AltoTech Global – ML Engineer Test

Thank you for your interest in the Control Engineer position at AltoTech Global. Here, our vision and mission are to reduce greenhouse gas emissions and energy consumption in HVAC system in hotels, buildings, and factories through the use of AI and IoT technologies, in order to develop a sustainable and productive world. This aligns with the goals of the UNFCCC and IPCC to address the challenges of climate change and limit global warming to well below 2 degrees Celsius above pre-industrial levels. We believe that sustainability is key to maintaining the long-term health and productivity of the Earth's ecosystem, and we will use our technologies to support a low-carbon and climate-resilient future.

As part of our recruitment process, we would like to invite you to take a test to assess your knowledge and basic understanding before joining our Engineering Team.

Introduction

Talking about air conditioning system, normal households typically use **Split-Type** systems which consists of an indoor unit and an outdoor unit that work together to regulate temperature and humidity in a single room. On the other hand, large buildings use another air conditioning system which is called **Chiller Plant** in order to provide cooling to the indoor spaces. Check out these links to get basics understanding of how chiller plant work:

1. Chiller Basics - How they work - YouTube
2. How Chiller, AHU, RTU work - working principle Air handling unit, rooftop unit HVAC system - YouTube

Chiller plant systems are much larger and more complex, consisting of multiple chillers, pumps, cooling towers, and other components that work together to cool entire buildings or complexes. These systems are designed to handle much larger cooling loads and require specialized engineering expertise to design, install, and maintain.

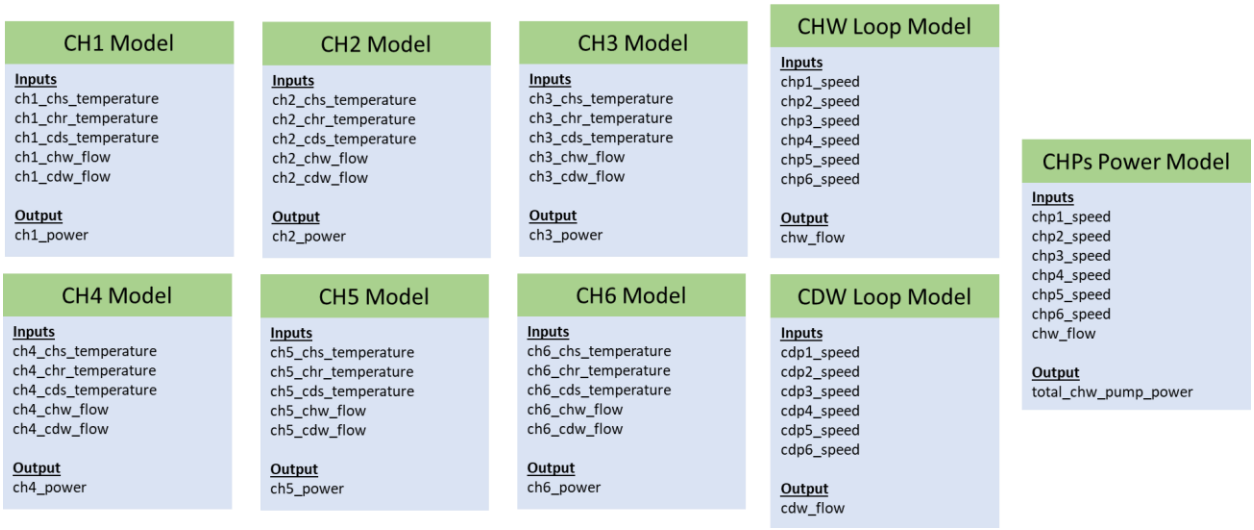
Since HVAC system is typically the most energy-consuming part of the building, chiller plant usually consumes over 50% of the entire building's energy consumption, leaving a huge opportunity for energy savings. Unfortunately, optimizing such a complex system is not an easy task especially for system which the underlying dynamics are not mathematically expressible.

Thus, **System Identification** (Link) is important and can be used for constructing a model of physical systems based on measured IoT data. The model can be used to predict how the system will behave under different conditions and to optimize system performance, reduce energy consumption, and improve overall efficiency.

Problem 1

You have been tasked with performing a system identification on a chiller plant to discover the underlying model that can be used to predict the behavior of the plant. This chiller plant consists of 6 chillers, 12 pumps (6 variable-speed primary chilled water pumps, 6 variable-speed condenser water pumps) and 6 variable-speed cooling towers.

The relationship between variables are expected to be as the following diagram but feel free to explore any other correlations or feature combinations of your interests that you find more suitable:



Your task is to perform system identification of the chiller plant that accurately captures the dynamics of the chiller plant and can be used to predict the power consumption of the plant for control and optimization purposes. You can choose ANY available techniques or solutions (machine learnings, DNNs, non-linear math models, combinations of many approaches, etc.) to solve this problem.

Please use the data attached to fit the model for this problem. You can use any tools or software to help solving the problem (MATLAB, Python, GAMS, etc.).

The result report should include

- Which technique to use to perform system identification?
- Discussion on the performance of the model. How well does the model fit the data? Which metrics do you use to verify the quality of the model?
- Are the model parameters physical meaningful? The model parameters should have physical interpretations that make sense in the context of the chiller plant. (you don't need to deeply study the chiller plant but at least you should try to discuss how parameters interact with each other)
- (Optional) Any other discovery or information that you think is SUPER COOL

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Problem 2

From the models you got from Problem 1, create a visualization dashboard to observe the behavior of your trained models. The dashboard should have the following properties:

1. Users can freely choose the model which is used to predict the result
2. The dashboard should be able to predict the inference result of the model based on the users' given inputs
3. The dashboard should show inference result in a timeseries manner for the selected time period of the dataset

You can use any tools or framework to create this dashboard but I would recommend using Python Plotly Dash (Link) for easy interactive dashboard. Please also deploy your dashboard on a production-ready environment so that our team can access your wonderful dashboard as well.

Feel free to surprise us with anything beyond the scopes of the problems listed above to show your awesomeness!

If you have any question regarding the test, don't hesitate to email back to me. AND I really encourage you to do so. Just imagine that we're working together as a team.
(andaman.l@altotech.ai)

Have fun!