

User Guide

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The program provide the interactive interface to visualize a water distribution network as well as solving the optimization problem to find the optimal flow and pressure of the network that consume the least energy. The demo of the interface can be found online [here](#).

Installation

1. Clone the project from GitHub

```
git clone https://github.com/mikephul/pump_webapp.git
cd pump_webapp
```

2. Install the requirement

```
pip install -r requirements.txt
```

3. Obtain and install the [mosek license file](#)
4. Make sure that the project folder contains the .inp file that describe the water distribution network (We include the Small.inp and Big.inp with the project.)
5. Execute the flask application with the script below. This will open the flask webserver.

```
python app.py Small.inp
```

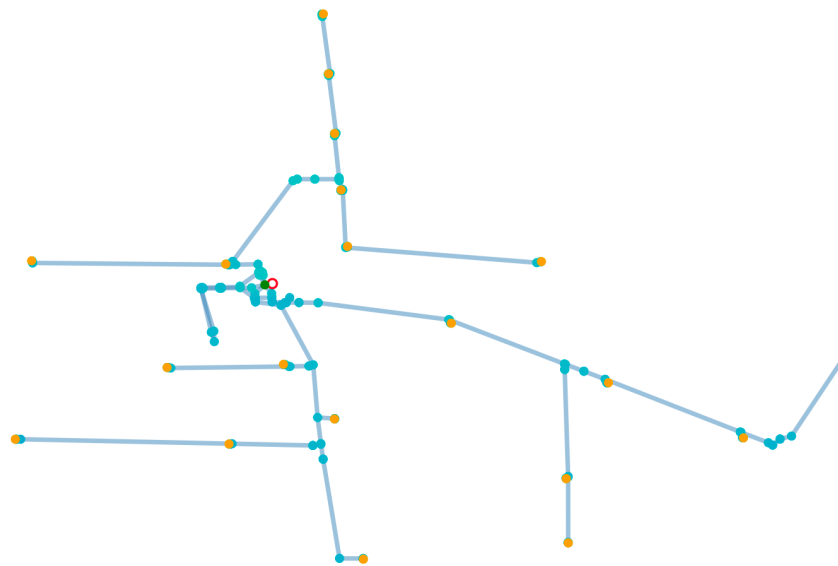
6. Pull up any web browser (Chrome is recommended.) You can see the application at the address below. The default port is 5000.

```
http://localhost:5000/
```

Then, you should see the following interface.

Flow & Pressure

An interactive exploration of water distribution network



● High Head ● Low Head ● Customer ● Source ● Tank

Pause

Predirection

Imaginary

Iteration

Improve Solution

Network

☐ Overview ☐ Pressure ☐ Flow
☐ Gap ☐ Energy Loss ☐ Pump Energy

Name	Small.inp
# Nodes	272
# Edges	276
# Customers	1
# Sources	20
# Tanks	1
# Pumps	20
# Valves	49

