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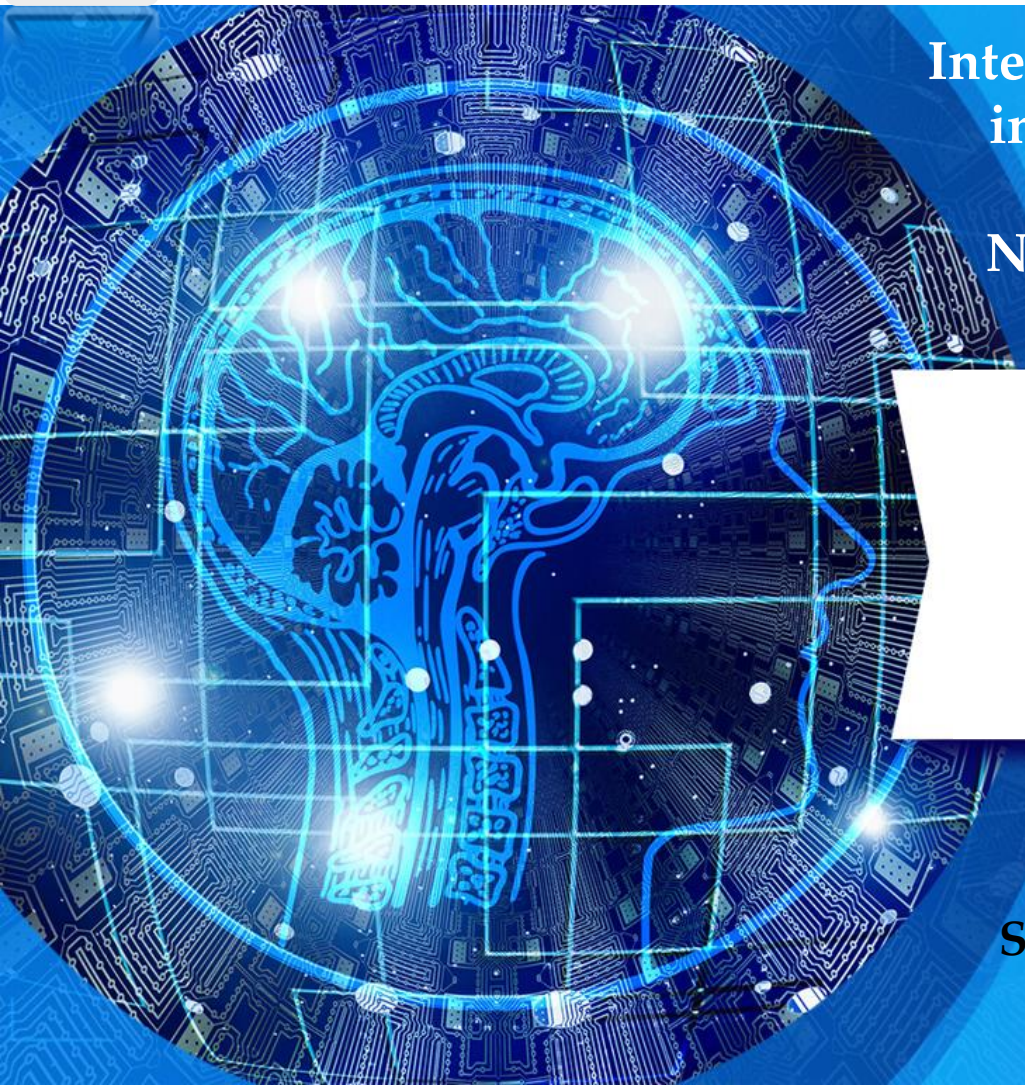

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AI – Based Approach For Mobile User Interface Adaptation

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Who am I ?

