Optimization of offshore wind farm installations

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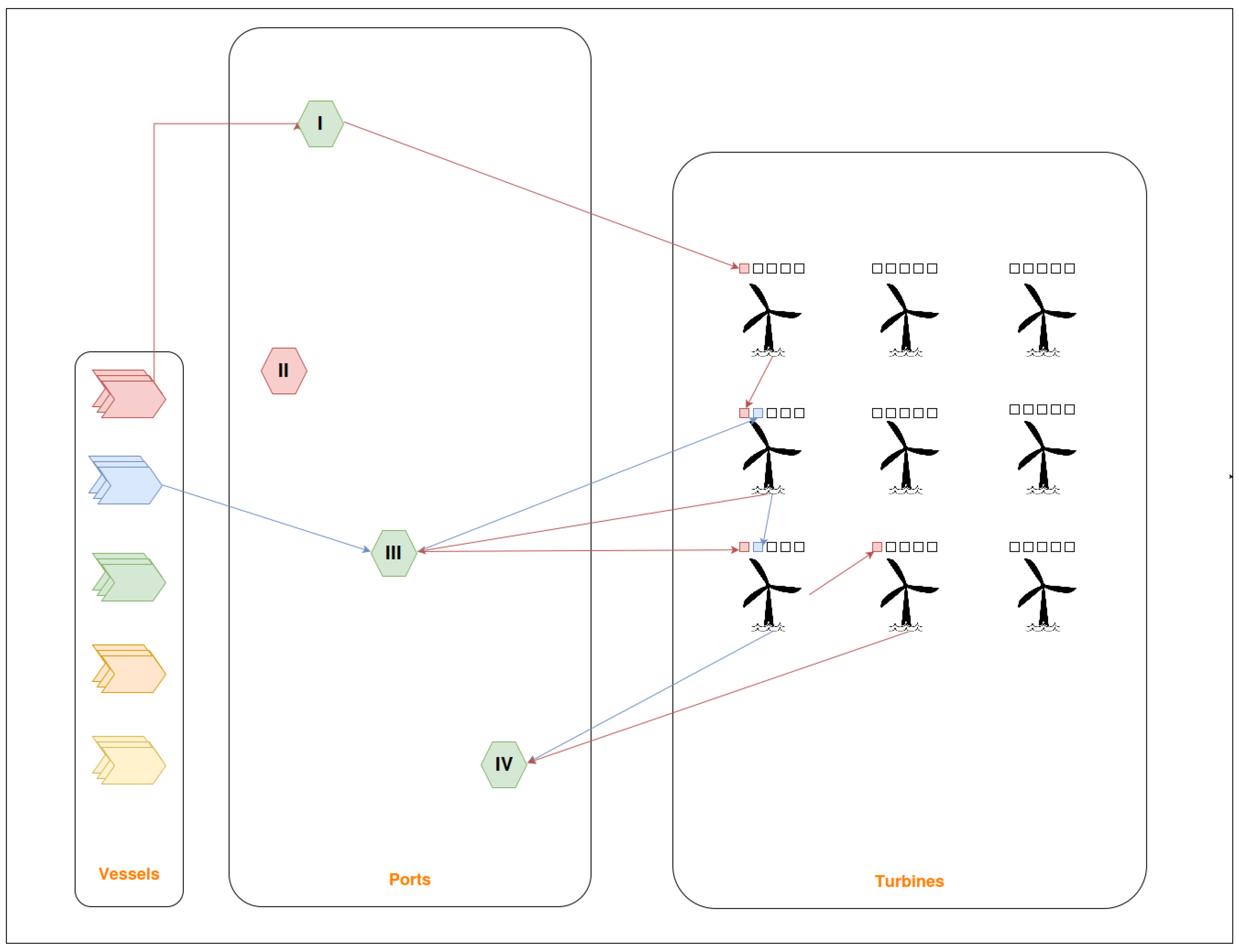
Harvesting offshore wind is an expensive way of producing electricity. Cost reductions can be made by optimizing through the supply chain. This work focus on optimizing logistics when installing the turbines.



An illustration of the installation process as it is modelled.

As wind farms offshore grow in size, the need for decision support in planning installation becomes evident when seeking cost reduction. This model will be a decision support system (DSS) that may be used to optimize the logistics of installing an offshore wind park. Using mixed integer linear programming (MILP), the problem is described mathematically. Through implementation in AMPL, an optimal solution is sought.

