Enabling Log Recommendation Through Machine Learning on Source Code

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1. Logging

- Is used in software development.
- Is a common practice.
- Reveals important runtime information.
- Helps with debugging and maintenance.
- Should only reveal necessary information and not hurt performance

It is a challenging task [1-3].

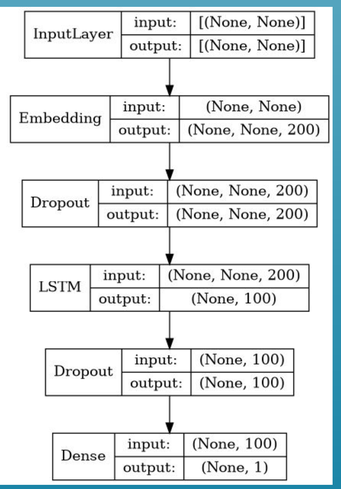
2. Research question

What is the performance of a log recommendation model developed following the methods of Li et al. [1], using CloudStack® source code as training data?

3. Methodology

- Creating a dataset (Figure 1)
  - Extract Java files
  - Extract methods from each file
  - Build Abstract Syntax Trees
  - Identify blocks
  - Label blocks
  - Remove all statements related to logging
  - For each block extract features (structural token sequence)
- Deep learning (Figure 2)
  - Embed each token using language processing (NLP)
  - Feed sequences of embeddings to a Recurrent Neural Network (RNN)
  - Convert output to a binary prediction
- Fine tuning
  - Adjust feature extraction, NLP, RNN algorithms
  - Adjust number of epochs, internal RNN states
- Evaluation
  - Calculate the performance of the model

Figure 2: Neural network model



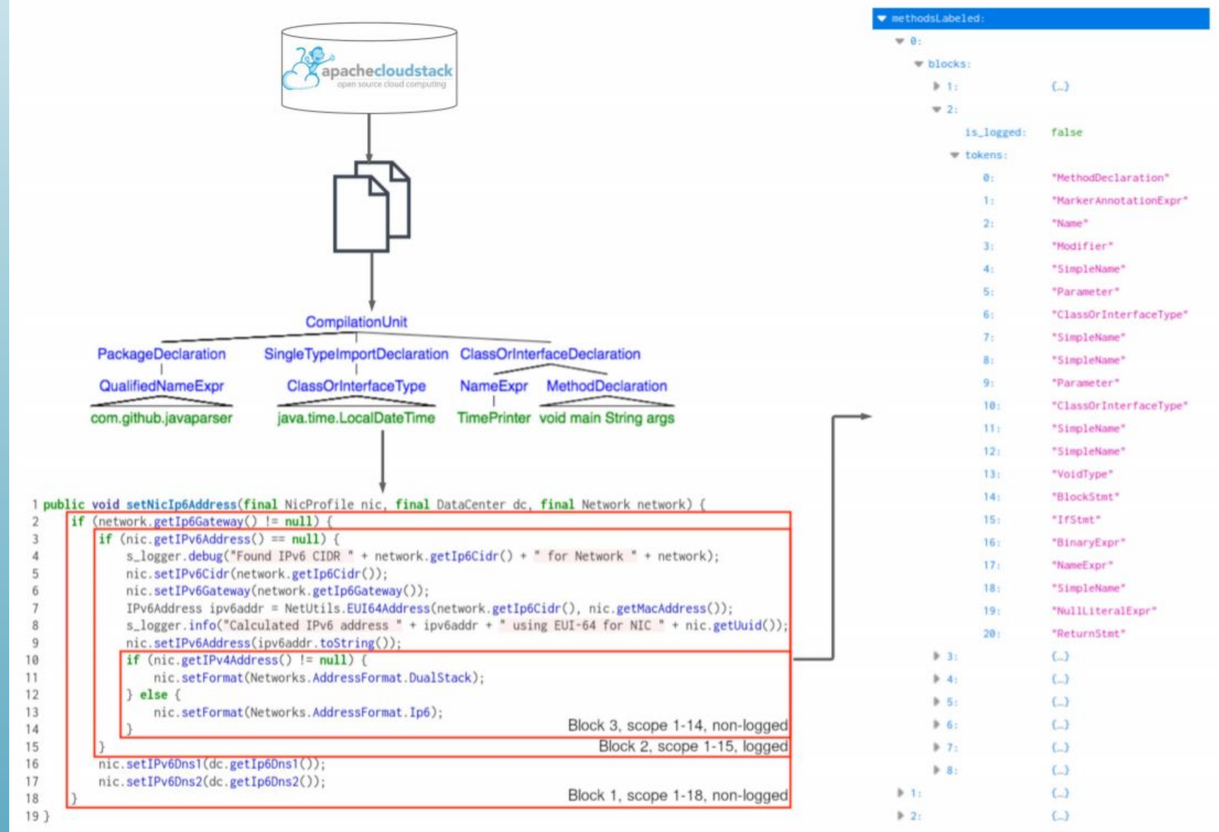


Figure 1: Flowchart of dataset creation method. This shows the most general steps

4. Results (Figure 3)

- F-Measure (FM) peaks at epoch 9 with a value of **0.57** (precision - 0.73, recall - 0.47)
- Average FM is **0.53** (average precision - 0.72, recall - 0.43)
- In 15 epochs the model showed potential for learning with 13% increase in FM and a positive sum of FM differences between every two neighbours

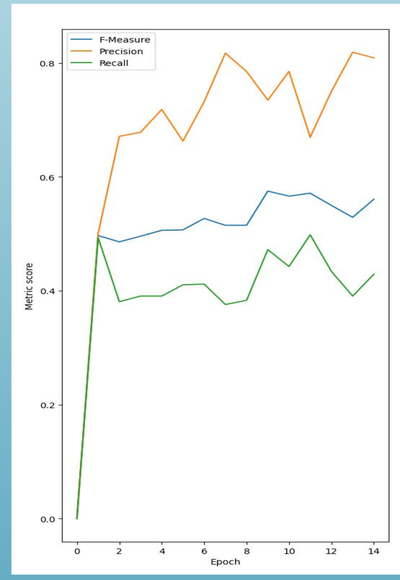


Figure 3: FM, precision and recall over 15 epochs

5. Conclusion

- Methods of Li et al. are reproducible
- Model trained on this specific dataset showed good performance predicting logs within project
- The performance is similar to that of Li et al. (they gained FM of 0.55)
- The gap between precision and recall is bigger than that of Li et al.
- A study on feature filtering was made and it revealed that not filtering features results in an increase of all tested metrics

6. Future recommendations

- Study computationally expensive configurations (more epochs, more hidden nodes, larger word vectors)
- Extend model to predict log level
- Study cross-project performance
- Investigate what causes a bigger gap between precision and recall

7. References

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