Hajer DAMMAK

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- **Ph.D. Thesis, University Tunis El Manar.**
- **Master of Science, University of Sfax.**
- **Teaching Assistant:**
  - Artificial Intelligence. (2019 - 2020 • FST), (2018 - 2019 • FST)
  - Integrated Development Environment. (2018 - 2019 • FST)
  - Object Oriented Design. (2017 - 2018 • ASSAIET)
  - Certificate of Computer and Internet, C2I. (2014 - 2015 • FSS)

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.**

MOTIVATION

- ✓ **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.**

MOTIVATION

- ✓ **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.**

MOTIVATION

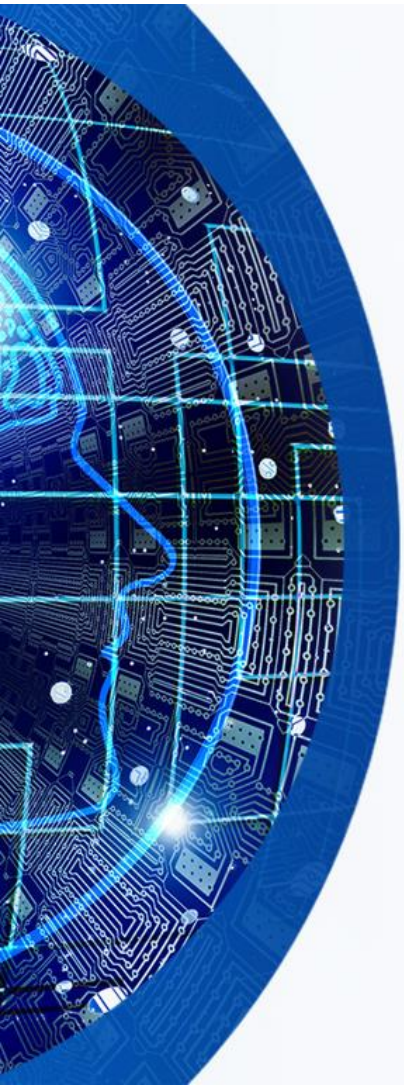
WHY ?

- ✓ **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.**

AGENDA



01. RELATED WORK

02. PROPOSED APPROACH

03. CASE STUDY

04. CONCLUSIONS & FUTURE WORK

RELATED 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.

RELATED WORK

- ✓ **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

	[Fernandez et al., 2009]	[Ma et al., 2013]	[Kluth et al., 2014]	[Marczal et Junior, 2015]	[Holzamann et al., 2017]	[Ferre et al., 2017]	[Riegler et Holzmann., 2018]
Plateform	Android	Android	iOS	Android + iOS	Android	Android	Android
Log format	CSV	-	-	-	CSV	-	-
Storage	Mobile device	Central server	Central server	Server	Mobile device	GAMA Server	Web Server
Instrumentation	√ (manually added code)	√ (requires code modificationl)	√	-	×	√	-
Type de collection	Triggered by the user		Auto	Auto (service)	Triggered by the user	Auto	Triggered by the user
Scaling	×	×	-	√	×	√	×
Collected data	Interaction data	Interaction info: UI events	Interaction info	• Interaction info • Mobility (GPS, data sensor)	• Context of use • Interaction info	Interaction info	• Visited apps' screenshot • Interaction info
Test / evaluation	Real world / lab	Lab	Lab	Real world	Real world	Lab + Real usage	Lab
Purpose	Usability analysis	Usability eval	Usability eval	Behavior analysis	UI eval	Usability eval	UI Evaluation
Object of study	Mobile apps	Mobile apps	Mobile apps	Mobile apps	Mobile device	Mobile apps	Mobile UI

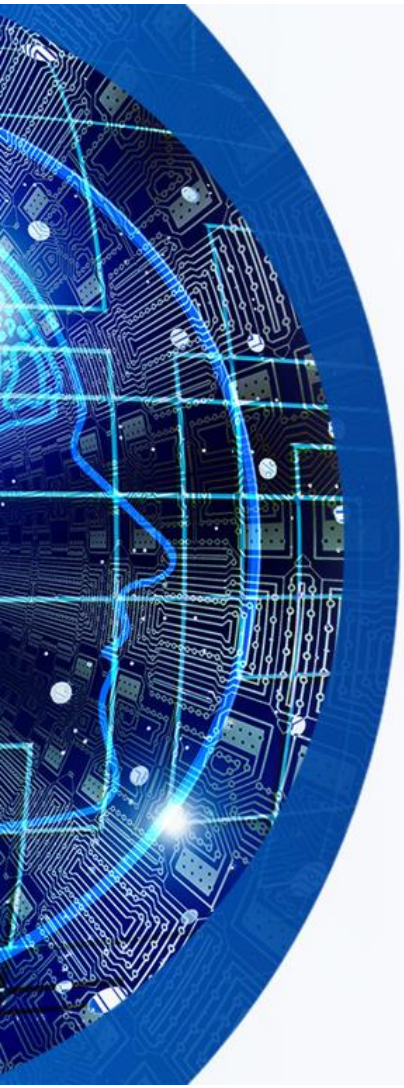
RELATED WORK

✓ **Notes:**

- **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.