Problem description

Given an amount of turbines, where each turbine consist of components that need to be installed in a certain order, the goal is to find an optimal composition of installation vessels and inventory ports such that the costs of installing all components is minimized.

Assumptions

All installations must be finished within a time window. Each vessel can carry its own capacity in components during one circuit. When performing a circuit, a vessel installs all components on board. Each vessel can perform several circuits, always returning to a port in between. A vessel is not restricted to only operate from one inventory port. All components are assumed to be available at any inventory port when it is needed for loading.

Input

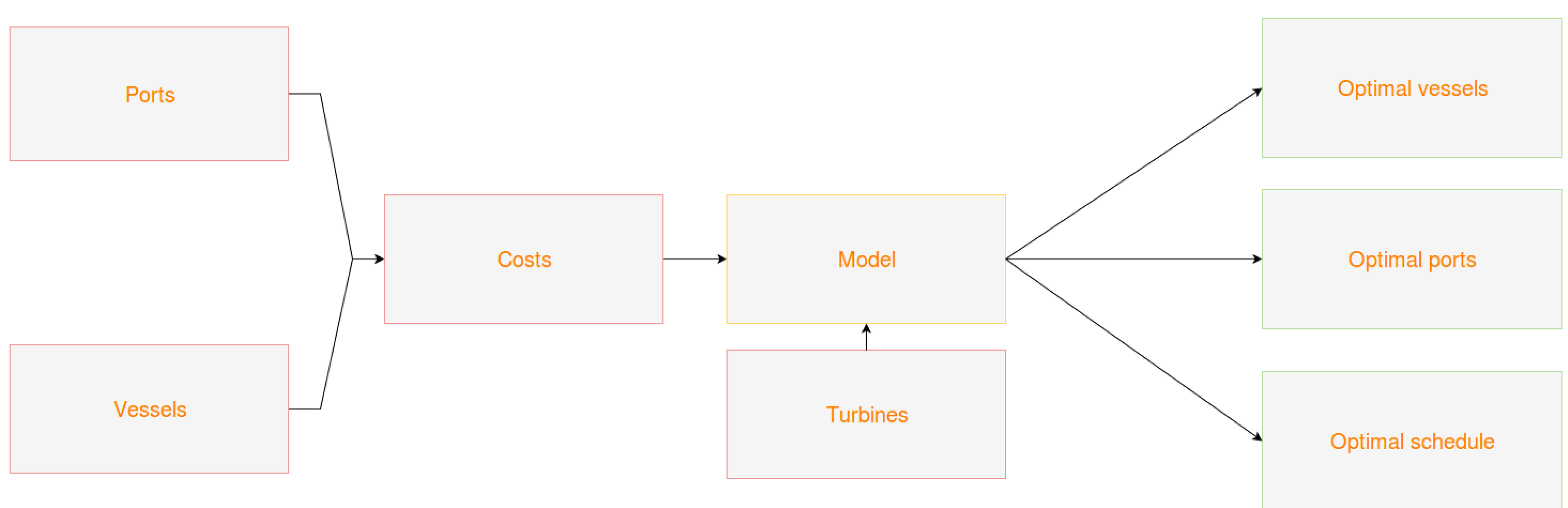
The model needs certain data in order to calculate an optimal solution:

- **Vessels:**
  - Costs of mobilization
  - Time charter costs
  - Capacity
  - Task costs (transportation, installation etc.)
  - Efficiency (time consumption)
  - Ability to perform task
- **Ports:**
  - Costs of using port
  - Location
- **Turbines:**
  - Park size
  - Location
  - Components
- **Time horizon**
  - Total time available
  - Vessel circuits possible

Output

Upon minimizing the total costs of performing the installation, the solution will provide:

- **Optimal vessels:**
  - Choice of vessels to use
  - How to load a vessel
  - Cooperation with other vessels
  - What components to install
- **Optimal ports:**
  - Choice of ports to operate from
  - What components must be available at what time
- **Optimal schedule:**
  - When to perform loading
  - When to perform installation
  - When to time charter vessels



Challenges

When formulating such a model, taking into account uncertainties can be a challenge. A great challenge includes weather restrictions, making certain tasks not possible to perform. This project will seek to consider this uncertainty on a later stage.

Application

The tool can be applied for several purposes including:

- Strategic wind farm installation planning
- Development of wind farm installation vessels
- Investigation of potential wind farm location

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