



# ADCATER

Advanced Digital-Health Solution  
Professional Food and Nutrition Care



Meal on a Tray



Personal Nutrition Management  
Medical Centers

רשות החדשנות  
Israel Innovation  
Authority



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## Gaps Between Intention and Action

30~60% of the food served is wasted



~50% of global in-patients are at malnutrition risk !



Menus  
Meals

Medical  
instructions

Personal nutrition  
habits

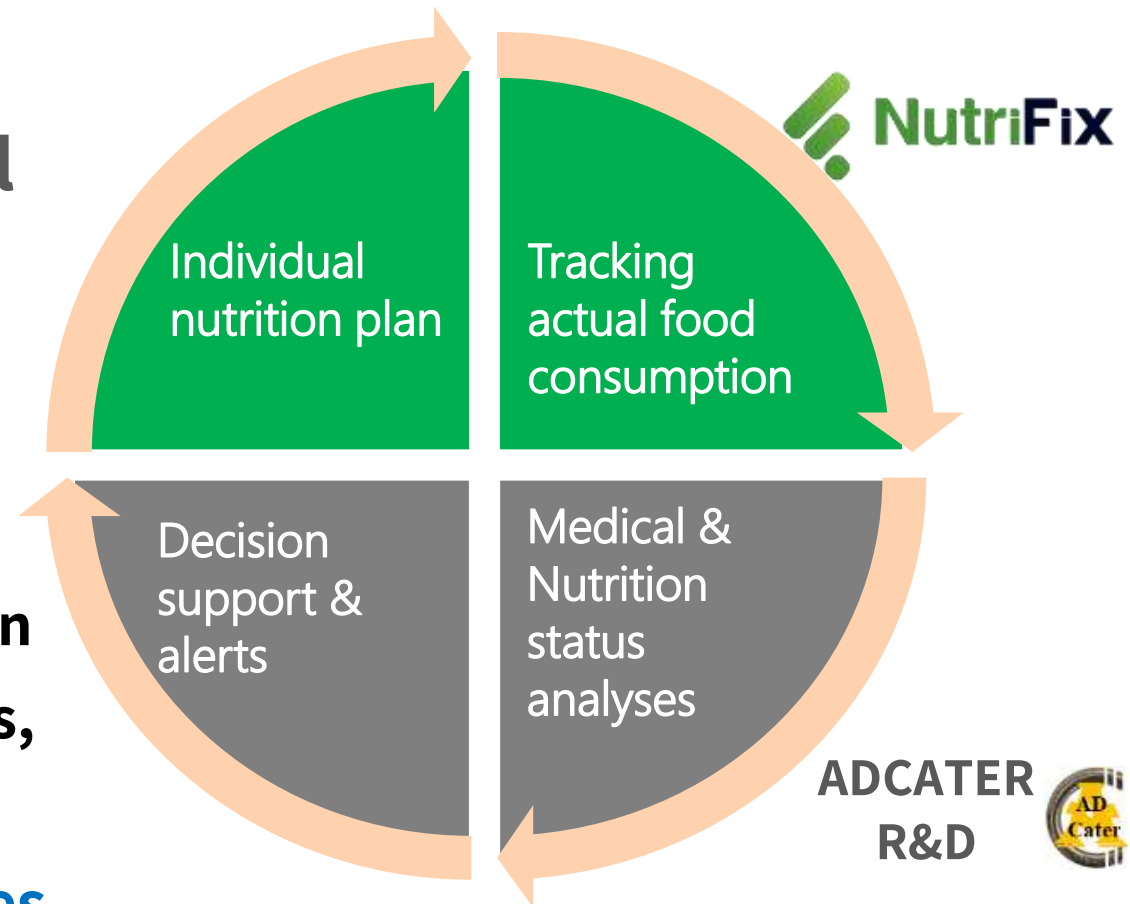
What and how to serve  
the patient ?

## Lunch – after meal



## An **Operational & Analytical** system

A holistic and comprehensive solution based on professional methodologies, focused on:  
**improving patient outcomes**



# AI Platform

# ADCATERT R&D project



## Reconciled Database



## Computer Vision identification



Food Item	% consumed
Vegetable Salad	100
White Cheese	0
Egg	100
Tahini	100
Whole Wheat Bread	52.8

