

***I'm an unusual customer**

Wishlist

*I'm an unusual customer



Keep fighting the good fight

Wishlist

***I'm an unusual customer**

- Stability. Keep fighting the good fight. All else optional.

Wishlist

***I'm an unusual customer**

- Stability. Keep fighting the good fight. All else optional.
- Lazy constraint callbacks
- IIS
- Better documentation of the C API (this is really a TODO for me)
 - What fields can be NULL and when
 - What arrays need to be length N or N+1

JuMP-dev 2025

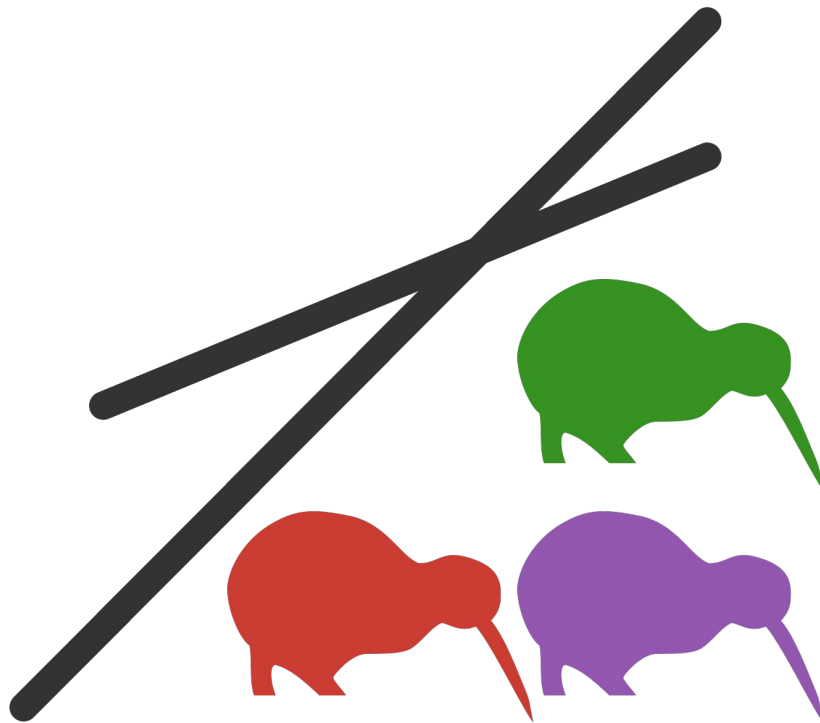