Node



Edge



Pump



Feature

There are three main feature of the application

1. Network Geometry
2. Network Information (Node and Edge)
3. Solver actions

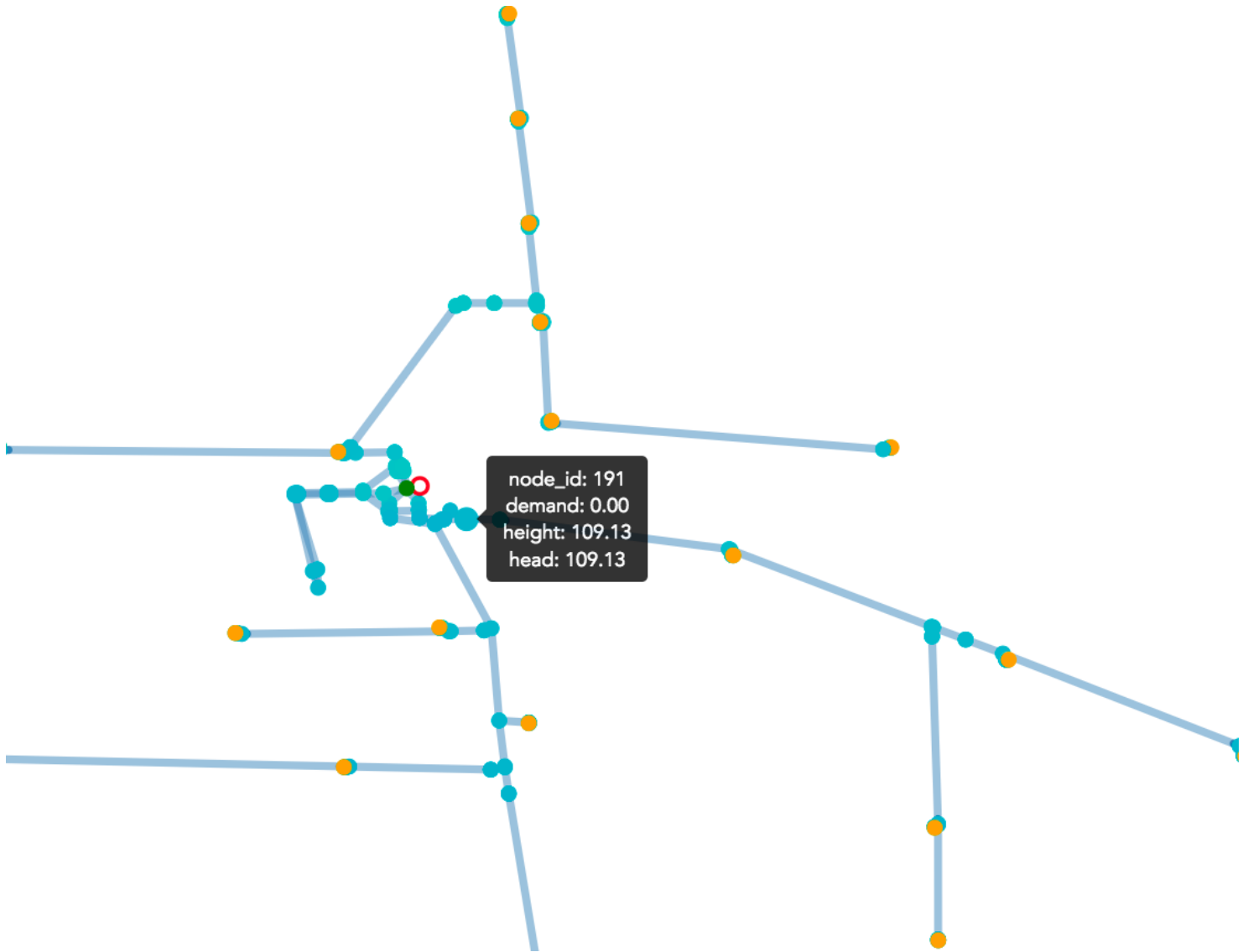
Flow & Pressure

An interactive exploration of water distribution network



1. Network Geometry

The geometry of the input network gives a sense of where each components in the network is located physically. When hover cursor over the the network, there is a tooltip that show the information of the particular node or edge.



2. Network Information

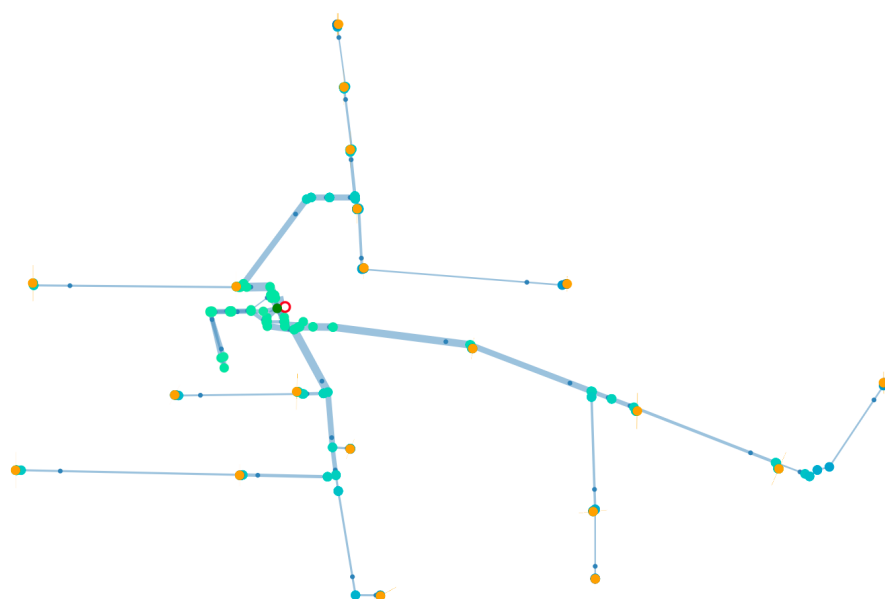
You can choose to see the information of the network, nodes, edges, or pumps.