## Unique Supply Chain K.P.I

**O.T.A.C<sup>©</sup>**  
**On Time Accurate Consumption**  
 [Consumption vs. Plan]



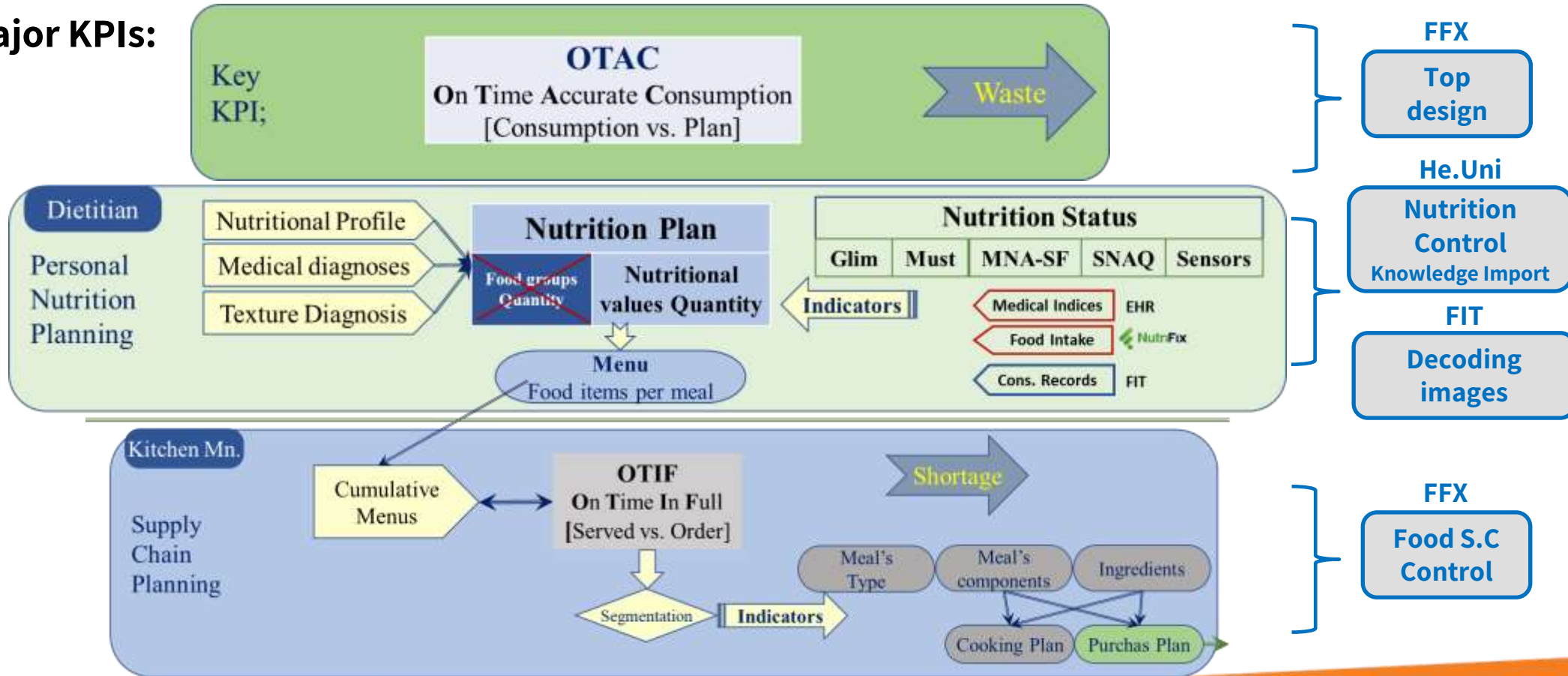
# ADCATER

# R&D's Core Models

- ❖ Composite Patient's Status in near Real-Time
- ❖ Food Supply Chain KPIs
- ❖ Analytical Decision Support

