An Ising Machine-as-a-Service Platform

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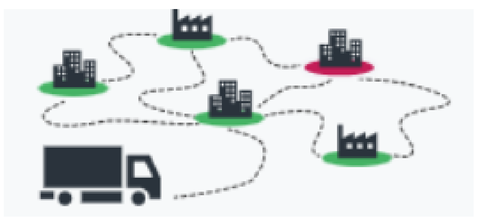
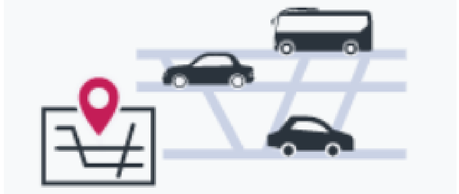
Motivation

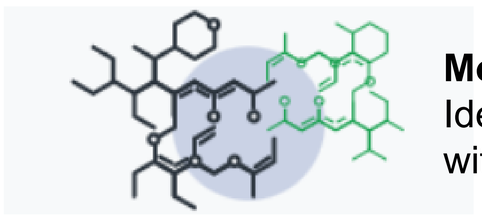
Combinatorial optimization problems require a large set of trials in order to identify the optimal solution which makes it impossible to solve with conventional computing systems



Logistic Optimization
Find a route with the shortest travel distance

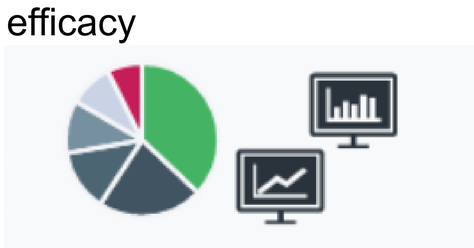
Traffic Congestion Alleviation
Determine the route of each vehicle, to minimize congestion



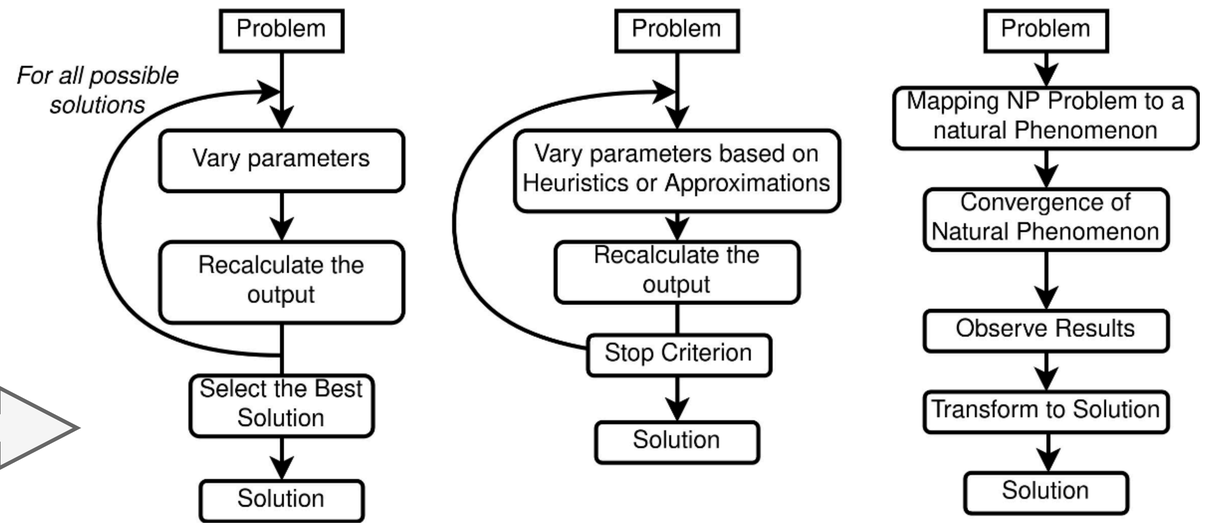


Molecular Design for Drug Discovery
Identify the molecular makeup of drugs with the desired efficacy

Financial Portfolio Optimization
Find a combination of different stocks with high return and low risk



Solving NP-Complete Problems



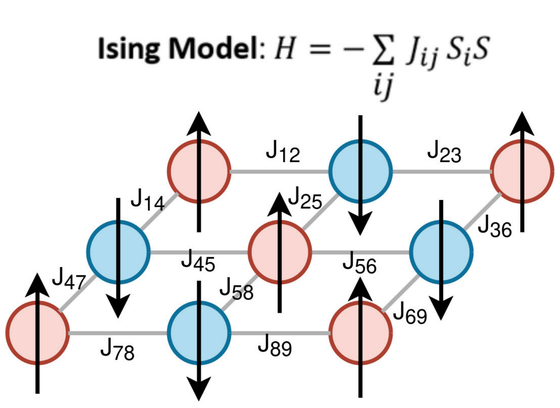
The most well-known techniques for solving NP problems are:

- **Brute-force,** that evaluates all possible combinations/solutions
- **Approximations,** which do not guarantee the best solution
- **Physical-inspired systems,** which can solve specific NP problems

