Personalized Health Recommendations adopting Deep Learning Tools

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At a Glance

2013
PhD in Computer Science
National and Kapodistrian
University of Athens

2016 Call
Marie Skłodowska-Curie
Action (MSCA)
Individual Fellowship
School of Computing Science
University of Glasgow

June 2020
Assistant Professor
Department of Informatics
and Telecommunications
University of Thessaly
http://kostasks.users.uth.gr

July 2020
Founder of the
Intelligent Pervasive Systems
(iPRISM) Research Group
http://www.iprism.eu

Oct. 2020
Co-Founder of the Intelligent
Systems for Orchestrating
Pervasive Computing Applications
(METIS) Research Lab
http://metis.cs.uth.gr

Dec. 2020
Director of the METIS Lab

Current Activities:

- Applied Artificial Intelligence and Machine Learning
- Distributed Intelligence
- Pervasive Data Science

Short Video with Our Activities

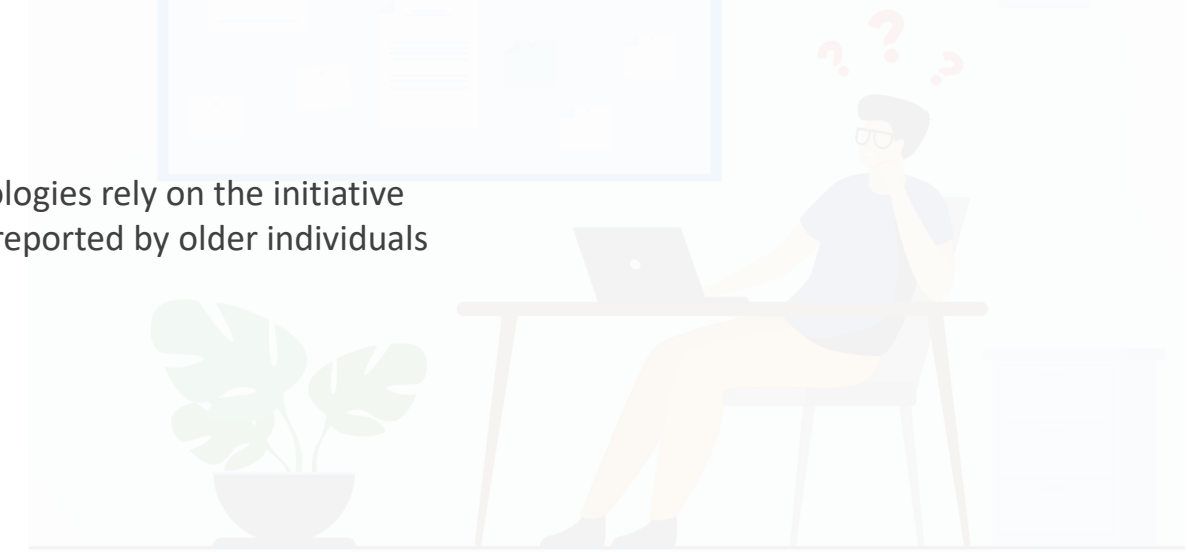
https://www.youtube.com/watch?v=s9vaO5OiKgU&t=146s

Deep Learning for Personalized Health Recommendations

The ELLIOT Project

- Accepted and implemented in the SHAPES Open Call 1
- Use of Artificial Intelligence (AI) for tracking and administrating the nutrition intake of elderly
- Prevent the negative effects of malnutrition
- Have a clear view on the nutrients that older individual get every single day
- Malnutrition and unintentional weight loss contribute to progressive decline in health

Legacy Techniques



Initiative to Individuals

Traditional nutrition intake methodologies rely on the initiative of subjects, i.e., on the information reported by older individuals

Methods

Measuring is not quite as easy

Food records, food frequency questionnaires, and 24-hour recalls

Disadvantages

Heavily rely on the subjects' desire to maintain the schedule and report their nutrition activities

