



THE UNIVERSITY OF
AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

Cows, Lakes, and a JuMP extension for multi-stage stochastic programming

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Julia meats Daisy

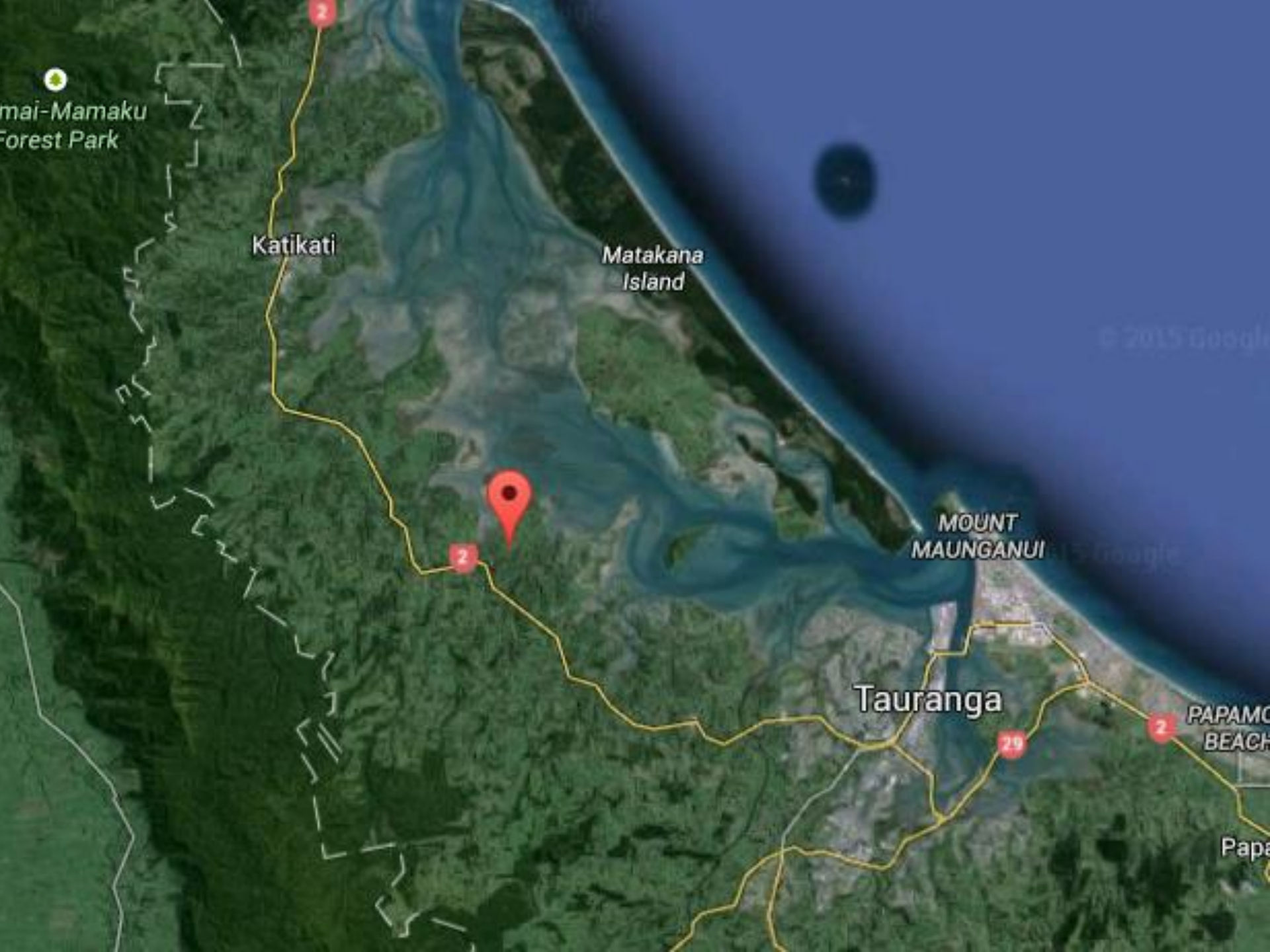
in the field of multi-stage stochastic optimisation