To use the last type of solvers, we must map the input problem into a configuration, compatible with the respective physical system, and then translate the output from the physical system into a useful representation

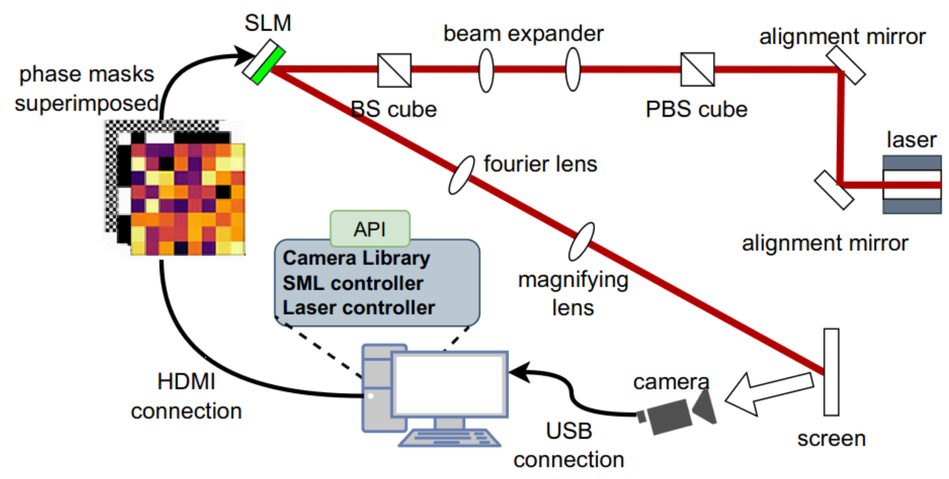
Ising Machine Model

The ising model represents a lattice of spins with:



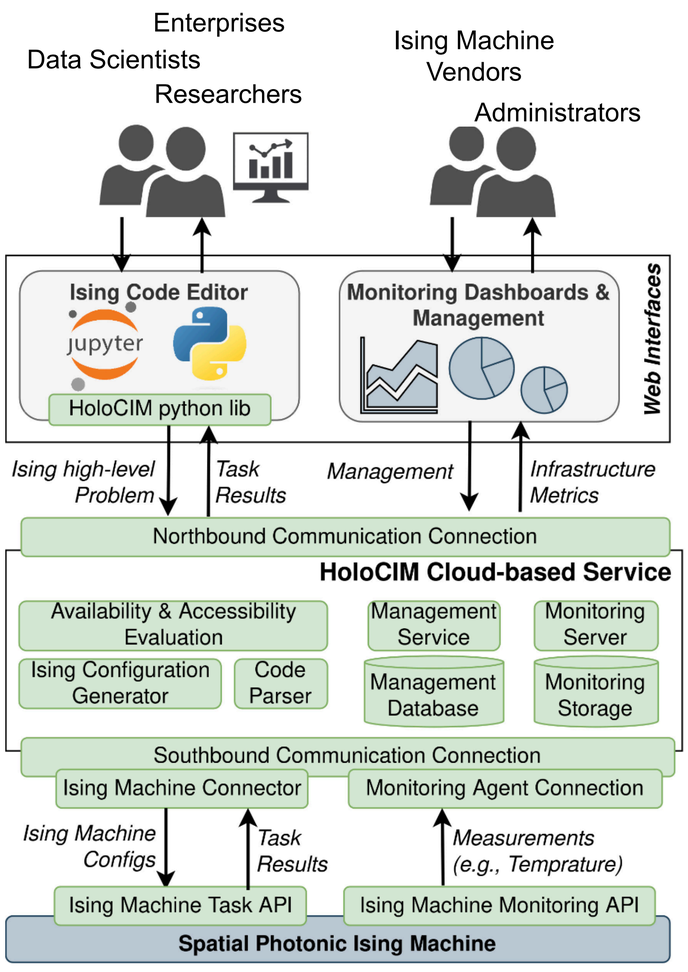
- Discrete variables with two states, positive (+1) and negative (-1)
- Connections among spins have specific interactions' weights and
- A function, namely the Hamiltonian (or cost function), that highlights the system's overall state

Hardware Implementation



Hardware implementation of HoloCIM solves the Ising model by utilizing interconnected components (e.g., laser beams generators, lens, monitoring devices, etc.), and discovers the ground state, or in other words, the solution of the problem, more efficiently

HoloCIM Platform



- An as-a-service UI and Cloud-based Platform
- Auto-compiling of NP-complete problems to Ising representation
- User, Security, and Permission Management
- Well-defined and abstract APIs for Ising Machines
- Monitoring Capabilities

NP-Complete Problems Mapping

Through the **HoloCIM's Python library**, users encode their combinatorial problems into the lattice's interaction weights and decode the solution from the Ising spin configuration

HoloCIM provides automated translation for a set of problems, like:

- Number partitioning problem
- Bin packing problem
- Ising model problem

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