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# Small-scale LNG market optimization – intelligent distribution network

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# LNG

- LNG (Liquified Natural Gas) is natural gas that has been converted to a liquid form by cooling it down to a temperature of about -162°C

- LNG volume is approx. 600 times smaller than in the gas (natural) state, which makes it more economically effective to transport and store

- LNG is gaining interest and is becoming more and more researched topic due to the significant growth of the LNG world market

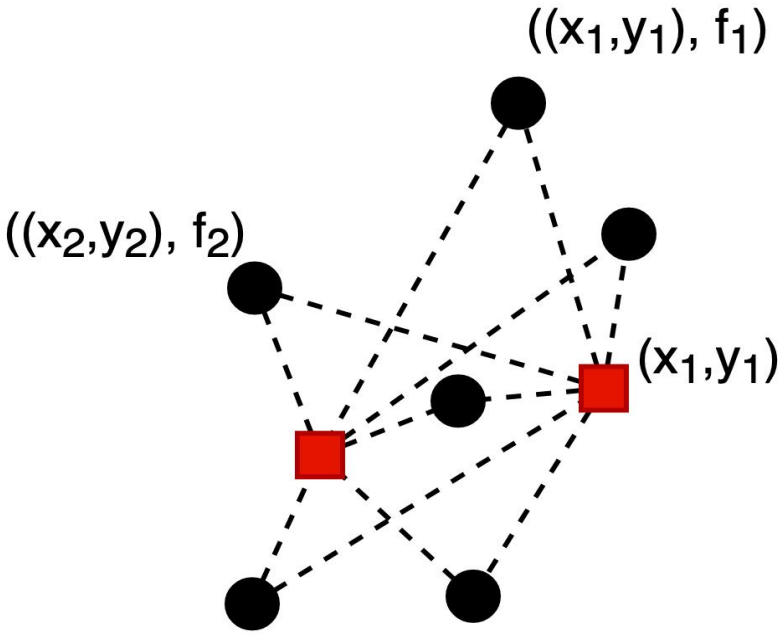
# Small-scale LNG

- Nowadays, natural gas is mainly transported in a gaseous state through pipelines, but some customers are located in remote areas what makes it not cost effective to use pipelines to transport gas
- Within small-scale LNG market, LNG is transported by trucks from large supply terminals to smaller regasification terminals, where LNG is vaporized and fed into local gas pipeline network
- Such regasification terminals are located in villages that have no access to gas distribution networks as well as directly at end-users (industrial customers).

# Problem formulation

- The goal is to optimize LNG tank trucks paths
- From mathematical point of view, this problem type can be classified as Vehicle Routing Problem (VRP), which is well recognized topic in the literature
- The classical VRP problem is a problem of designing delivery routes for vehicles, where each of them only travels one route, has the same characteristics and there is only one central depot