AGENDA



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PROPOSED APPROACH

✓ 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.**

PROPOSED APPROACH

✓ **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

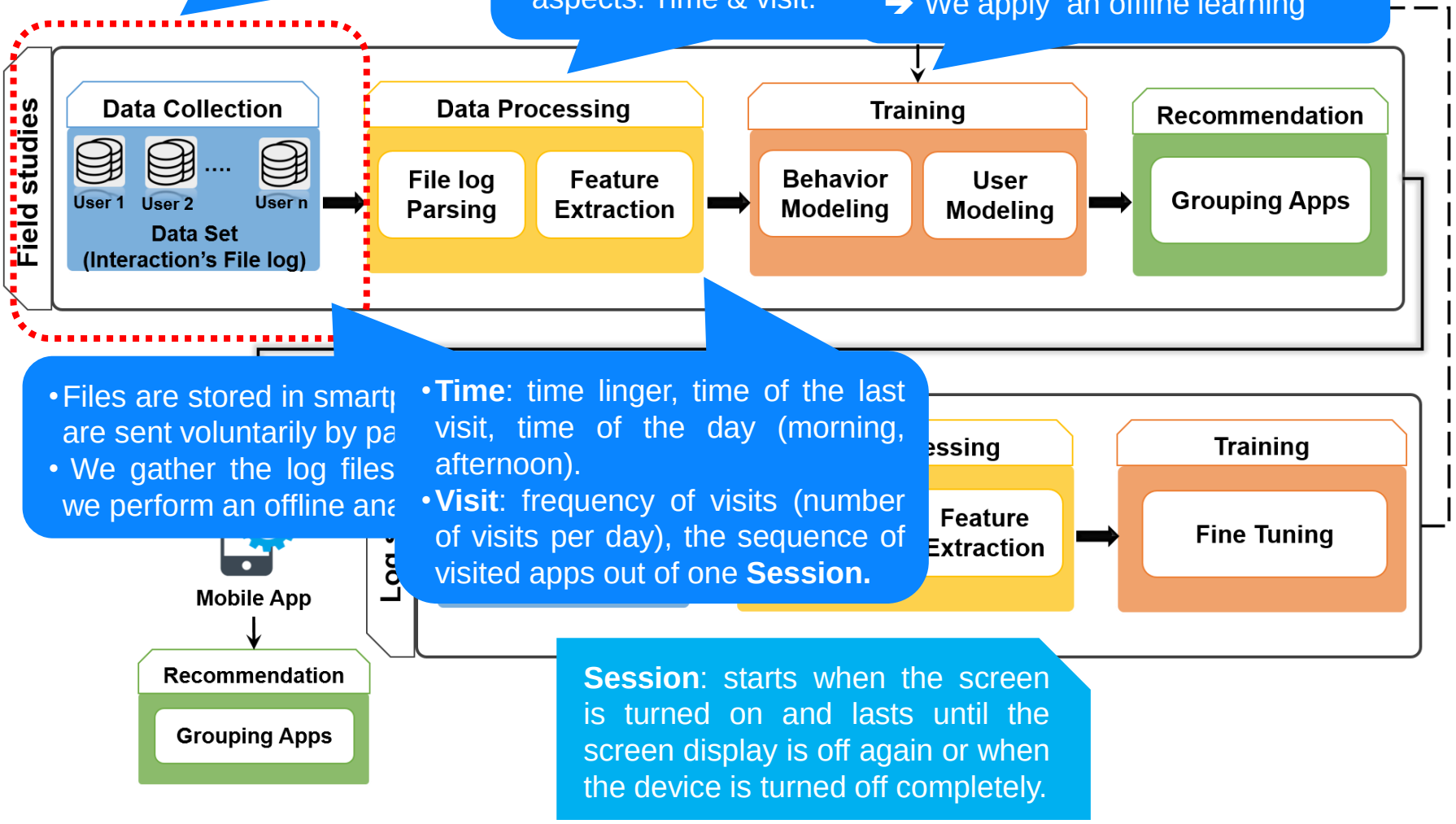
For continuous improvement.
Send them to the model so it can cope with the changes.