- Personal nutrition management & control
- Supply chain availability

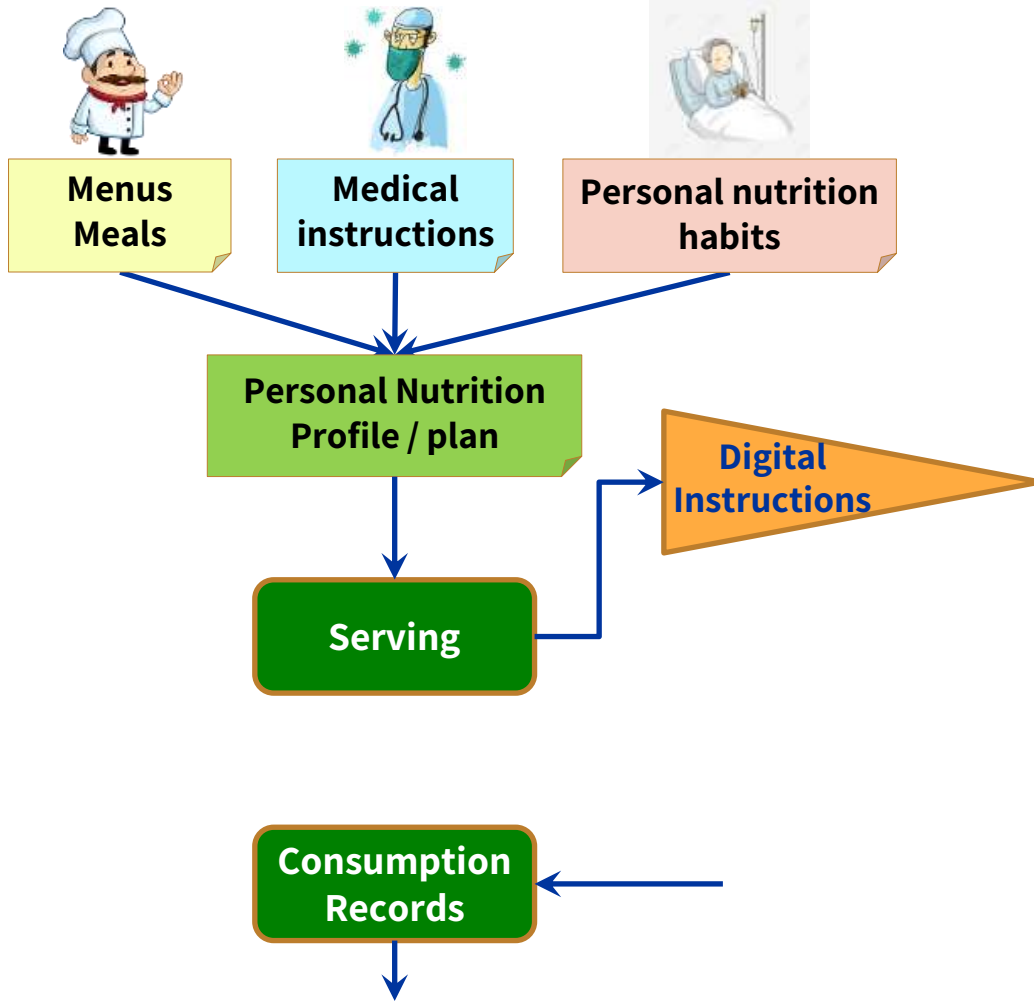
## Major KPIs:





# Process - 1

## NutriFix



# Consumption Monitoring & Control

**Personalized menu**  אליהו אביגד Eliyahu  
Hebrew Spanish

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**dietary Parameters**

  
**Negative Preference** Cucumber

  
**Positive Preference** Coffee

  
**Sensitivity** eggs

  
**Sensitivity** peanuts

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**Feeding Parameters**

  
**eating method** Completely Dependent Feeding

  
**Food Texture** Soft

  
**Liquid Texture** Liquid

---

serving in meal			
<b>Pastries</b>	 White Bread	 Sweet Pastry	<b>X</b> Not served
<b>Porridge</b>	 Oatmeal	<b>X</b> Not served	
<b>eggs</b>	 Boiled Egg	 Herb Omelet	<b>X</b> Not served
<b>Dairy Products</b>	 Gvina Levana	<b>X</b> Not served	
<b>Hard Cheeses</b>	 Tzfatit Cheese	<b>X</b> Not served	
<b>Dairy Product Containers</b>	 Vanilla Pudding	 Leben/Gil	<b>X</b> Not served
<b>Fresh Vegetables</b>	 Ground Vegetable Salad	<b>X</b> Not served	

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capture food tray:  
  No file chosen



# Process - 2

# Consumption Monitoring & Control



Food Item	% consumed
Vegetable Salad	100
White Cheese	0
Egg	100
Tahini	100
Whole Wheat Bread	52.8