# Graph representation of the problem




$(x_i,y_i)$ - coordinates

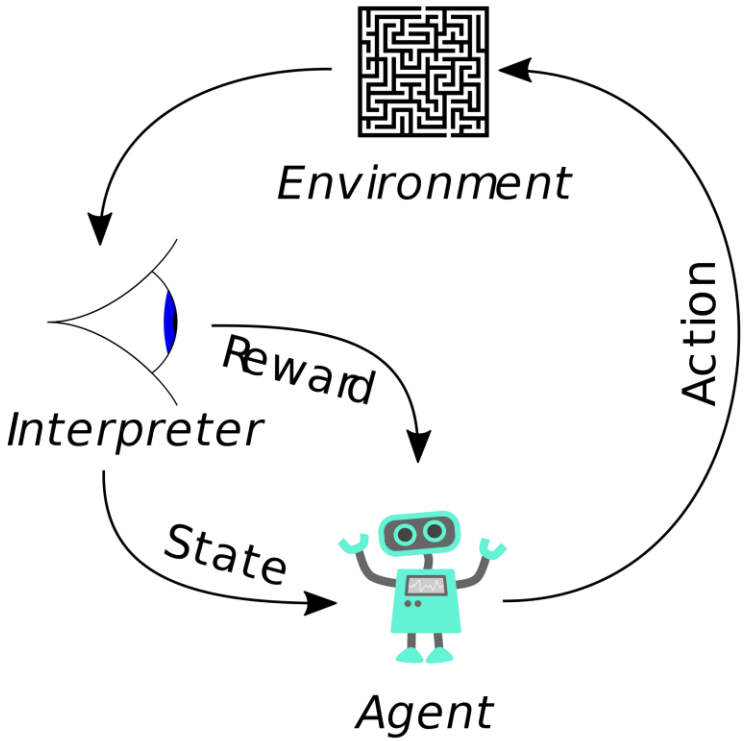
$f_i$ - current tank fill level

- destination point

- pickup point

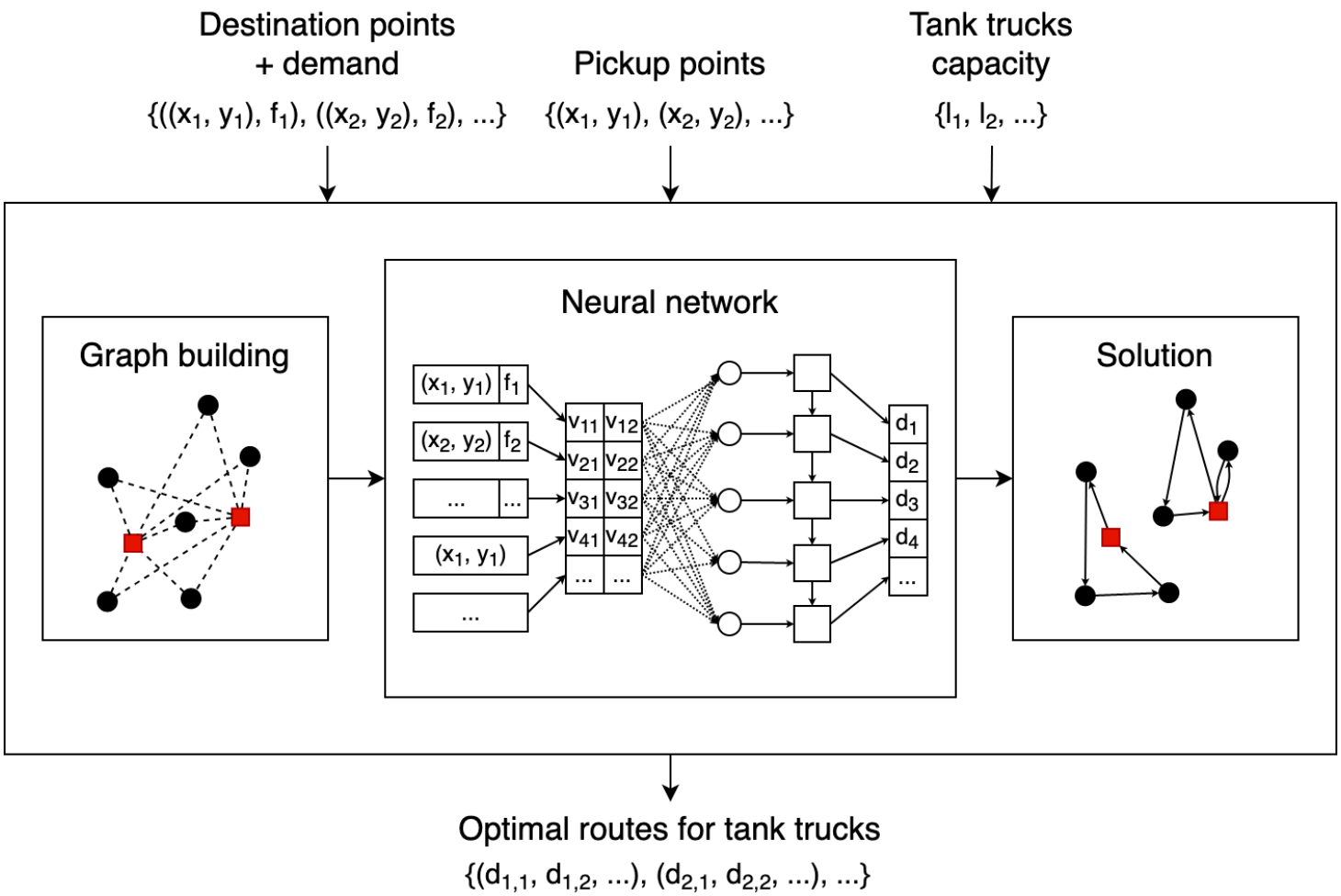
# Methodology

- Artificial intelligence/ machine learning approach
- Reinforcement learning combined with the neural network




**Reinforcement learning principle of operation**

# Proposed system schema



# Economic benefits

- Minimizing the costs of LNG transport to the regasification terminals
- Reducing the delivery time
- Reducing the cost of distribution service
- Increasing the efficiency of tank trucks use – servicing a larger number of customers for given number of tank trucks or slowing down tank trucks' wear
- Increasing competitiveness on the LNG suppliers' market

# Conclusion

- Economically effective intelligent small-scale LNG distribution network has been developed
- LNG truck tanks paths have been optimized dynamically
- Novel approach is based on graph theory and advanced machine learning methods, such as reinforcement learning, neural networks and online learning.
- Better management of LNG tank trucks routes and the possibility of dynamic route changes can be obtained

# Thank you for attention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