Such an approach may discourage individuals from participating in the review especially when we consider an everyday setup

The ELLIOT Tool

- A tool that detects the nutrients consumed by subjects
- A tool that assists people to maintain a good health through interventions in their nutrition
- A tool that assists health care stakeholders to gain a view on the health status of the population
- A tool accessible through personal, ‘everyday’ devices, e.g., smartphones and tablets

ELLIOT Objectives

Decide

Decision Support System (DSS) and Knowledge Base

Record

Profiling mechanism

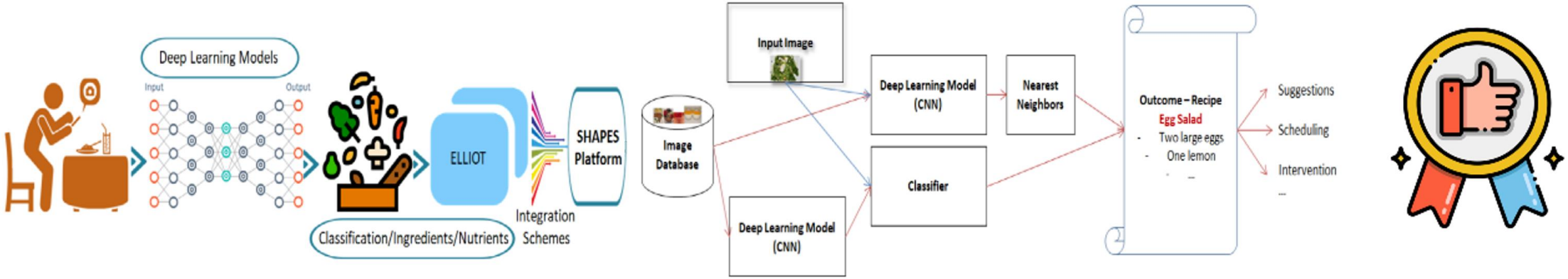
Process

Advanced image processing

Intelligence