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**New
Zealand**

Tasman Sea



Kaimai-Mamaku
Forest Park

Katikati

Matakana
Island

MOUNT
MAUNGANUI

Tauranga

PAPAMO
BEACH

Papa











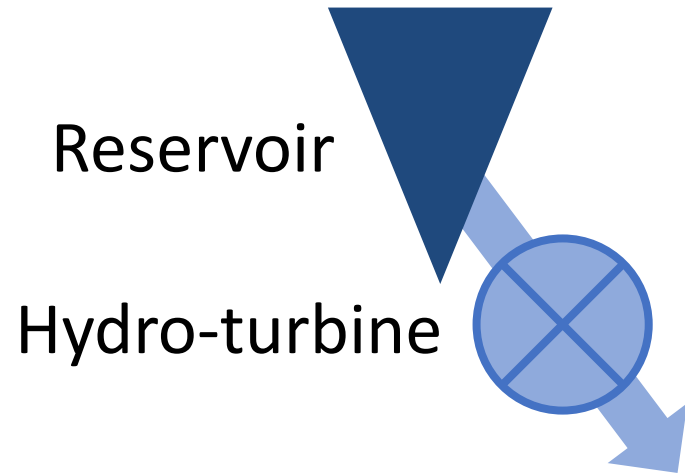


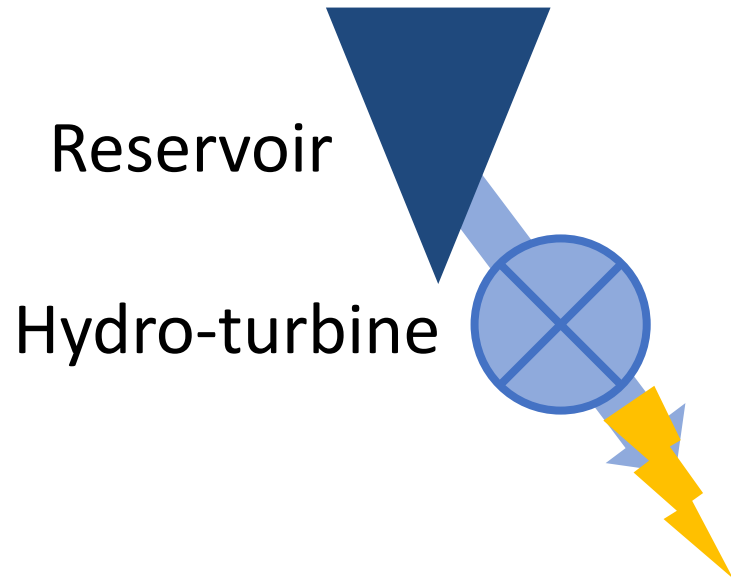
Help!

I don't know what multi-stage stochastic optimisation is!

