A Deep Learning-Based Framework to Predict Sequential Design Decisions
CIE 2019 Graduate Research Poster

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Research Motivations and Gaps
Research Motivations
• In-depth understanding of the sequential design decision would help to discover beneficial design heuristics.
• Accurate prediction of design sequences is also vital to improve and implement design automation.

Research Gaps
• Existing studies mainly focus on exploring design patterns and characterizing design sequence based on only dynamic data.
• Although deep learning has been achieved state-of-the-art performance in many fields, it is unexplored in design area.

Research Hypothesis & Objectives
Research Objectives
• The objective of this study is to predict human sequential design decision in engineering system design context
• Develop a framework based on deep learning models [3] (long short-term memory (LSTM) unit and gated recurrent unit (GRU)) by integrating static data and dynamic data.

Research Hypothesis
Combining static data and dynamic data in deep learning models will improve the prediction accuracy

Methodologies and Implementation

- Raw CAD log data
- Sequential data of design actions
- FBS model encoding [1]
- Sequential data of design process stages
- Clustering sequential design behaviors [2]
- Data analysis & preparation
- Static data
- Dynamic data
- Text data vectorization using one-hot encoding
- Recurrent neural network modeling
- Predict sequential design process stages

Figure 2: The general framework for combining static and dynamic data

- Predict Sequential Design Decisions
- Combining static data and dynamic data in deep learning models will improve the prediction accuracy

Figure 3: Transformation of the sequential data of design actions to the sequential data of design process stages based on FBS model

Results

- Prediction accuracy for design challenges dataset
- ROC curve for Energy-plus home dataset
- ROC curve for solarized parking lot dataset

Future work
• A two-level framework will be developed to predict design action level sequence instead of predicting design process level sequence.
• We will add more static data by extracting psychological factors related to design thinking and cognitive skill.
• The further step of this research is to leverage the reinforcement learning as a core implementation of design automation.

References

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