View Reviews

Paper ID
3723

Paper Title
Identifying Relations between Equipment in Commercial Buildings by Learning from Correlated Events

Reviewer #1

Questions

1. [Summary] Please summarize the main claims/contributions of the paper in your own words.
The paper investigates how each equipment in commercial buildings is functionally connected with another. The main insight of this work is that connected equipment face the same events in the physical world, which as effect has simultaneous changes in the time series data of both pieces of equipment. The authors claim to be the first to attempt automatically inferring the functional
relationships between equipment in buildings. A Markovian Event Model is used to capture system's behaviour and outperforms the baseline models by 9% in terms of accuracy.

2. [Relevance] Is this paper relevant to an AI audience?
Likely to be of interest to a large proportion of the community

3. [Significance] Are the results significant?
Significant

4. [Novelty] Are the problems or approaches novel?
Novel

5. [Soundness] Is the paper technically sound?
Technically sound

6. [Evaluation] Are claims well-supported by theoretical analysis or experimental results?
Sufficient

7. [Clarity] Is the paper well-organized and clearly written?
Excellent

8. [Detailed Comments] Please elaborate on your assessments and provide constructive feedback.
The paper is well-written overall and claims are well-supported. It has a strong motivation as building analytics are and will be important, and I believe the claims are important for the domain. In particular, the paper improves performance by an average of 9% compared to the baseline models. Also, it is important it is evaluated on 5 different buildings and further analysis of the results is provided.
However, it is a bit unclear to me the use of kinematics and how matrices F, H are chosen.

9. [QUESTIONS FOR THE AUTHORS] Please provide questions for authors to address during the author feedback period.
How is this model potentially applicable in other domains? Is it possible to fully automate the model without the need for manual input from building managers?

10. [OVERALL SCORE]
6 - Marginally above threshold

11. [CONFIDENCE]
Reviewer is knowledgeable but out of the area

15. Please acknowledge that you have read the author rebuttal. If your opinion has changed, please summarize the main reasons below.

I have read the authors' rebuttal as well as other reviewers' feedback. Even though the paper is nice overall, it seems to have some weaknesses. I wouldn't change my score.

Reviewer #2

Questions

1. [Summary] Please summarize the main claims/contributions of the paper in your own words.

The paper presents a novel mechanisms based on a Markovian Event Model to infer relations between equipments installed in building using streams of sensed data. Authors first introduce the addressed problem, where one want to infer the relations between VAV (variable air-volume boxes) and AHU (air handling units). The contributed approach is expounded and relies on a Markovian event model (MEMO) which models latent states, latent true values and observed values (contrary to state-of-the-art techniques). Thank to this techniques, events are detected which enables relation inference. The proposed approach is evaluated using real data coming from connected buildings, from which a company provides ground truth values. It is compared to SOTA techniques (K-Means, HMM, Kalman Filters, adaptive event detection, sliding window likelihood). All in all, MEMO (parameter with K=2 possible states, steady or event) outperforms others techniques (94% accuracy, against 85% for KF). It is also shown that with growing K (number of states to detect) the accuracy of relation inference.

2. [Relevance] Is this paper relevant to an AI audience?

Relevant to researchers in subareas only

3. [Significance] Are the results significant?

Moderately significant

4. [Novelty] Are the problems or approaches novel?

Somewhat novel or somewhat incremental

5. [Soundness] Is the paper technically sound?

Technically sound

6. [Evaluation] Are claims well-supported by theoretical analysis or experimental results?

Somewhat weak

7. [Clarity] Is the paper well-organized and clearly written?

Good

8. [Detailed Comments] Please elaborate on your assessments and provide constructive feedback.

[Relevance] The paper is fully relevant for AAAI audience, especially dealing with ambient intelligence, context acquisition, and event detection.

[Significance] The proposed techniques significantly improves the state-of-the-art (as far the competitors are relevant, for which I'm not an expert). Are KF the best ever competitors for this kind of task? Seems OK, but not sure.

[Novelty] The use of Markovian approach to deal with context acquisition and event detection is not novel, but, the used of several layers to cope with noise in sensed data seems novel to me (AFAIK with my limited knowledge on this very topic).

[Soundness] The technicalities seems correct in the paper.