(Pre)trained deep learning models

ELLIOT Scenario

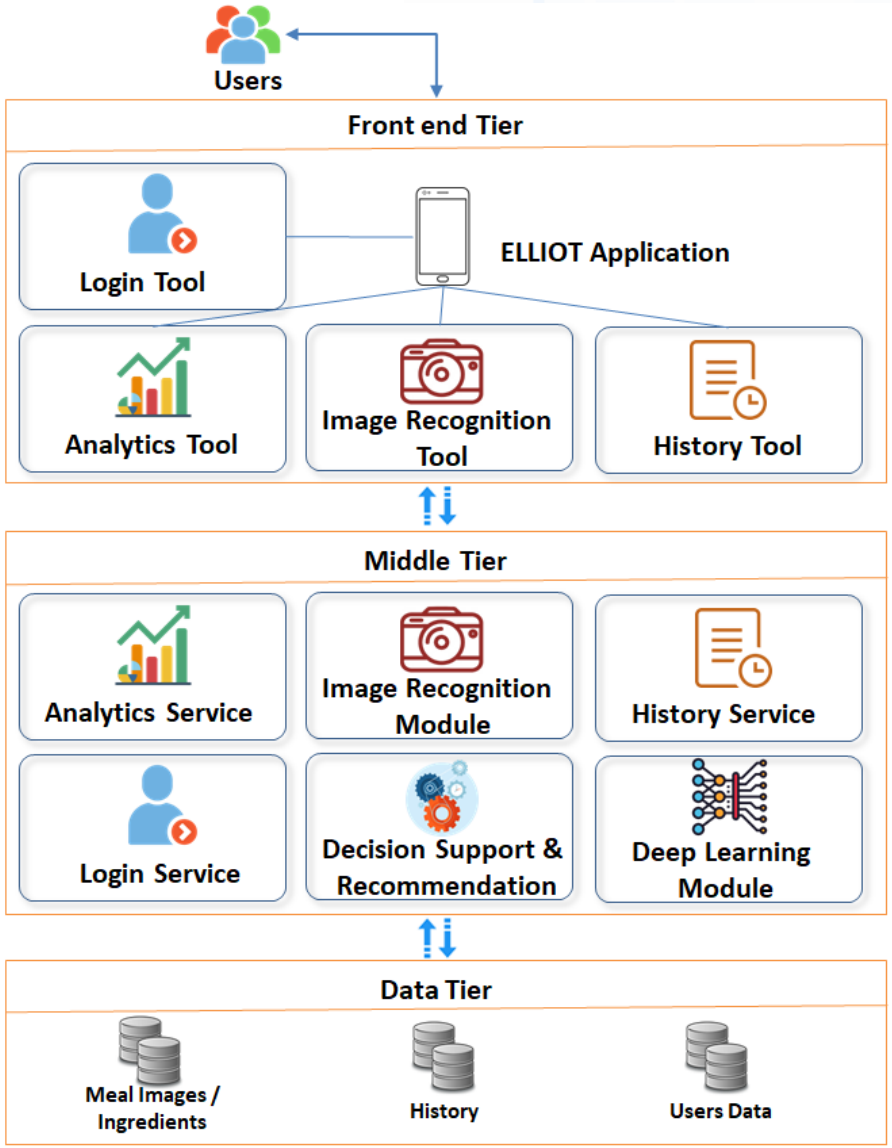


Step 1 Users record meals

Step 2 Image processing

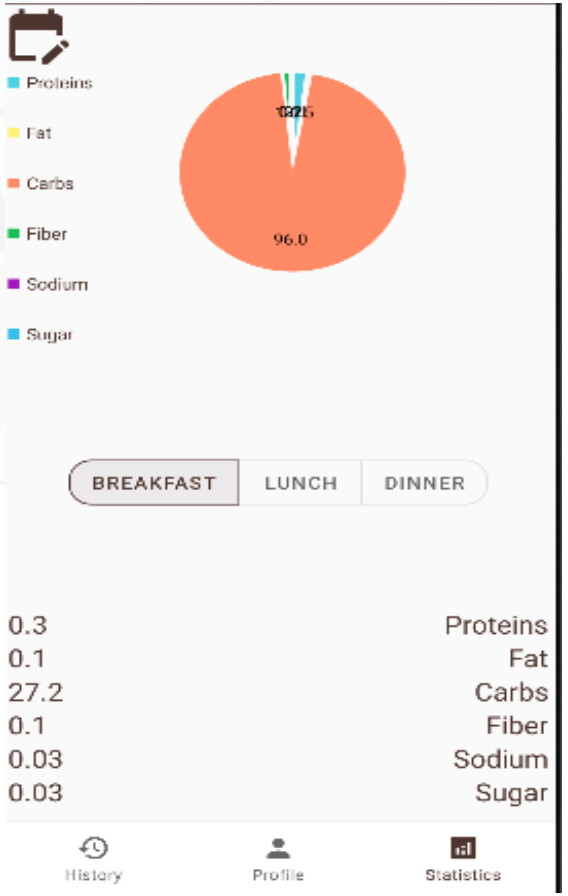
Step 3 Recommendations

ELLIOT Architecture



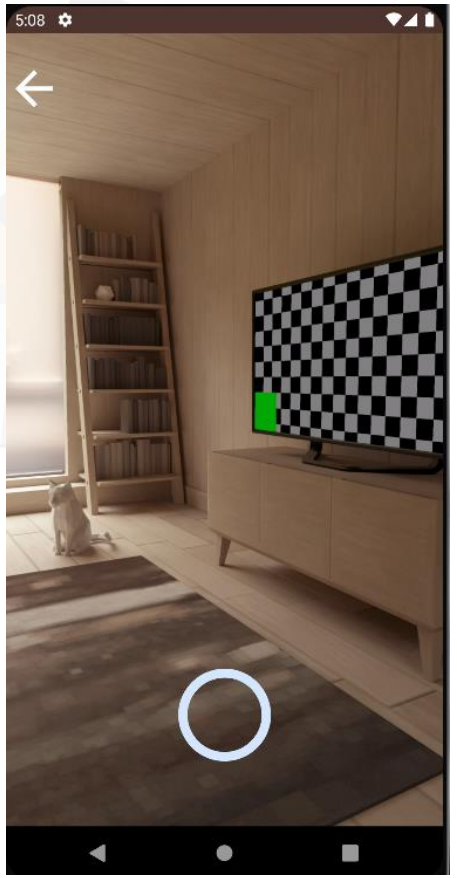
ELLIOT Components

- ✓ The **Analytics Tool and Service** is used to visualize different aspects of data to the user at the form of pie charts
- ✓ Each piece of the pie describes the percentage that each nutrient covers at the meal consumption
- ✓ The user is able to choose a date-span to access specific nutrient data to be visualized
- ✓ Along with the Pie Chart more detailed information is provided on the nutrients



