

Code Template Inference Using Language Models

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What are Templates?

- File Operations

```
try {  
    FileReader input = new FileReader(aFile);  
    try {  
        while (( line = input.read() != -1){  
            contents.append(line);  
        }  
    }  
    finally {  
        input.close();  
    }  
}  
catch (IOException ex){  
    ex.printStackTrace();  
}
```

- Java Collection Framework e.g., List, Map
- JDBC Operations

Project-Specific Templates

```
public static void DeleteMessage(String chat_id) { /* Method to delete message with the given chat id */
    Session thirdSession = HibernateUtil.getSessionFactory().openSession();
    Transaction thirdTransaction = thirdSession.beginTransaction();
    Query query= thirdSession.createQuery("DELETE FROM message WHERE chat_id = '"+chat_id+"'");
    query.executeUpdate();
    thirdTransaction.commit();
    thirdSession.close();
}

public List getMessages(String chat_id) { /* Method to get all messages for a given chat id */
    Session secondSession = HibernateUtil.getSessionFactory().openSession();
    Transaction secondTransaction = secondSession.beginTransaction();
    List messages =
        secondSession.createQuery("from Message where chat_id='"+chat_id+"'").list();
    System.out.println( messages.size() + " message(s) found: " );
    secondTransaction.commit();
    secondSession.close();
    return messages;
}

/* Method to create and save a message */
public void saveMessage(String chatId,String userId,String userName,String msg,String postTime) {
    Session session = HibernateUtil.getSessionFactory().openSession();
    Transaction tx = session.beginTransaction();
    Message message = new Message(chatId,userId,userName,msg,postTime);
    session.save(message);
    tx.commit();
    session.close();
}
```

Hibernate Usage Examples

Project-Specific Templates

```
public static void DeleteMessage(String chat_id) { /* Method to delete message with the given chat id */
    Session thirdSession = HibernateUtil.getSessionFactory().openSession();
    Transaction thirdTransaction = thirdSession.beginTransaction();
    Query query= thirdSession.createSQLQuery("DELETE FROM message WHERE chat_id = '"+chat_id+"'");
    query.executeUpdate();
    thirdTransaction.commit();
    thirdSession.close();
}

public List getMessages(String chat_id) { /* Method to get all messages for a given chat id */
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    Transaction tx = session.beginTransaction();
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    session.save(message);
    tx.commit();
    session.close();
}
```

Hibernate Usage Examples

The Goal

Given

An incomplete code segment, which is the unsaved portion of code that is being edited by the programmer.

Goal

Find the closest matching template if one exists from a generated database

Usage and Template

- What are templates and usages?

```
Session thirdSession = HibernateUtil.getSessionFactory().openSession();
Transaction thirdTransaction = thirdSession.beginTransaction();
Query query= thirdSession.createQuery("DELETE FROM message WHERE chat_id = '"+chat_id+"'");
query.executeUpdate();
thirdTransaction.commit();
thirdSession.close();
```

Hibernate 'delete' Usage

```
Session thirdSession = HibernateUtil.getSessionFactory().openSession();
Transaction thirdTransaction = thirdSession.beginTransaction();
Query query = thirdSession.createQuery("");
query.executeUpdate();
thirdTransaction.commit();
thirdSession.close();
```

Hibernate 'delete' Template

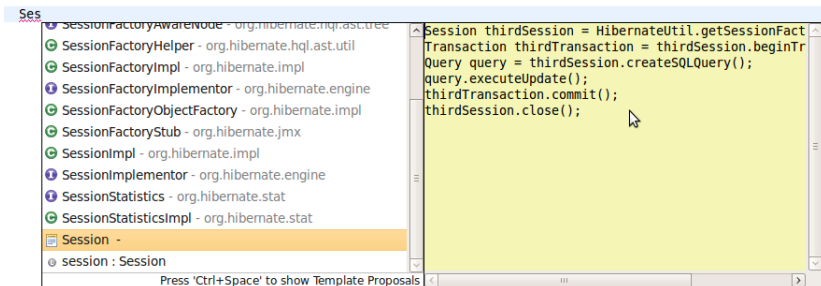
From source code Usages to Templates

A 4-step process

- 1 Find the frequent code usages
- 2 Learn from the usages
- 3 Monitor programmer editing actions in editor
- 4 Propose template within the editor

Templates within Editor

- End goal : After programmer typing 'Ses'



Editor Screenshot

Data Collection and Language Models

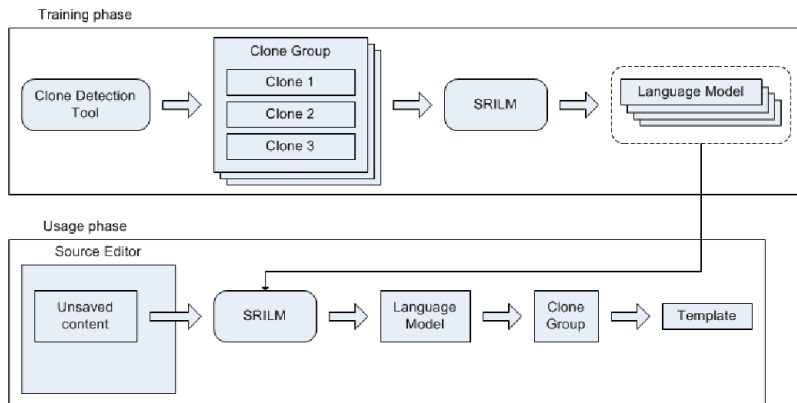
Data Collection and Clones

- Repeated usage \Rightarrow Clones
- Every Clone group has a template linked to it
- Clone Detectors: Simscan, Deckard, CCFinder

Training and Language Models (LM)

- Words sequence probability \Rightarrow Language Models
- 3 gram method
- Made some changes to meet domain specific changes
- LMs are generated for every clone group

A pictorial representation of the tool



Editor Screenshot

Limitations and Future Work

Dependency with the Clone detectors

- Are all clones useful?
- Do clone detectors get all usages?

Usage to template conversion

- More usages better the template
- Similar templates

Pre and Post processors for Clone detectors

- Include project specific information
- Removes unwanted clones

Conclusion

- Applied NL techniques in Software Engineering
- A tool to predict source code using Language model
- Word based trigrams are efficient for creating source code LM's
- A comparative study with related works

Thank You