Network

- **Overview** - shows the general info about network such as number of nodes or edges, and etc.
- **Pressure** - shows the histogram of pressure at each nodes
- **Flow** - shows the histogram of flow at each edges
- **Gap** - shows how much the pressure-flow coupling constraint gap is violated at each iteration
- **Energy Loss** - shows the energy that lost within the network
- **Pump Energy** - shows the energy consumer by pumps

Flow & Pressure

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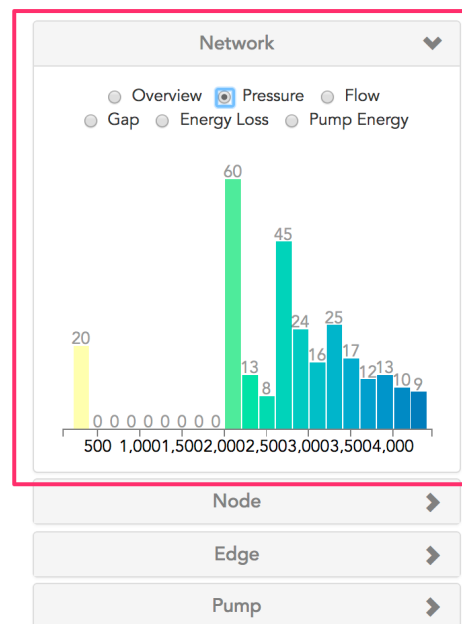
Pause

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Improve Solution



Node

- **Sources** - shows information about source node
- **Customers** - shows information about customer node
- **Nodes** - shows information of all nodes
- **Lowest Pressure** - show information of the top 5 lowest pressure nodes
- **Highest Pressure** - show information of the top 5 highest pressure nodes
- **Search by Node id** - show information of the specified node

Flow & Pressure

An interactive exploration of water distribution network



Network					
Node					
<input checked="" type="checkbox"/> Sources <input type="checkbox"/> Customers <input type="checkbox"/> Nodes <input type="checkbox"/> Lowest Pressure <input type="checkbox"/> Highest Pressure					
Node id		Search			
ID	Flow out	Head	Height	Satisfy?	
252	0	99.28	99.28	⊘	
253	0	98.39	98.39	⊘	
254	0	98.29	98.29	⊘	
255	0	98.36	98.36	⊘	
256	0	97.89	97.89	⊘	
257	0	99.58	99.58	⊘	

Edge

- **Valves** - shows information about valve edges
- **Edges** - shows information about edges
- **Lowest Flow** - shows information of the top 5 lowest flow edges
- **Highest Flow** - shows information of the top 5 highest flow edges
- **Search by Edge id** - shows information of the specified edge

Flow & Pressure

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Improve Solution

Network					
Node					
Edge					
<input type="radio"/> Valves <input checked="" type="radio"/> Edges					
<input type="radio"/> Lowest Flow <input type="radio"/> Highest Flow					
Edge id		Search			
ID	Type	Head ID	TAIL ID	Flow	Gap
1	pipe	2	1	55.51	0.06
2	pipe	3	39	55.51	0.06
3	pipe	4	3	55.51	0.06
4	pipe	6	14	13.37	89.00
5	pipe	165	6	13.37	89.00