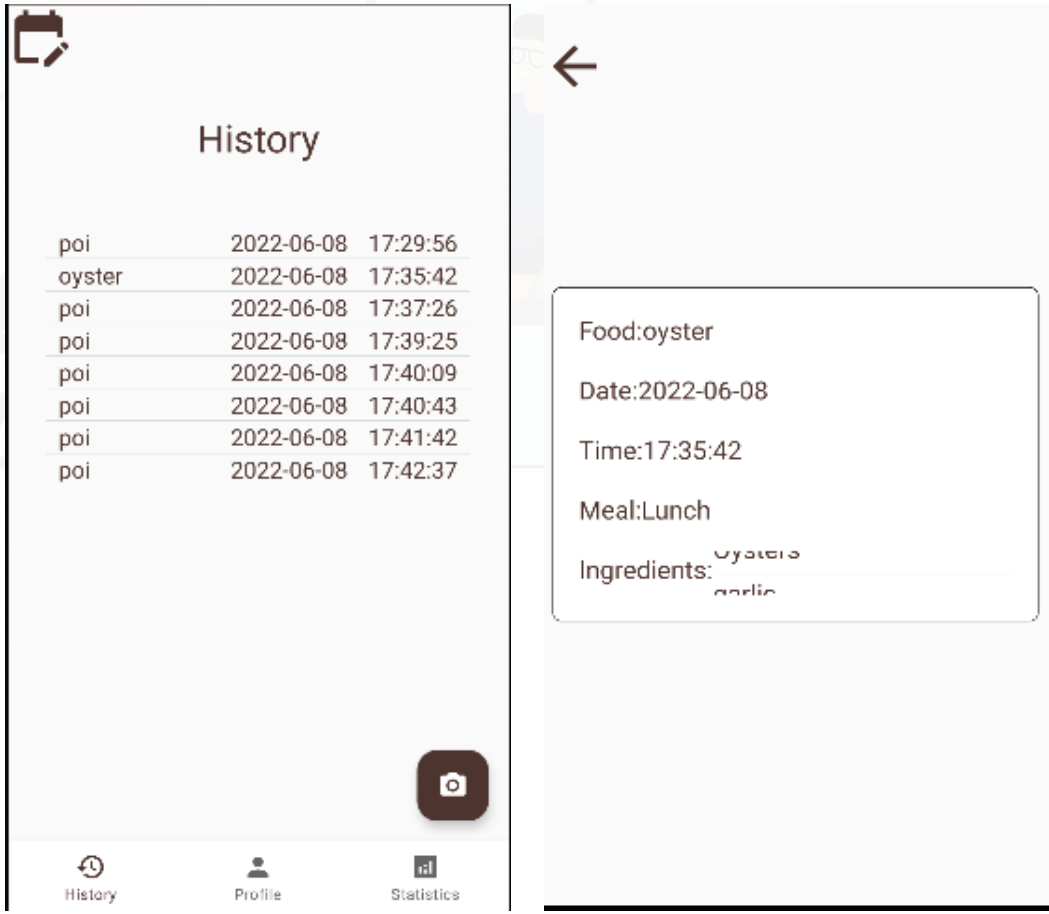
ELLIOT Components

- ✓ The **Image Recognition Tool and Module** is used for the process of capturing and storing an image to the smartphone
- ✓ This module is also connected with other sectors of the application like the **Deep Learning Model** and the **Decision Support and Recommendation Service**
- ✓ This module is equipped with a button that acts as a trigger to activate the image capture sequence
- ✓ The image is forwarded to the Deep Learning Model trained to detect meals



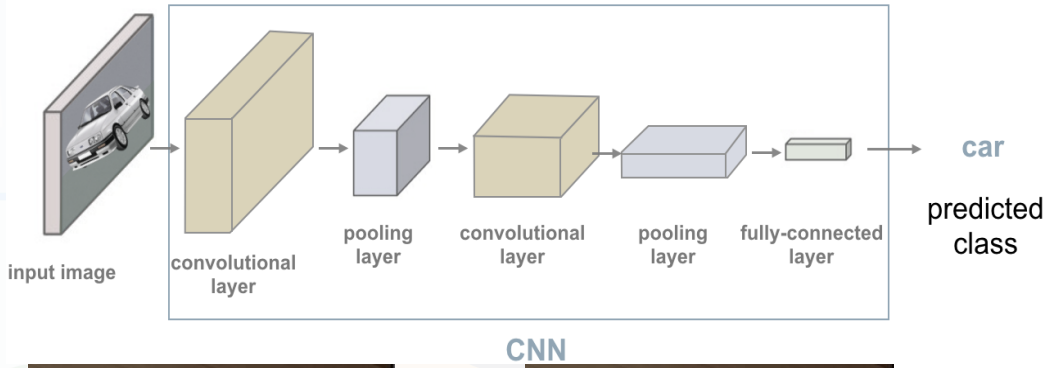
ELLIOT Components

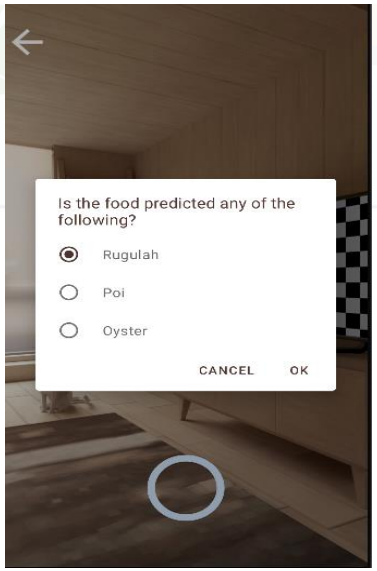
- ✓ The **History Tool and Service** are responsible for accessing the past dietary habits and meal options
- ✓ Users may find more information on what they consumed on a specific day, as well as other useful information for their broader understanding regarding their diet
- ✓ The data fetched and generated by this Tool and Service is sourced from the History table in the database
- ✓ We record the meal name, the meal type (breakfast / lunch / dinner), the ingredients, the time and the date consumed

