

# BFR: Bug Fixing Patches Ranking Model in Linux Kernel

## ABSTRACT

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## 1 INTRODUCTION

## 2 RELATED WORK

## 3 CONVOLUTIONAL NEURAL NETWORKS FOR SENTENCE CLASSIFICATION

## 4 APPROACH

### 4.1 Formalization

Let  $S$  be a set of stable bug fixing patches and  $P$  a set of all bug fixing patches in Linux kernel. We call  $U \in (S \cap P)$  is a set of unknown bug fixing. In our problem, we try to provide a bug fixing patches ranking  $\subset P^2$  for a developer, where each bug fixing patch has to meet the following properties [2]:

- *Totality*:  $\forall i, j \in P : i \neq j \Rightarrow (i > j) \vee (j > i)$
- *Antisymmetry*:  $\forall i, j \in P : (i > j) \wedge (j > i) \Rightarrow i = j$
- *Transitivity*:  $\forall i, j, k \in P : (i > j) \vee (j > k) \Rightarrow i > k$

### 4.2 Bug Fixing Patch Ranking

The architecture of bug fixing patch ranking is represented in Fig. 1. Our model based on convolutional neural network [1] to map bug fixing patches to vectors, which can be used to compute their ranking score. In the following, we describe how the model computes the ranking score given by a pair of bug fixing patches. We briefly explain each component (i.e., hidden layer, logistic function, etc.) of our model.

### 4.3 Learning Relationship Between Text and Code in Single Patch

In Linux kernel, each patch contains both a textual commit message and commit code. The commit message, which can help a developer to speed up the reviewing process, is a short description of source code change. The commit code is the changes that are applied on the buggy file.

### 4.4 Hidden Layer

### 4.5 Feature Representation

### 4.6 Output Layer

### 4.7 Training

Our model is trained by minimizing the cross-entropy lost function:

$$\begin{aligned} \mathcal{L} &= -\log \prod_{i \in S, j \in U}^N p(y_{ij} | p_i, p_j) + \lambda \|\theta\|_2^2 \\ &= - \sum_{i \in S, j \in U}^N \log \sigma(\mathbf{a}_{ij}) + \lambda \|\theta\|_2^2 \end{aligned} \quad (1)$$

where  $S$  and  $U$  are the stable and unknown bug fixing patches datasets respectively,  $y_{ij} = 1$  since  $p_i$  has higher rank compared to  $p_j$ ,  $N$  is the total number pairs of bug fixing patches in  $S$  and  $U$ ,  $\sigma(\cdot)$  represents the logistic function to identify the rank order of patches pair.  $\mathbf{a}_{ij}$  is the output of our ranking model and can be decomposed as:

$$\mathbf{a}_{ij} = \mathbf{a}_i - \mathbf{a}_j \quad (2)$$

to satisfy the properties mentioned in Sec. 4.1.

### 4.8 Regularization

## REFERENCES

- [1] Yann LeCun, Yoshua Bengio, et al. 1995. Convolutional networks for images, speech, and time series. *The handbook of brain theory and neural networks* 3361, 10 (1995), 1995.
- [2] Steffen Rendle, Christoph Freudenthaler, Zeno Gantner, and Lars Schmidt-Thieme. 2009. BPR: Bayesian personalized ranking from implicit feedback. In *Proceedings of the twenty-fifth conference on uncertainty in artificial intelligence*. AUAI Press, 452–461.

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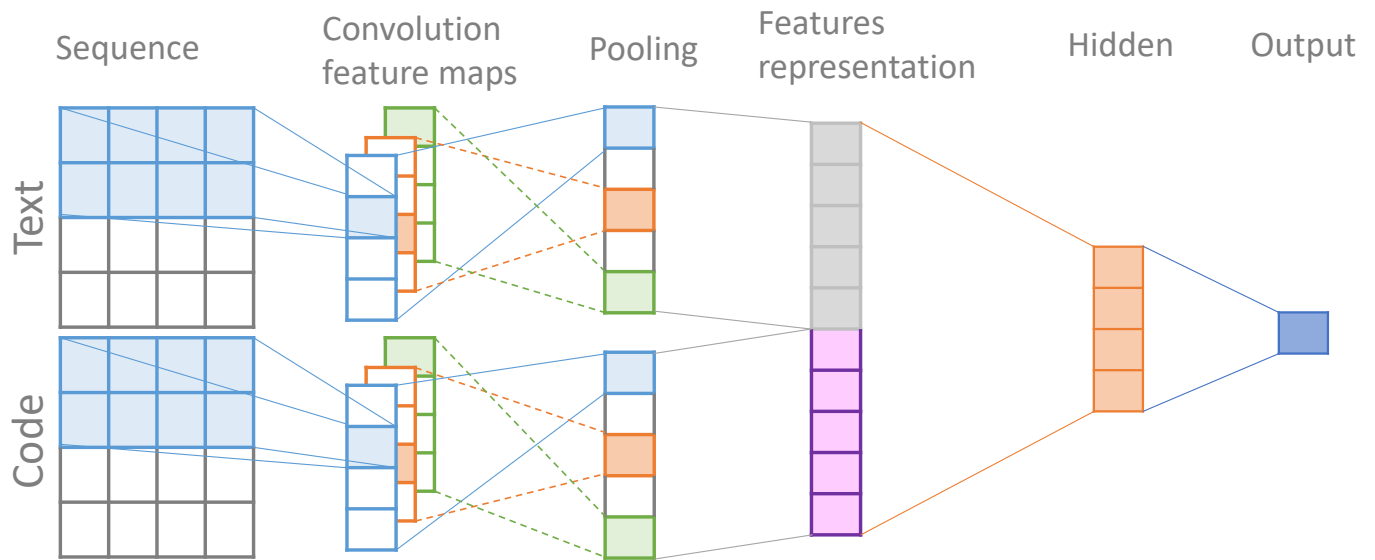


Figure 1: An architecture of bug fixing patches ranking model in Linux kernel.