PROPOSED APPROACH

Android Toolkit "AUTC
allows automate logging c
device usage in the backgr

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

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



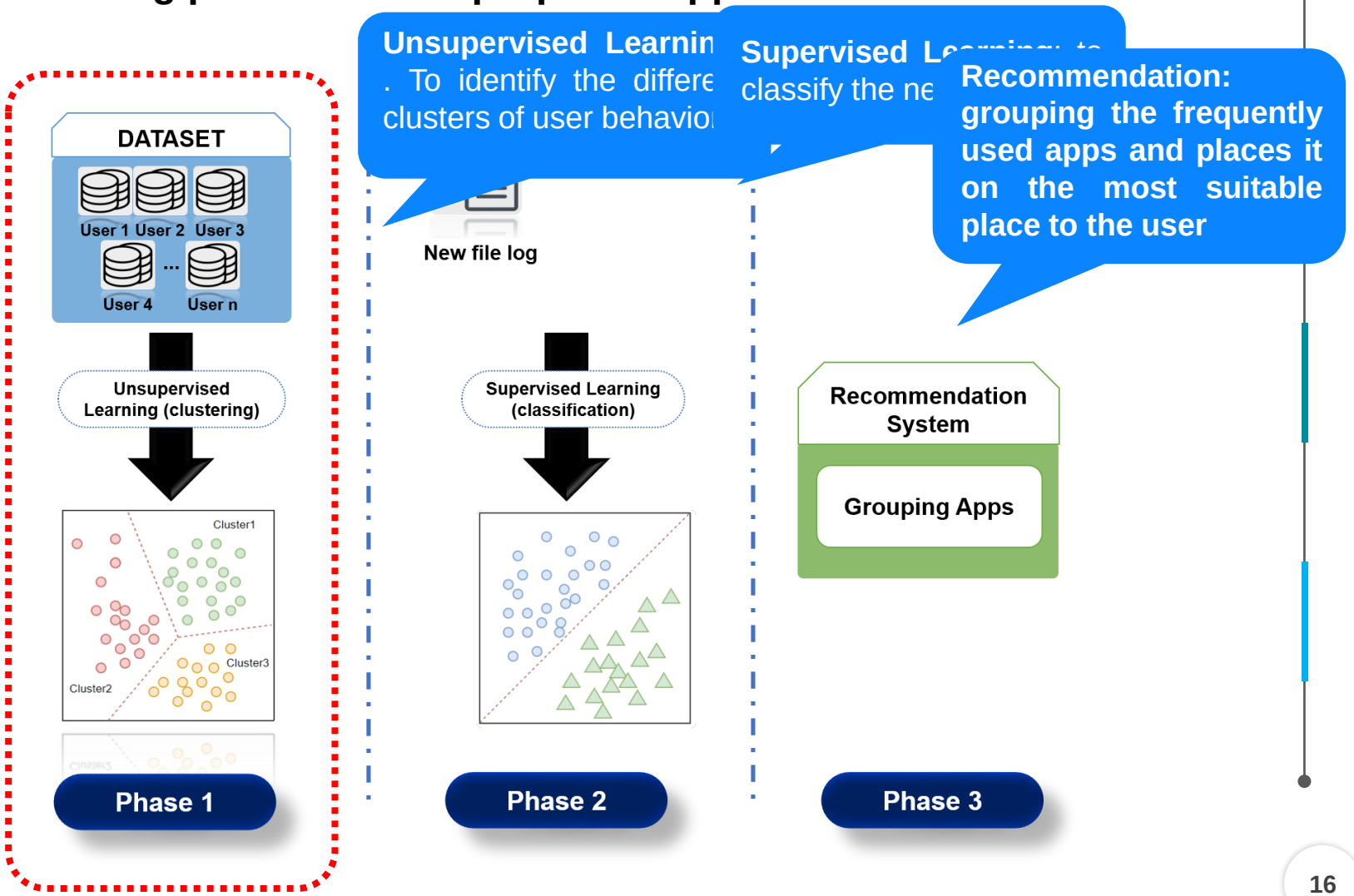
- Files are stored in smartp are sent voluntarily by pa
- We gather the log files we perform an offline ana

- **Time**: time linger, time of the last visit, time of the day (morning, afternoon).
- **Visit**: frequency of visits (number of visits per day), the sequence of visited apps out of one **Session.**

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.