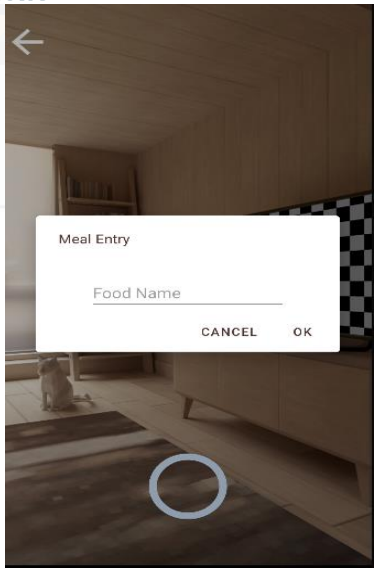


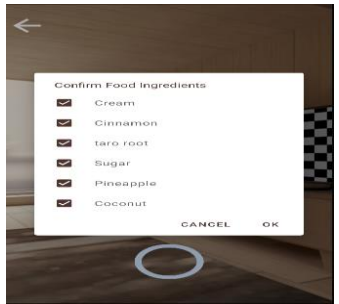
ELLIOT Components

- ✓ The **deep learning model** is required to classify a large amount of food categories based on images
- ✓ The training dataset is Food-251, which contains thousands of images for each of the 251 food categories
- ✓ Training and evaluation images come with their corresponding food labels to optimize the model



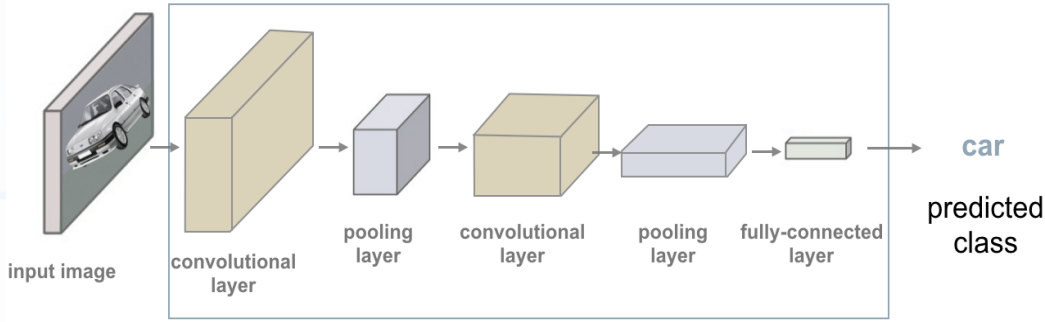




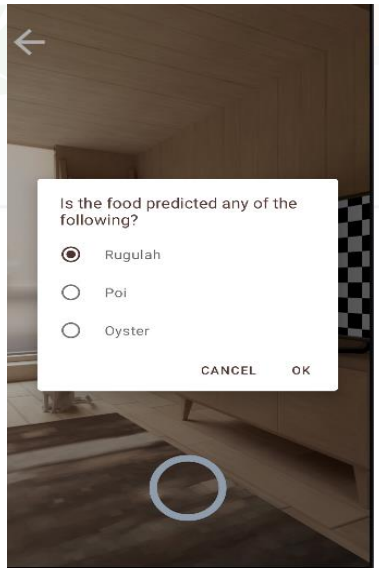


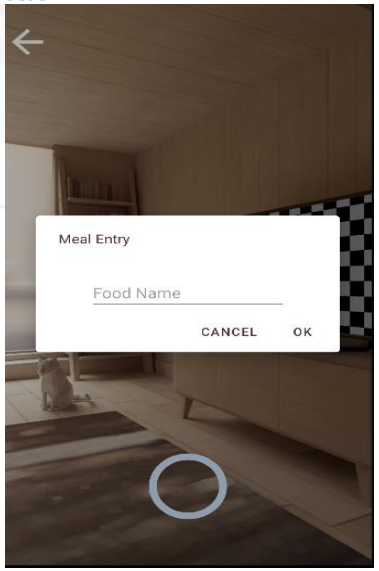
ELLIOT Components

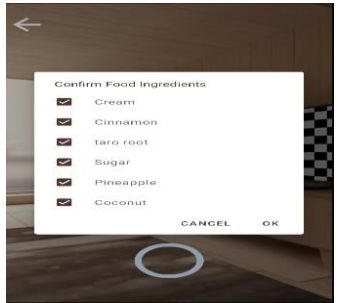
- ✓ Training was performed on a GPU with learning rate (1e-3), batch size (128), image size (224x224), etc
- ✓ The training process was performed in a maximum of 100 epochs using early stopping to avoid overfitting (when training loss < evaluation loss)
- ✓ Batches of images were properly preprocessed, e.g., dimension swapping, data augmentation (different versions of the images are generated by rotating, brightening or moving them), etc.
- ✓ As food images may be similar, to increase the accuracy, we get the top 3 food candidates into account