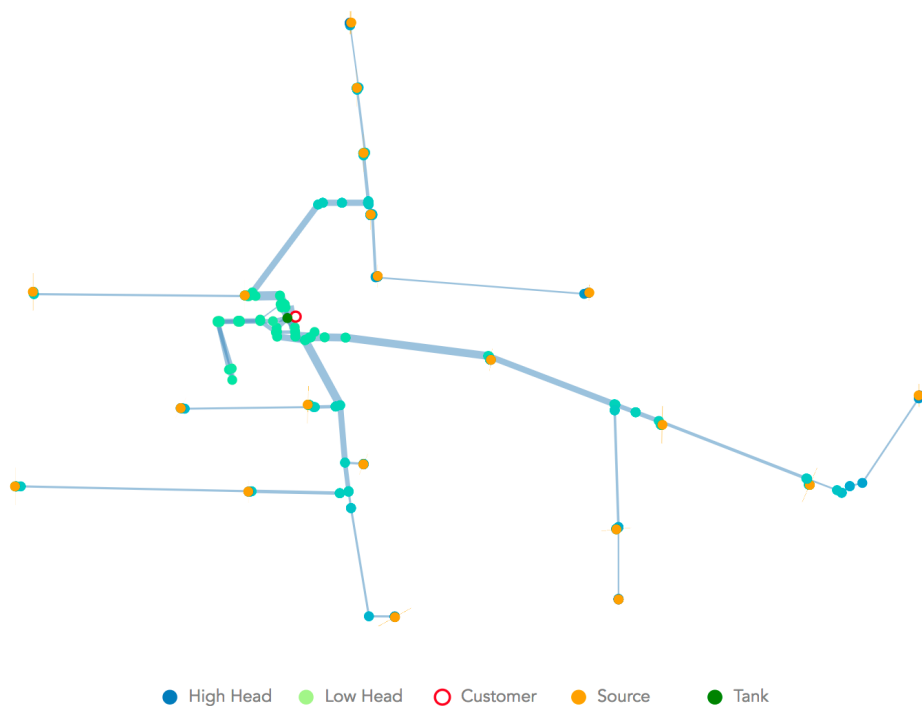
Pump

Pump

- **Search by pump id** - shows pump characteristic curve and information of the specified pump

Flow & Pressure

An interactive exploration of water distribution network



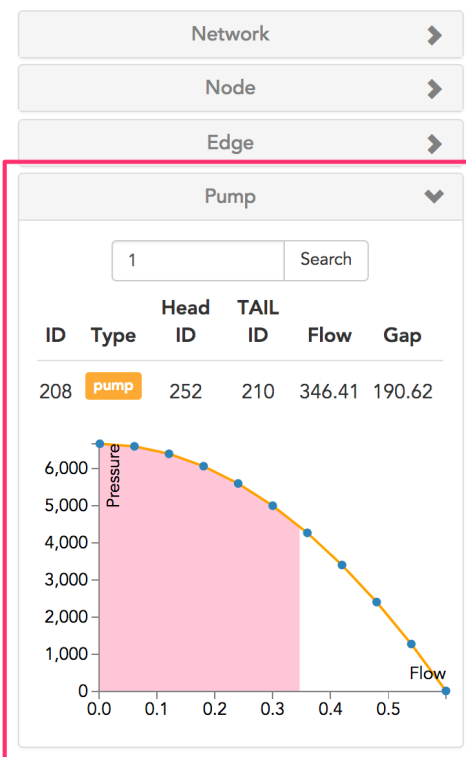
Pause

Predirection

Imaginary

Iteration

Improve Solution



3. Solver Action

- **Play/Pause** - Play or pause the direction of the edges
- **Predirection** - Redirect the network to get the feasible minimum energy flow direction
- **Imaginary** - Solve the convex relaxation problem to find minimum energy flow and pressure
- **Improve Solution** - Improve the existing constraint gap from the pre-solve method to achieve better accuracy by specify the number of iteration to run

Flow & Pressure

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Network	
<div><div>● Overview</div><div>● Pressure</div><div>● Flow</div><div>● Gap</div><div>● Energy Loss</div><div>● Pump Energy</div></div>	
Name	Small.inp
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Node