PROPOSED APPROACH

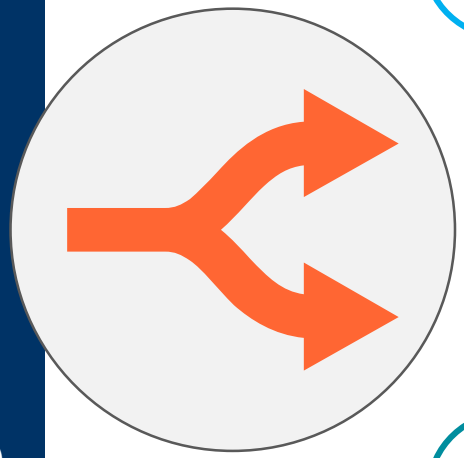
✓ **The Learning process of the proposed approach:**



PROPOSED APPROACH

✓ **In this study, we examine the following <u>unsupervised</u> ML algorithms:**

Machine Learning
(Unsupervised)



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.

PROPOSED APPROACH

✓ **In this study, we examine the following supervised ML algorithms:**

Machine Learning (Supervised)

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)

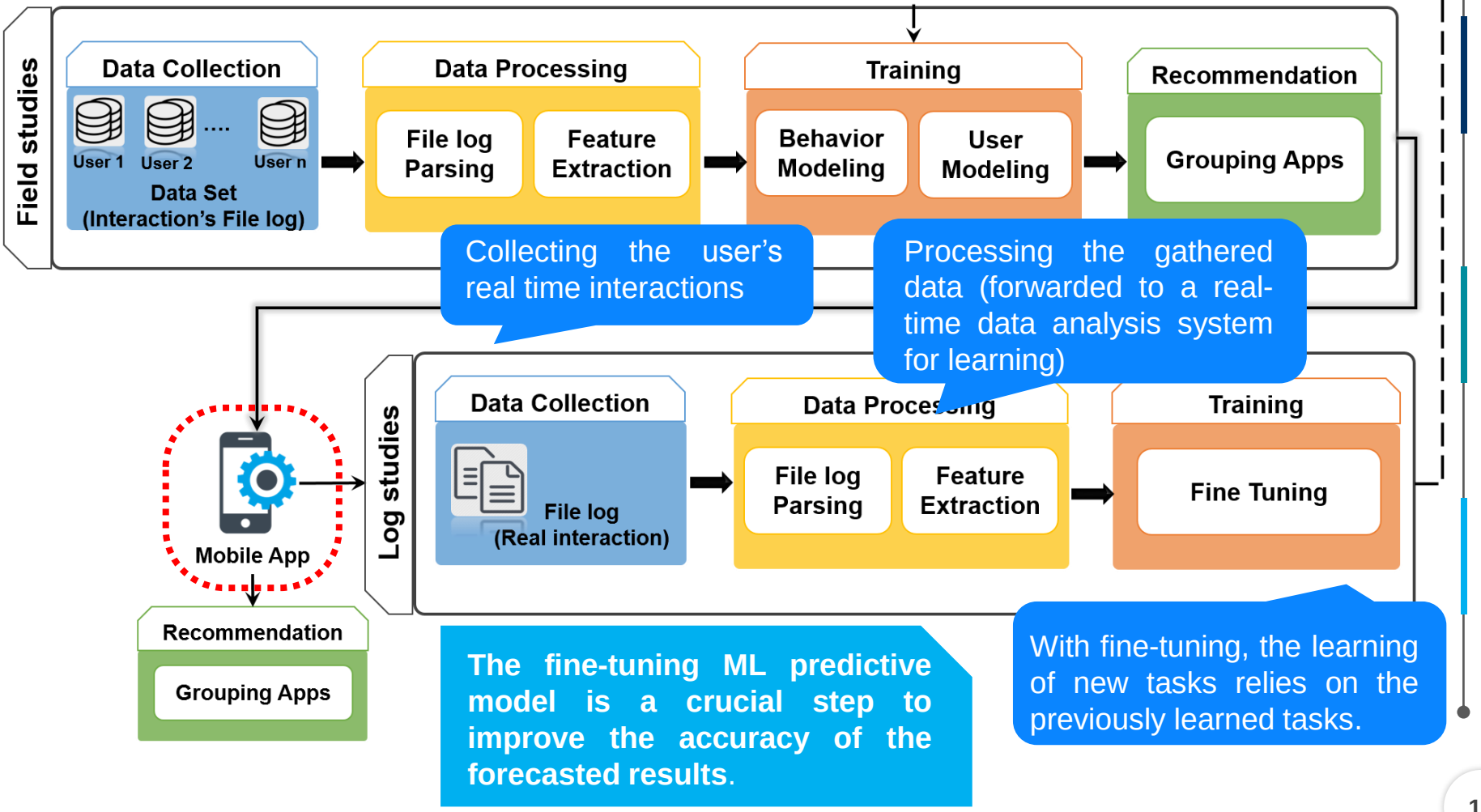
› Uses training examples to create a hyperplane that separates the dataset into classes.

