AI – Based Approach For Mobile User Interface Adaptation

Hajer DAMMAK

Supervisor: Pr. Faouzi MOUSSA
Mrs. Meriem RIAHI
Who am I?

Hajer DAMMAK
PhD Student

Email Address: dammak.hajer@gmail.com

- Master of Science, University of Sfax.
- Teaching Assistant:
  - Object Oriented Design. (2017 - 2018 • ASSAIET)
RESEARCH STUDIES GOALS

✓ Adapting Mobile User Interfaces based on applications usage behavior: how user interact with his smartphone.

✓ Use the smartphone’s log files in a Machine Learning approach to model User Behavior and propose the appropriate adaptations.
✓ User can change effortlessly the purpose of his mobile device through the applications he used.

- Smartphone can be transformed into GPS, musical instruments, credit cards among others.

Consequently, applying the traditional HCI adaptation methods for mobile applications is not efficient.

➔ Crucial to understand how the user interacts with his device and applications.
✓ Smartphones are equipped with various applications: some exist by default and some of them are installed by the user.

→ Many applications remain unused, or rarely used, while others are regularly used.

Goal

✓ Create an adaptive Mobile User Interface (MUI) by adopting the grouping approach.
The idea behind adopting this hypothesis: applications’ grouping is static and fixed by the device manufacturer.

→ We wanted to test the efficiency and the practicality of this method.

→ Consequently, we tried in this study to group applications in a dynamic and modifiable way.
01. RELATED WORK

02. PROPOSED APPROACH

03. CASE STUDY

04. CONCLUSIONS & FUTURE WORK
Different UI adaptation approaches exist in the literature.

- Generally based on the user model. This model is usually static and is previously defined.
- Doesn’t take into account the user's behavior changes and its evolution while using his mobile device.

Relying on the user's behavior via the log files seems interesting for the success of the adaptation process.
✓ Data collection is an important task in the adaptation process.

➢ Thus we tried to enhance our knowledge about collecting data by answering the following questions:

**WHY ?**
› What is the main purpose behind collecting data?

**WHAT ?**
› What data is collected?

**HOW ?**
› How it is collected (approaches/methods)?

**WERE ?**
› Where it is stored? What are the types of Logs (extension)?
# RELATED WORK

<table>
<thead>
<tr>
<th></th>
<th>Fernandez et al., 2009</th>
<th>Ma et al., 2013</th>
<th>Kluth et al., 2014</th>
<th>Marczal et Junior, 2015</th>
<th>Holzmann et al., 2017</th>
<th>Ferre et al., 2017</th>
<th>Riegler et Holzmann, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Platform</strong></td>
<td>Android</td>
<td>Android</td>
<td>iOS</td>
<td>Android + iOS</td>
<td>Android</td>
<td>Android</td>
<td>Android</td>
</tr>
<tr>
<td><strong>Log format</strong></td>
<td>CSV</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>CSV</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Mobile device</td>
<td>Central server</td>
<td>Central server</td>
<td>Server</td>
<td>Mobile device</td>
<td>GAMA Server</td>
<td>Web Server</td>
</tr>
<tr>
<td><strong>Instrumentation</strong></td>
<td>✓ (manually added code)</td>
<td>✓ (requires code modification)</td>
<td>✓</td>
<td>-</td>
<td>x</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td><strong>Type de collection</strong></td>
<td>Triggered by the user</td>
<td>Auto</td>
<td>Auto (service)</td>
<td>Triggered by the user</td>
<td>Auto</td>
<td>Triggered by the user</td>
<td></td>
</tr>
<tr>
<td><strong>Scaling</strong></td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td><strong>Collected data</strong></td>
<td>Interaction data</td>
<td>Interaction info: UI events</td>
<td>Interaction info</td>
<td>Interaction info</td>
<td>Interaction info</td>
<td>Interaction info</td>
<td>Interaction info</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Interaction info</td>
<td>• Context of use</td>
<td>• Visited apps’ screenshot</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Mobility (GPS, data sensor)</td>
<td>• Interaction info</td>
<td>• Interaction info</td>
<td></td>
</tr>
<tr>
<td><strong>Test / evaluation</strong></td>
<td>Real world / lab</td>
<td>Lab</td>
<td>Lab</td>
<td>Real world</td>
<td>Real world</td>
<td>Lab + Real usage</td>
<td>Lab</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Usability analysis</td>
<td>Usability eval</td>
<td>Usability eval</td>
<td>Behavior analysis</td>
<td>UI eval</td>
<td>Usability eval</td>
<td>UI Evaluation</td>
</tr>
<tr>
<td><strong>Object of study</strong></td>
<td>Mobile apps</td>
<td>Mobile apps</td>
<td>Mobile apps</td>
<td>Mobile apps</td>
<td>Mobile device</td>
<td>Mobile apps</td>
<td>Mobile UI</td>
</tr>
</tbody>
</table>
Most of works using log files are oriented applications: focus on evaluating the usability of a particular application.

