MINISTRY OF EDUCATION

TECHNICAL UNIVERSITY
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FACULTY OF AUTOMATION AND COMPUTER SCIENCE
COMPUTER SCIENCE DEPARTMENT

SUMMARY
of the License Thesis entitled:

DETECTING DEVIATIONS IN THE DAILY ROUTINE OF A PERSON TECHNIQUE FOR DETECTING DEVIATIONS USING ENTROPY RATE AND COSINE SIMILARITY

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1. **Requirements**:

The main requirement of this project was to develop a technique for detecting deviations from daily routine of a person using the entropy rate and cosine similarity. The proposed technique should be integrated into a full-stack medical application, validated on daily living activity data, and evaluated using appropriate metrics.

2. **Proposed solutions**:

The proposed technique for anomaly detection uses the entropy rate and the cosine similarity measurement to detect deviations from daily routine of a person. In the anomaly detection process we take into consideration both the order of the activities and their duration. The anomaly detection technique is integrated as part of a medical platform consisting of the following modules:

- **The platform front-end**. The front-end application is the interface that the healthcare professionals use to interact with the rest of the medical platform and particularly with the anomaly detection component.
- **The platform back-end**. The platform back-end handles all the application business logic except for the anomaly detection itself.
- **The anomaly detection module**. The anomaly detection module integrates the develop anomaly detection technique. To detect deviations from daily living routine of a person, anomaly detection module component interacts with the baseline detection module.

Figure 1 presents the conceptual architecture of the platform.

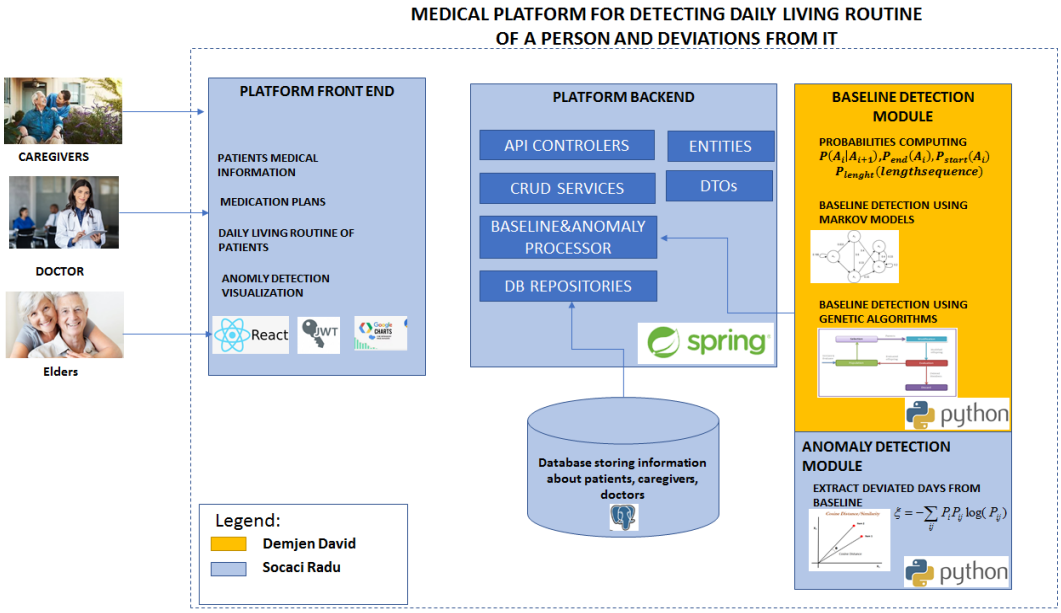


Figure 1: Conceptual architecture of the platform

3. Results obtained:

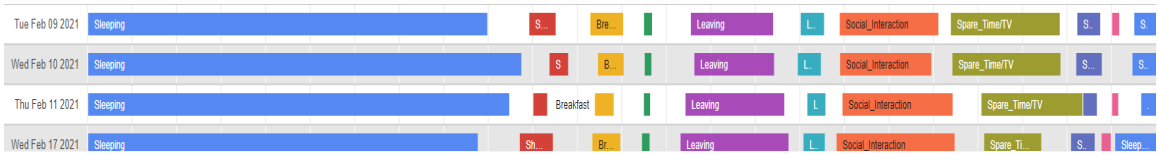
The obtained result is a medical platform that integrates the technique for detecting deviations from daily routine of a person based on the entropy rate and cosine similarity measurements. Using the medical platform, a healthcare professional is able to register a patient, extract his routine, detect deviations from that the daily living routine and visualize the results using timeline graphs and pie charts for the day classification distribution.

4. Tests and verifications:

The proposed method was tested using a generated dataset, due to the complexity of manually labeling a large dataset. The generation process started from a specific routine containing activities observed primarily in elders with dementia and generated 2 datasets (1-month and 3-month long) using a controlled randomization of the routine, labeling each day based on the randomness factor used when generating it.

The method was validated by computing the *sensitivity* and *specificity* on both datasets, using an 80/20 training/testing split factor. For the smaller dataset, we obtained a perfect sensitivity and specificity of 1 due to the reduced number of testing days (i.e. 6 days). For the larger dataset (the testing data set consists of 18 testing days, and the training data set consists of 72 days), we obtained more realistic values of 0.8 and 0.75 for the *sensitivity* and *specificity* measurements, respectively.

Figure 1 shows the normal days, (i.e., days that respect the baseline) identified by our technique based on the 3-month data set, while Figure 2 shows the days that deviate from the baseline both in terms of the order of activities and their duration.



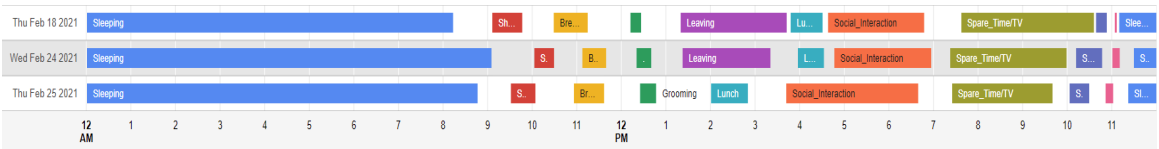


Figure 1: Regular days (respecting the baseline) for 3-month dataset

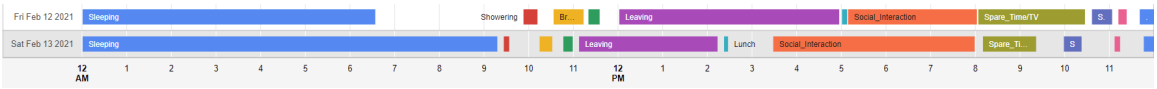


Figure 2: Deviated days (respecting the baseline) for 3-month dataset

5. Personal contributions:

The project was developed as part of a team. My personal contributions include: (I) selecting/generating the dataset, (II) developing a technique for detecting deviations using entropy rate and cosine similarity, (III) testing and validating the method on the selected dataset, (IV) implementing the anomaly detection component and integrating it with the rest of the platform, (V) implementing the platform back-end, (VI) implementing the platform front-end, (VII) containerizing each component, building the continuous integration pipeline and deploying the entire platform.

These steps were preceded by a research period that led to a better understanding of the methods and tools that need to be used to detect an individual's daily living anomalies.

6. Documentation sources:

The documentation sources of the research project include a number of research papers, United Nation's 2020 and 2017 World Population Ageing highlights, and the official docomentations of Docker, Spring, Heroku, Flask and React.

Date: 12.07.2021 Author _____

Coordinator _____