Hydro-Thermal Scheduling

The “lake” part of the talk





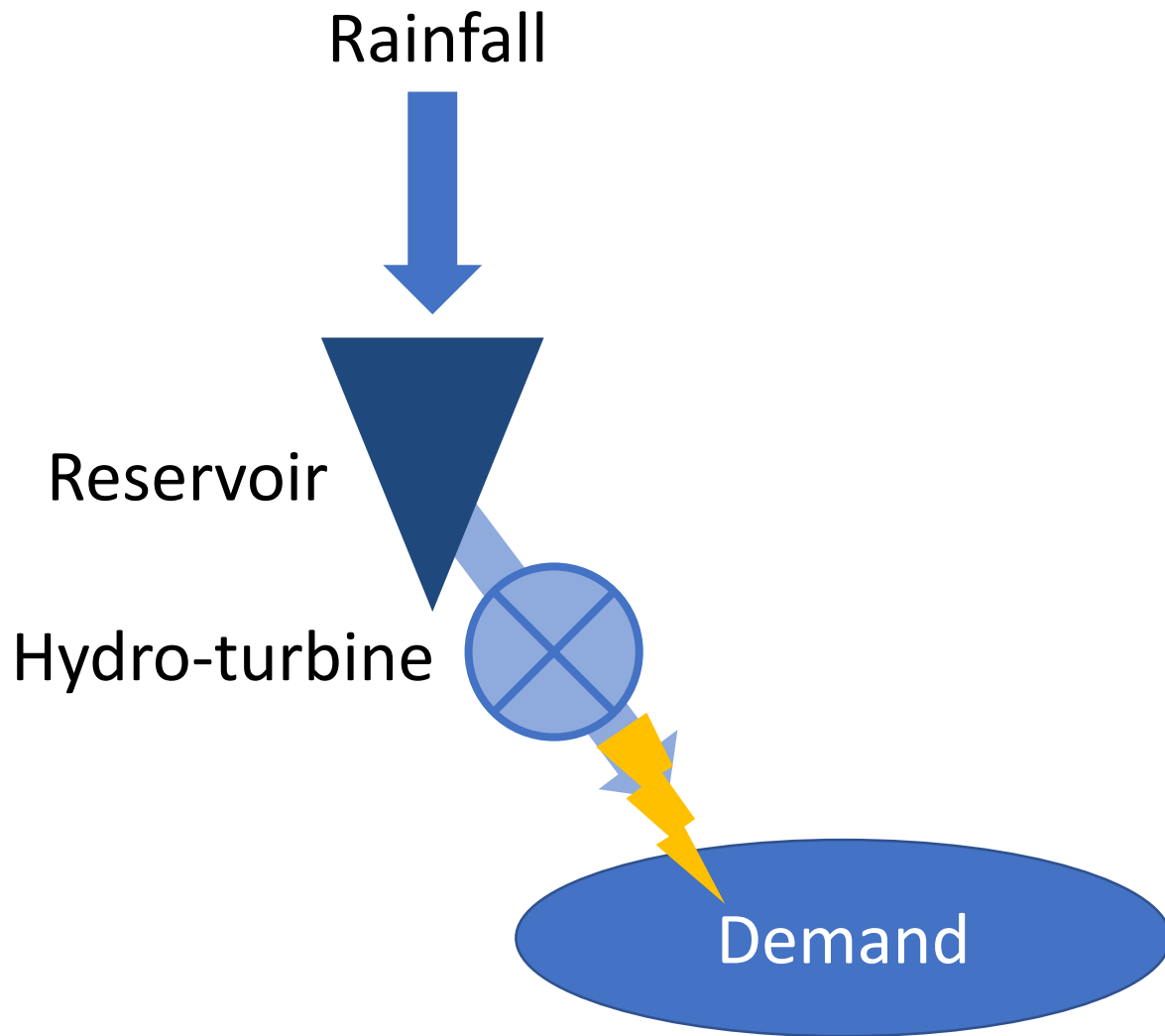
Rainfall

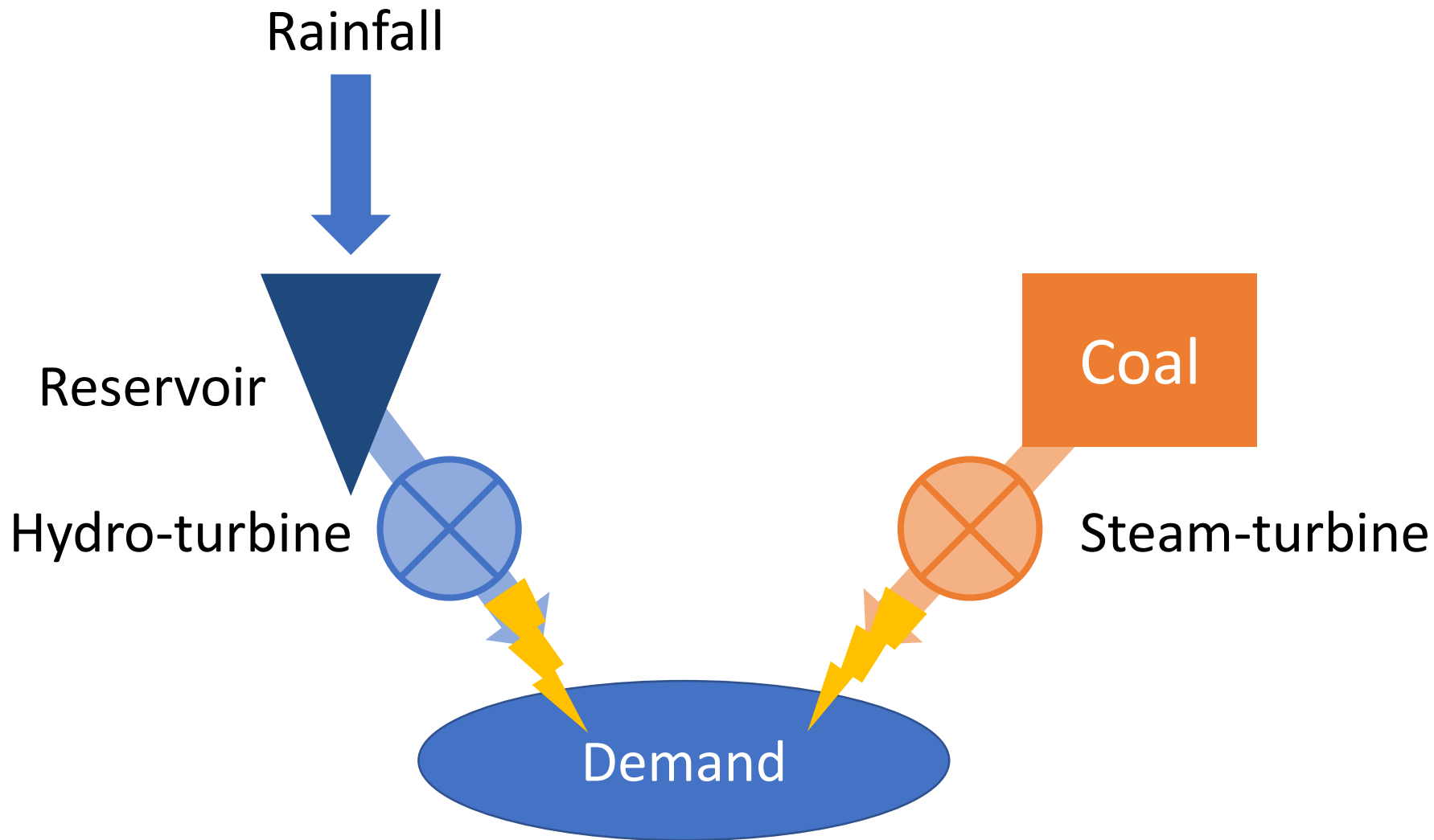


Reservoir

Hydro-turbine







The Milk Output Optimiser

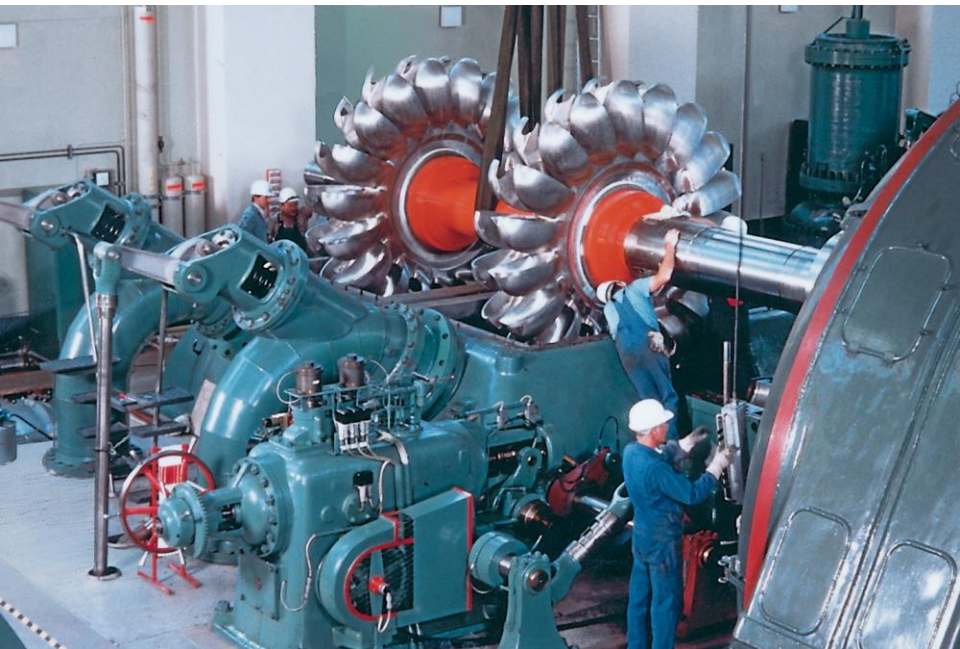
The “cow” part of the talk