Rare are the works that are interested in evaluating the mobile device and that focus on the adaptation part.
01. RELATED WORK

02. PROPOSED APPROACH

03. CASE STUDY

04. CONCLUSIONS & FUTURE WORK
✓ PURPOSE:

➢ Adapting MUI basing on user behavior: his interaction with mobile applications.
➢ Thus, we can manage the used Apps by grouping them as “frequently used apps” in a dynamic and changeable way.

➢ We use the ML in our approach to adapt the MUI basing on user interaction.
✓ The proposed approach is based on 3 phases.

**Phase 1: Training the model**
Considered as **Field studies**.

**Phase 2: Recommending**
Oriented **log studies** (real-world use).
Recommending a set of apps to the user.

**Phase 3: fine-tuning**
For continuous improvement.
Send them to the model so it can cope with the changes.
PROPOSED APPROACH

Android Toolkit "AUTO:" allows automated logging of mobile device usage in the background.

- Parsing the log files and extracting the most appropriate features.
- Group the features in aspects: Time & visit.

AI module to train the model by applying ML techniques. ➔ We apply an offline learning approach.

**Field studies**

- Files are stored in smartphones and are sent voluntarily by participants.
- We gather the log files and perform an offline analysis.

**Session:**

- Starts when the screen is turned on and lasts until the screen display is off again or when the device is turned off completely.

**Visit:**

- Frequency of visits (number of visits per day), the sequence of visited apps out of one Session.

**Data Collection**

- User 1
- User 2
- User n
- Data Set (Interaction’s File log)

**Data Processing**

- File log Parsing
- Feature Extraction

**Training**

- Behavior Modeling
- User Modeling

**Recommendation**

- Grouping Apps

**Loading**

- Mobile App

**Recommendation**

- Grouping Apps

**Fine Tuning**

**Offline Learning**

- Parsing the log files and extracting features.
- Grouping the features in aspects: Time & visit.
The Learning process of the proposed approach:

- **Unsupervised Learning**: To identify the different clusters of user behavior.
- **Supervised Learning**: To classify the new entry.
- **Recommendation**: Grouping the frequently used apps and places it on the most suitable place to the user.
In this study, we examine the following **unsupervised** ML algorithms:

**Agglomerative clustering**
- A subgroup of K-means clustering: an iterative algorithm that helps finding the highest value for every iteration.
- Does not require the number of clusters K as an input. It starts by forming each data as a single cluster.
- Uses some distance measure, reduces the number of clusters (one in each iteration) by merging process.

**Hierarchical Clustering**
- Builds a hierarchy of clusters. It begins with all the data which is assigned to a cluster of their own. Here, two close clusters are going to be in the same cluster.
- The algorithm ends when there is only one cluster left.
In this study, we examine the following **supervised** ML algorithms:

**Logistic Regression**
- Attempts to fit a line to data that has only two levels or outcomes, whereas, logistic regression models the chance of an outcome based on a transformation known as a logit.

**Support Vector Machine (SVM)**
- Uses training examples to create a hyperplane that separates the dataset into classes.
- The complexity of classes may vary, but the simplest form of the SVM algorithm has only two possible labels to choose from.
- To reduce misclassifications, a decision boundary is obtained while training the SVM algorithm. (decision boundary is known as the **optimal separation hyperplane**).
**PROPOSED APPROACH**

✓ Post training model?

- **Data Collection**
  - User 1
  - User 2
  - User n
  - Data Set (Interaction’s File log)

- **Data Processing**
  - File log Parsing
  - Feature Extraction

- **Training**
  - Behavior Modeling
  - User Modeling

- **Recommendation**
  - Grouping Apps

**Collecting the user's real time interactions**

**Processing the gathered data** (forwarded to a real-time data analysis system for learning)

**The fine-tuning ML predictive model is a crucial step to improve the accuracy of the forecasted results.**

**With fine-tuning, the learning of new tasks relies on the previously learned tasks.**
The idea of grouping the applications arises many questions:

- How many groups of applications should we create?
- Should we group according to the application’s category or according to the user’s category?
- How many applications per group?
- What is considered as the most suitable place for the user (bottom, up, left, right, in the middle)?
- What is considered as the most suitable place for the user (bottom, up, left, right, in the middle)?
- Does the user prefer a group of applications or does he prefer them to be placed in the main widget?
- In the case of many widgets, in wish widget should we place the recommended group? And if the widget is overloaded, what is the best decision to take?
PROPOSED APPROACH

✓ User’s feedback is important to evaluate the adapted interface.