› 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?**



PROPOSED APPROACH

✓ **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?

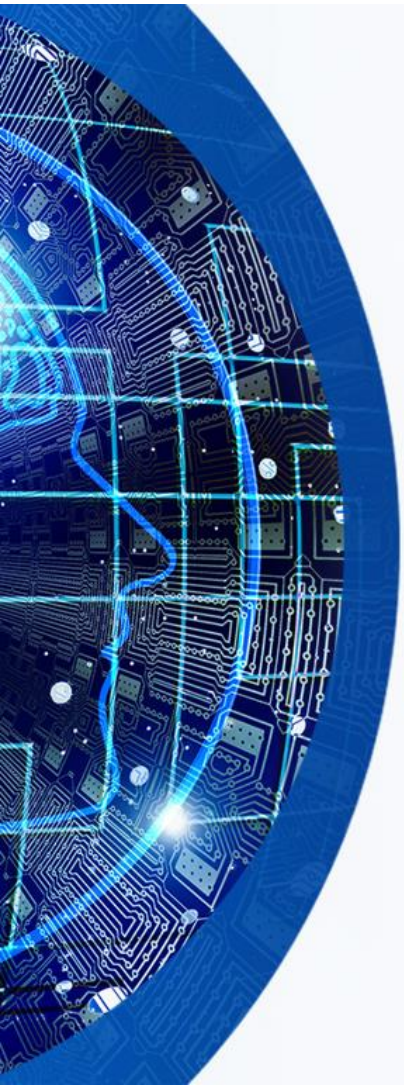
PROPOSED APPROACH

✓ **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.

AGENDA



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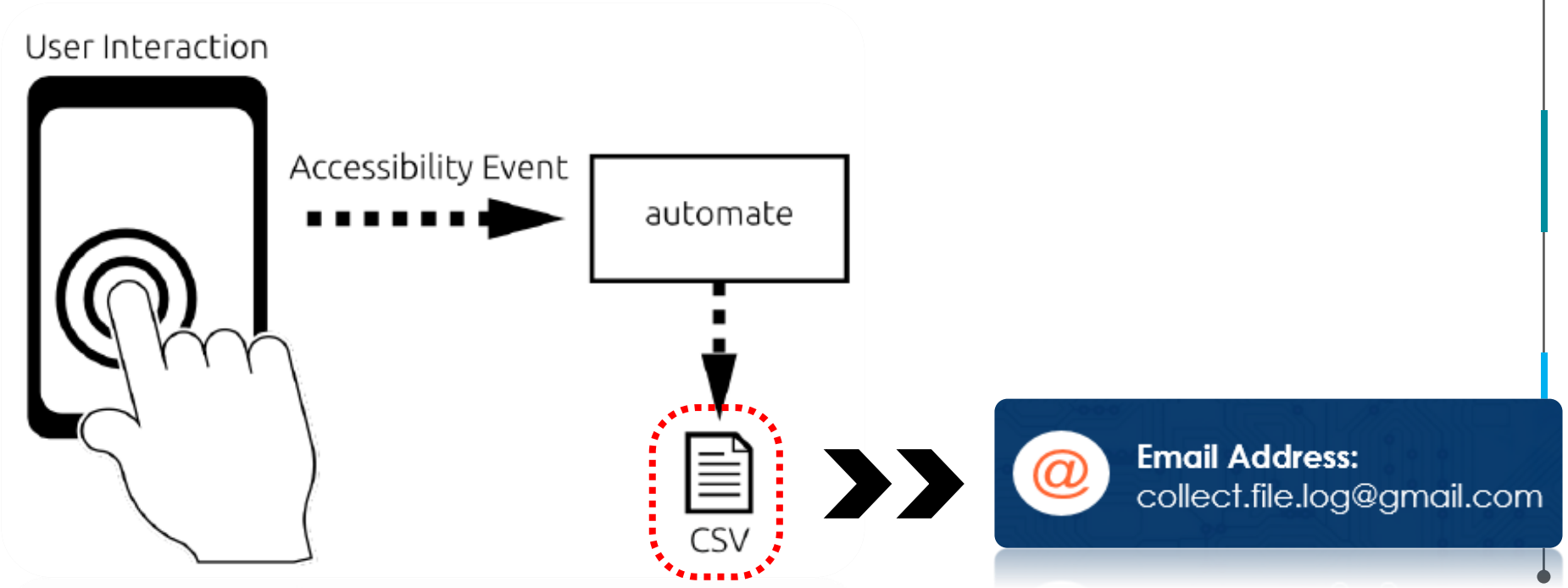
CASE STUDY