Edge

Pump

General Usage

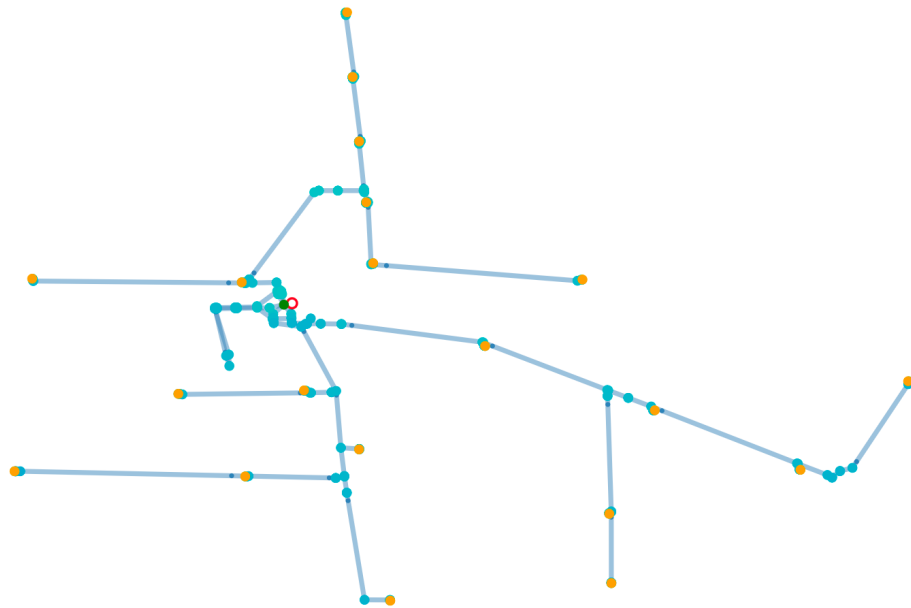
1. Start the network visualizer with

```
python app.py <inp file>
```

1. Predirection the network

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Pause Predirection Imaginary Iteration Improve Solution

Network	
<div><div></div> Overview <div></div> Pressure <div></div> Flow <div></div> Gap <div></div> Energy Loss <div></div> Pump Energy</div>	
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Node

Edge

Pump

1. Solve the convex relaxation problem to find minimum energy flow and pressure

Flow & Pressure

An interactive exploration of water distribution network



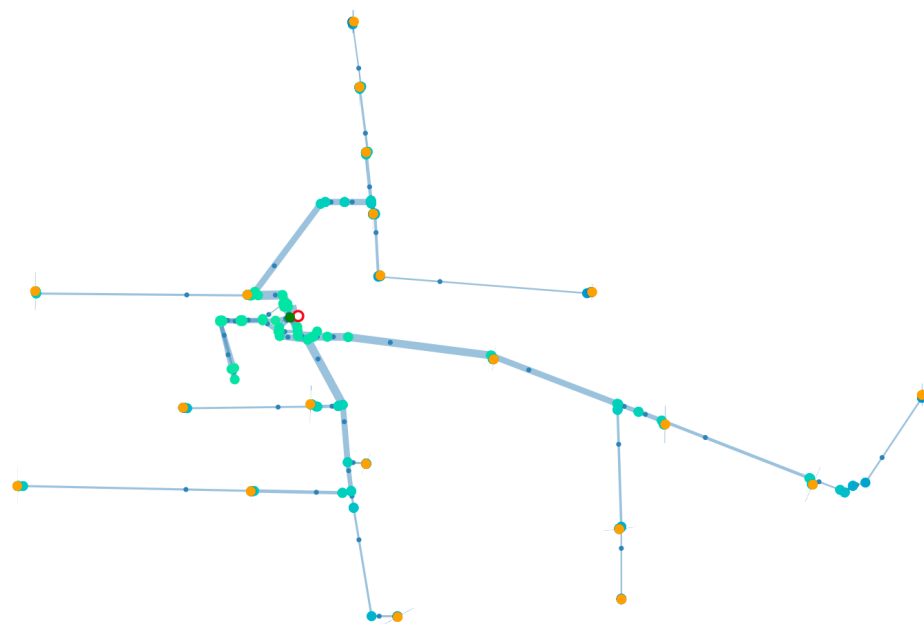
Network	
<input checked="" type="radio"/> Overview <input type="radio"/> Pressure <input type="radio"/> Flow <input type="radio"/> Gap <input type="radio"/> Energy Loss <input type="radio"/> Pump Energy	
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Node	➤
Edge	➤
Pump	➤

1. Specify the number of iterative improvement to run. Improve the existing constraint gap from the pre-solve method to achieve better accuracy

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Pump

1. View network information and the solution in the application
2. Alternately, The solution is saved as the numpy object (.npy). You can load them with

```
np.load(path/to/file)
```