CNN





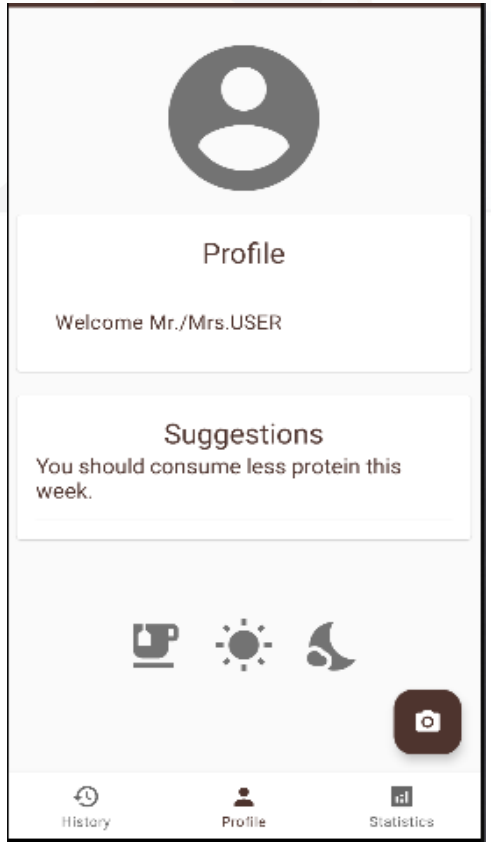


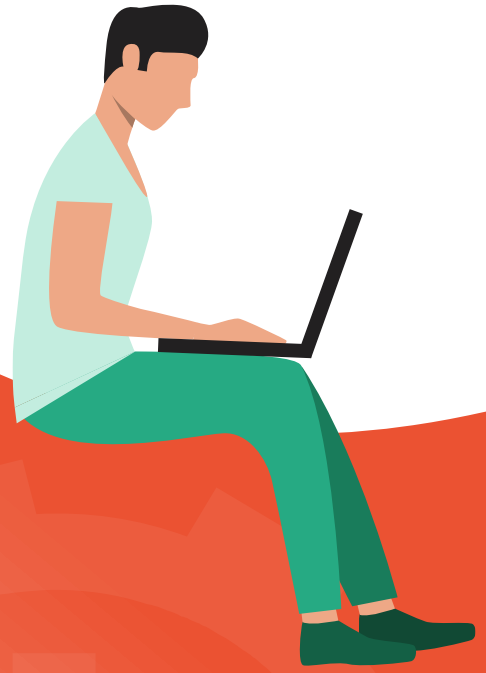
ELLIOT Components

- ✓ The **Decision Support and Recommendation Service** is responsible for detecting potential health problems and making suggestions
- ✓ We adopt a rules engine for firing recommendations
- ✓ The rule checking and suggestions provision are performed after a new meal is successfully recorded
- ✓ We check the previous seven (7) days are examined and the current day
- ✓ Rules check is nutrients exceed some extreme values
- ✓ Rules are written taking into consideration guidelines provided by
  - ✓ U.S. Department of Agriculture (USDA)
  - ✓ The Canadian and Australian Ministries of Health
  - ✓ World Health Organization (WHO)

  All of them have posted suggestions for the optimal nutritional intake for humans of all ages

```
val fatMaxRuleWeek = rule( description: "Check Maximum Percentage of Fat") { this: RuleExpression
    given { this: GivenExpression
        anyFloat()
    } and { it: Float
        it > 0.35
    } thenReturn { it: Float
        "You should consume less fat this week."
    } otherwiseReturn { it: Float
        ""
    }
}
```





THANK YOU

More Publications, Datasets, Presentations can be found at:

http://kostasks.users.uth.gr

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