Paddocks are Lakes of grass and **Cows are Lakes of energy**



Paddocks are Lakes of grass and **Cows are Lakes of energy**
Turbine grass into the cow and **Turbine the cow to produce milk**





Random grass growth instead of rainfall



Random grass growth instead of rainfall

Make up the difference with maize instead of coal

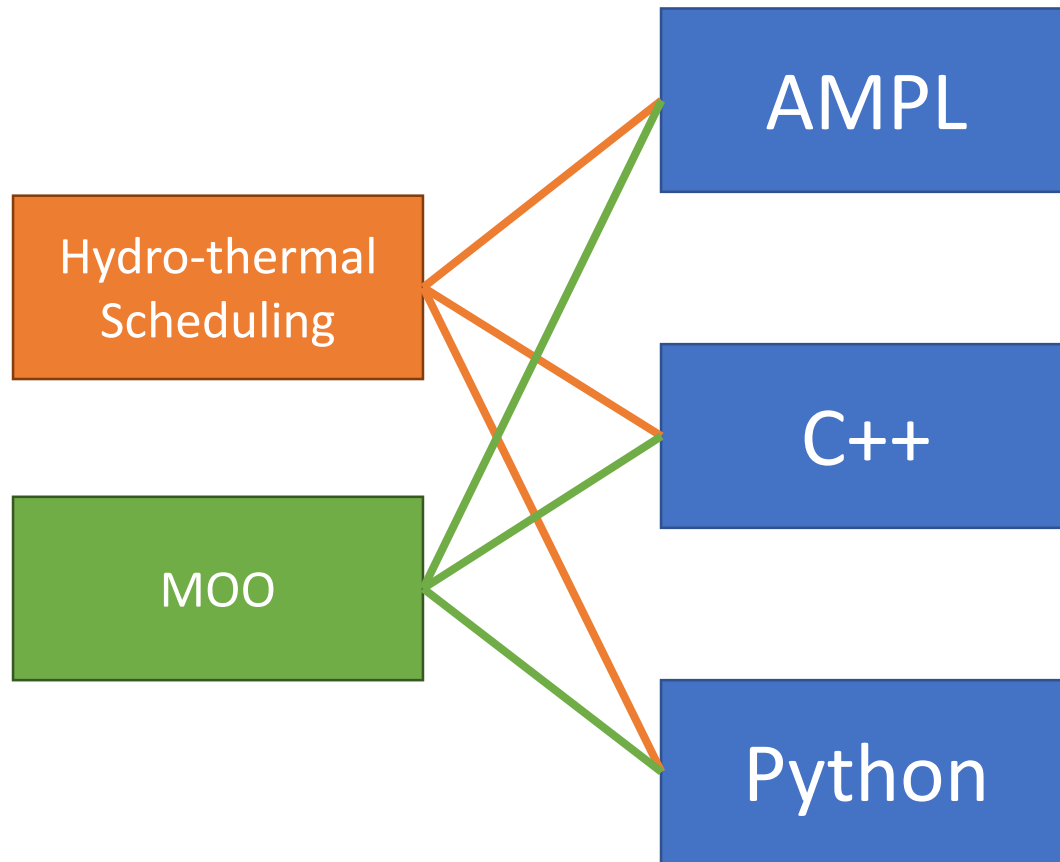


Solution Technique

Stochastic Dual Dynamic
Programming

SDDP

- Discrete time
- Discrete noise
- Continuous state, action
- Convex Bellman function



This seems inefficient

Why not do it in Julia?