Taking into account his interaction with the created grouping can improve the model

➔ **Modifying the place** of the group or **Re-adjusting** it must be considered in the next generation of grouping.
01. RELATED WORK

02. PROPOSED APPROACH

03. CASE STUDY

04. CONCLUSIONS & FUTURE WORK
✓ We used AUTOMATE toolkit for data collection.

➢ The resulting log file is a CSV format.
✓ Sample of log file shows the used application

➢ Log file: contains overall interesting information: sequence of opened apps, app usage duration, phone orientation, where the user clicked, etc.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<session>
  <appUsage>
    <packageName>com.google.android.googlequicksearchbox</packageName>
    <name>Google</name>
    <startTime>1573929957560</startTime>
    <state>
      <name>[Tap to update]" class="android.widget.FrameLayout" duration="211"
      interactionCount="1"
      orientation="1"
    </state>
  </appUsage>

  <appUsage>
    <packageName>cn.wps.moffice_eng</packageName>
    <name>WPS Office</name>
    <startTime>1573929958194</startTime>
    <state>
      <name>[WPS Office]" class="cn.wps.moffice.documentmanager.PreStartActivity" duration="2231"
      interactionCount="1"
      orientation="1"
    </state>
  </appUsage>

</session>
```
CASE STUDY

✓ We tested our approach on 3 users having different backgrounds and different attitude.

➢ **User#1**: an entrepreneur and actively toggles between work and fun every day. He has only 1 widget screen, where he put all his apps into multiple groups (professional, social, entertainment).

➢ **User#2**: a startup CEO and has multiple widgets screen but uses solely the home widget where he puts only productivity apps to focus on his work.

➢ **User#3**: a Ph.D. student and has many widget screens, and does not group her apps. Otherwise she uses many widgets screen.

**NOTE**: users have been using their configuration for a long time and they announced that they are satisfied with the way apps are arranged.
CASE STUDY

✓ Before/After grouping:

Before

User 1

User 2

User 3

After
CASE STUDY

✅ **User feedback:**

- **User#1:** said that the grouping didn’t go well with his needs as he initially grouped his apps based on his frequency of use and routine.

- **User#2:** said that while the grouping made sense, it's ineffective to have one group when there are a lot of empty spaces in the home widget.

- **User#3:** completely refused the proposition as she just doesn't like to have groups. She prefers to set the most important apps in the main widget.
✓ The given feedback highlight important point: As much as the solution can technically be good, is it really useful?
✓ Although the users' evaluation feedback is negative toward the grouping method.

➢ Does not indicate that the conceptual model of the prototype is wrong or needs revision.
➢ Denotes that it is natural that people don't like significant changes in a very short time: The case study here drastically changed routine usage.

➔ Making the approach more friendly to mobile users.
➔ Taking into account the periodicity, the frequency of adaptation and his user current mood.
AGENDA

01. RELATED WORK
02. PROPOSED APPROACH
03. CASE STUDY
04. CONCLUSIONS & FUTURE WORK
Conclusions

✓ AI – Based Approach For Mobile User Interface Adaptation where we suggest a method for grouping apps.

✓ Use Machine Learning techniques to understand user’s behavior. The learning process of the proposed approach is composed of 3 phases: Clustering, classification and recommendation.

✓ The case study: adapting interfaces from different users with different attitudes.

- User's feedback did not show a big interest in the grouping which brought us questioning **USABILITY VS UTILITY**.

- The given feedback points out that users do not like major changes in their devices in short period.
Perspectives

✓ Study and adjust the **periodicity** and the **frequency** of adaptation so the user can benefit from an outgoing interaction.

✓ Examine further the performance of many other Machine Learning algorithms.

✓ Consider the user mood for a smooth user experience.

✓ Explore users' implicit feedback (behavior after adaptation: deleting the grouping, changing it place, etc.) to improve the model to get a more accurate adaptation.
THANK YOU

Email Address: dammak.hajer@gmail.com