November 17–20

Auckland, New Zealand

More information at <https://jump.dev>

Need help? Join the JuMP forum

<https://jump.dev/forum>

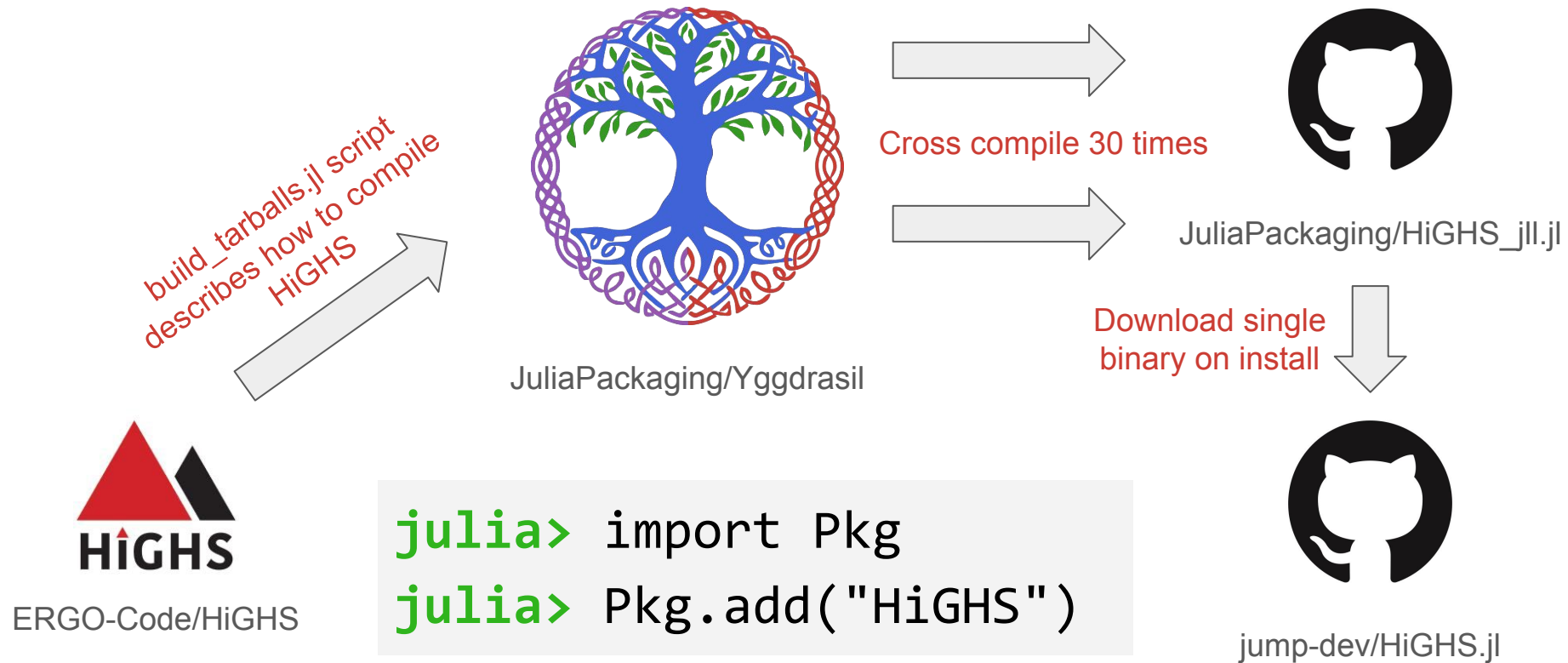


The binary distribution problem

How to avoid compiling on user computers

The binary distribution problem

How to avoid compiling on user computers



The binary distribution problem

How to avoid compiling on user computers



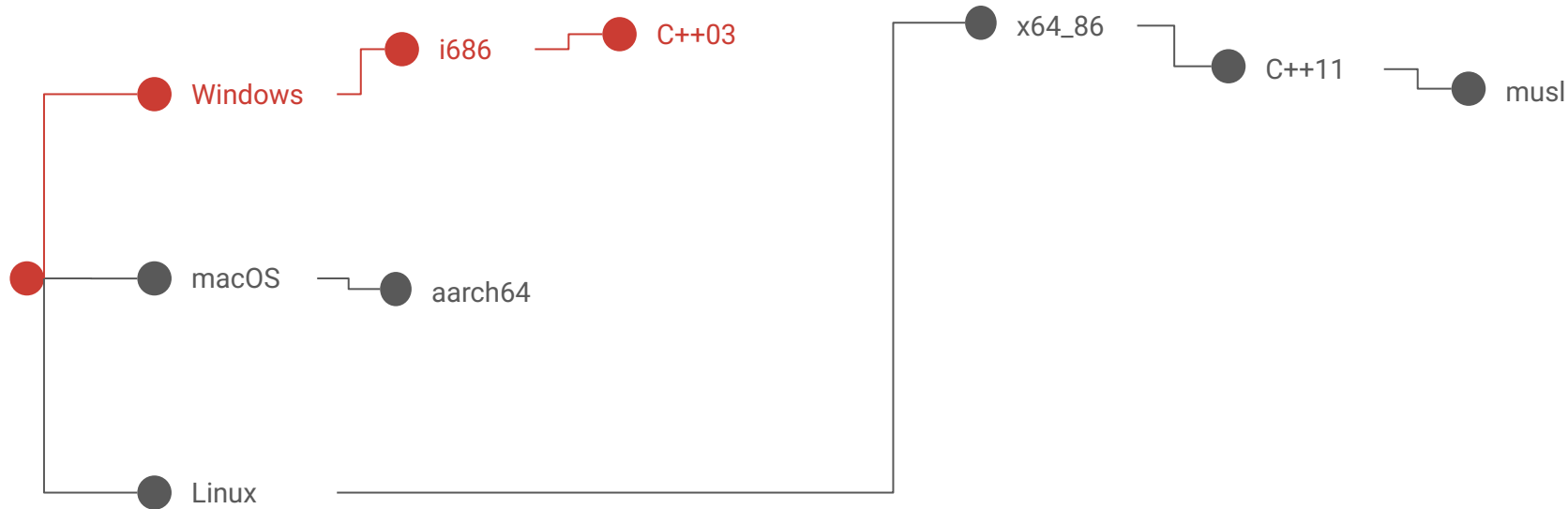
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