- ✓ **We used AUTOMATE toolkit for data collection.**
  - ➢ **The resulting log file is a CSV format.**



CASE STUDY

- ✓ **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 version="1.0" encoding="UTF-8"?>
<session>
    <appUsage
    packageName="com.google.android.googlequicksearchbox"
    name="Google"
    startTime="1573929957560">
        <state
        name="[Tap to update]"
        className="android.widget.FrameLayout"
        duration="211"
        interactionCount="1"
        orientation="1"
        />
    </appUsage>
    <appUsage
    packageName="cn.wps.moffice_eng"
    name="WPS Office"
    startTime="1573929960194">
        <state
        name="[ WPS Office]"
        className="cn.wps.moffice.documentmanager.PreStartActivity"
        duration="2231"
        interactionCount="1"
        orientation="1"
        />
    </appUsage>
</session>
```

Used application: **Google Quick Search Box**

Used application: **WPS office**

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).**

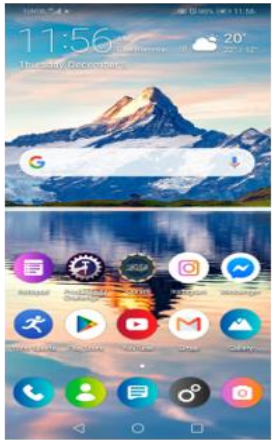
- ➢ **User#2: a startup CEO and has multiple widgets screen but uses solely the home widget where he puts only productivity apps to focus on his work.**

- ➢ **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:**

	User 1	User 2	User 3
Before			
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.

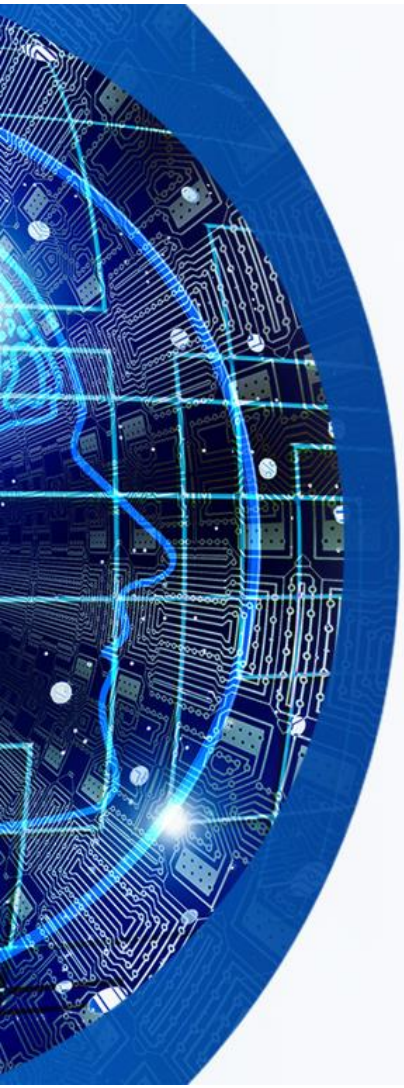
- **User#3**: completely refused the proposition as she just doesn't like to have groups. She prefers to set the most important apps in the main widget.

CASE STUDY

- ✓ **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



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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.**

CONCLUSIONS & FUTURE WORK

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

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