That's exactly what people have done over the last year or so...

- SDDP.jl
<https://github.com/odow/SDDP.jl>
- StochDynamicProgram.jl
<https://github.com/JuliaOpt/StochDynamicProgram.jl>
- StructDualDynProg.jl
<https://github.com/blegat/StructDualDynProg.jl>
- PSR (Commercial)
- A few other private research codes

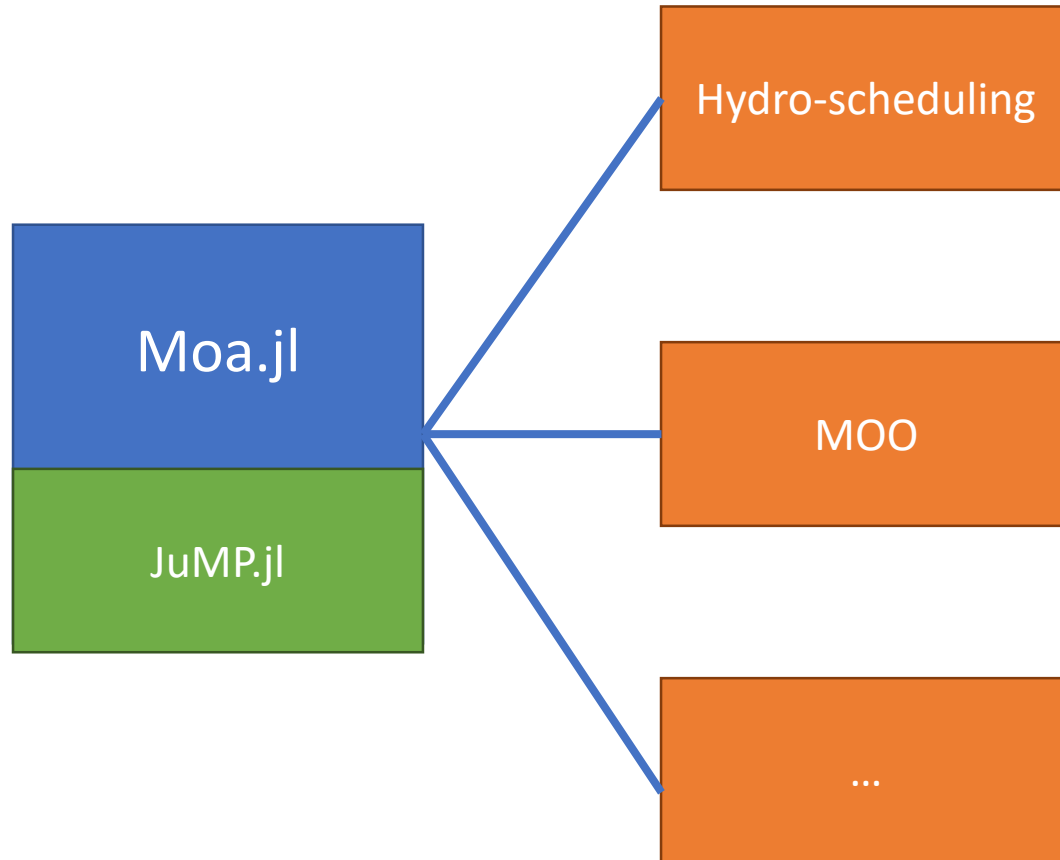
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Moa.jl

Multi-stage Optimisation
Application





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Yes.

Is it any good?

- Similar performance to problem-specific C++

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- Similar performance to problem-specific C++
- Much easier to apply to new problems
- Much easier to modify old problems
- Easier to code (and test) new heuristics which significantly improve performance

What should I take away from this talk?

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I know what SDDP is:

Let's talk.

github.com/odow/SDDP.jl

What should I take away from this talk?

I know what SDDP is:

I don't know what SDDP is:

Let's talk.

github.com/odow/SDDP.jl

New Zealand dairy farmers may someday use Julia to help them make better decisions under uncertainty.