[Evaluation] The evaluation is based on real data for which ground truth is known, which is a very good point to highlight. The dimensions which are analyzed (inference accuracy, effect of masking, effect of number of states and effect of amount of data) are enough to understand the performance of the system. However, the computation time is not evaluated (whilst discussed concerning parallelization... odd). Finally, the (thermodynamical and topological) complexity of the studied building is not presented, while it seems very impacting of the proposed technique.

[Clarity] The paper is well structured and clearly written, but with some few typos and form issues:
- it seems the authors changed the style and remove space before and after section title -> don't do that !

- ref (Bromiley) is incomplete
- senor -> sensor

9. [QUESTIONS FOR THE AUTHORS] Please provide questions for authors to address during the author feedback period.

Isn't possible to exploit more semantic data? By this I mean that it seems you learn from scratch while there is a lot of information available on the building structure nowadays (like the BIM model used by architects). I think it may drastically reduce the search space.

10. [OVERALL SCORE]

5 - Marginally below threshold

11. [CONFIDENCE]

Reviewer is knowledgeable but out of the area

15. Please acknowledge that you have read the author rebuttal. If your opinion has changed, please summarize the main reasons below.

I've read authors' rebuttal, and slightly changed my scores accordingly.
I don't really agree with the answer about BIM. BIM models are designed by architects and engineers having a lot of expertise in such fields. They have to do such work to certify buildings, so this is done manually, for a good reason. Besides, helping them to discover at design time some dependencies they didn't fill seems a good approach.

Reviewer #4

Questions

1. [Summary] Please summarize the main claims/contributions of the paper in your own words.

This paper proposed an approach to sensor/controller relationship extraction in a specific building analytics scenario. The approach first models the sensor/controller time series through a layered Markovian model in which the hidden state depicts the particular event of interest. Then these extracted state time series are used in a heuristic correlation search to find out relationships among sensors and controllers in an efficient way. Sufficient experiments have been done to show its good performance. The authors claim the proposed method is the first to automatically analyze and configure sensor/controller relationships in the domain of building analytics, which is used to be done manually. The authors also claim the proposed method scales well for thousands of sensors and controllers in the building for a long period of recording time.

2. [Relevance] Is this paper relevant to an AI audience?

Of limited interest to an AI audience

3. [Significance] Are the results significant?

Not significant

4. [Novelty] Are the problems or approaches novel?

Not novel

5. [Soundness] Is the paper technically sound?

Technically sound

6. [Evaluation] Are claims well-supported by theoretical analysis or experimental results?

Sufficient

7. [Clarity] Is the paper well-organized and clearly written?

Good

8. [Detailed Comments] Please elaborate on your assessments and provide constructive feedback.

The paper is a well written one. However, the applicable scenarios are limited due to restricted problem formulation. Instead of fully driven by contextual information analysis for equipments in modern buildings, the problem should be formulated under a more general setting and can be extended to broader domains. Otherwise, this paper should be sent to more specific venues, for example, BuildSys.

The novelties claimed in this paper are under the context of building analytics, which aim mostly at avoiding manual acquisition and configuration, or adaptations of AI/ML/DM methods to this particular real-world scenario. Audience may be more interested in real-world applications that can innovate new problems and solution, but are not solvable by adapting existing methods.

In the first step, the proposed approach tries to model the behaviors/events of sensors and controllers via HMM. The construction and inference of the layered Markovian model are not novel. The problem dimension (of x, y, ...) in this building analytics situation is extremely small, which makes me doubt how this approach is applicable and efficient for similar problems in other broader domains where we have much larger dimensions. While in the second step, estimated state time series from HMM are fed in a usual heuristic correlation search so that sensor relationship can be mined. Apparently, authors can develop this second step with smarter techniques to strengthen the paper. The proposed approach scales well for the number of sensors and the length of time series, mostly contributed by the parallel sampling in the first step and heuristic search in the second step.

The authors have done complete experiments that show the superior performance of the proposed method.

9. [QUESTIONS FOR THE AUTHORS] Please provide questions for authors to address during the author feedback period.
(a) Can you give me similar problems in other domains?
(b) Could this approach be still efficient for above given other-domain problems in which the dimension of variables is much larger?

10. [OVERALL SCORE]
4 - Reject

11. [CONFIDENCE]
Reviewer is an expert in the area