Computer Vision AI

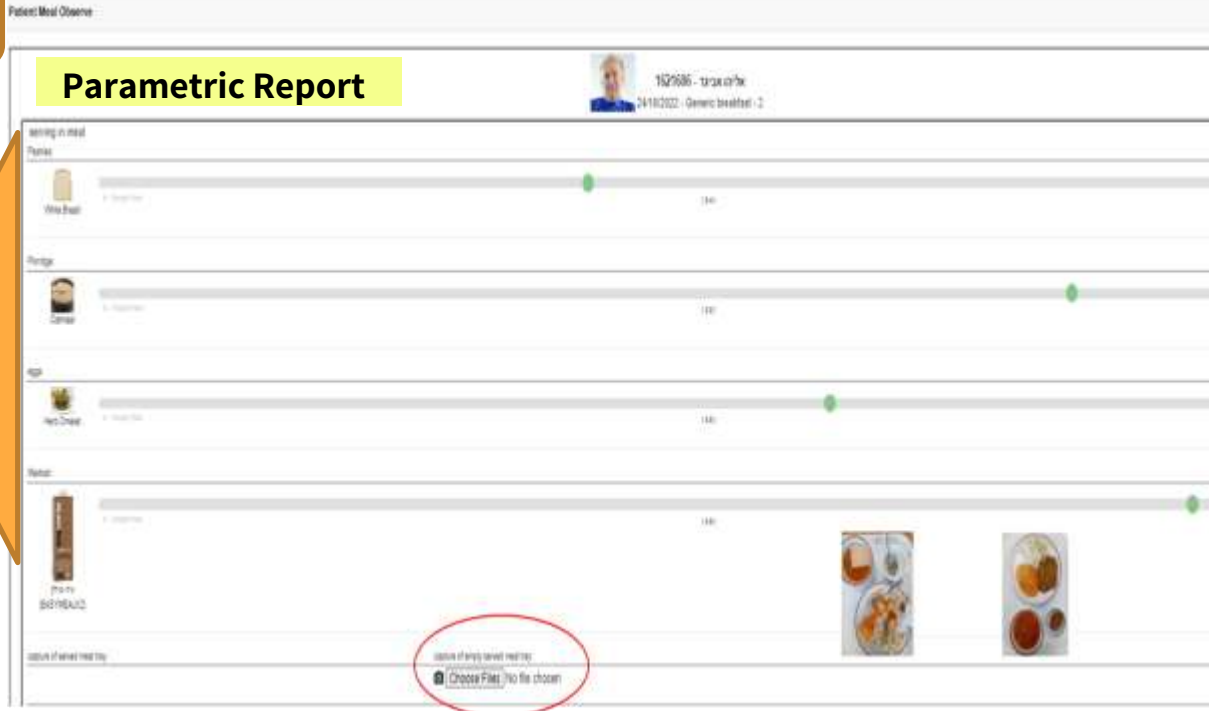
Serving

Consumption Records

Nutrition tables



NutriFix



BI

Consumption Control

Personal Nutrition Assessment

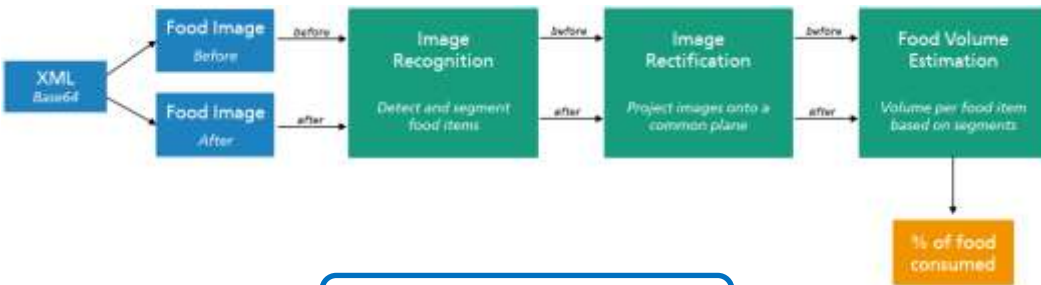
OTAC

Food Waste



Visibility of actual intake

## High Level Design



## Outcome

Working Prototype



Food Item	% consumed
Vegetable Salad	100
White Cheese	0
Egg	100
Tahini	100
Whole Wheat Bread	52.8

## Fraunhofer: Computer Vision Module Knowledge Import

### Development:

- Definition of user requirement and objectives for the computer vision module, aimed at automatic analysis of food images
- Generation of the image dataset, as needed for the training of the CNN model
- Training of the CNN model on the annotated training images
- CNN model testing on the “new” for the model food images and evaluation of the classification performance per food class
- Implementation of plate rectification for automatic estimation of consumed food quantity per food class
- Deployment of the CV Module for image processing on virtual machines in the cloud.

The obtained classification accuracy for salient food classes, with good (about **100 image** instances per food class) representation of these classes in the training image set, lies in the **range of 96% to 99%**.

The classification accuracy for food classes with indistinct appearance (i.e., white cheese versus white pudding) drops at the level of 75% to 85%. Similar decrease of the classification accuracy was recorded for highly compressed images below 80% of their original resolution. These results are highly promising for the project application scenario and automatic dietary monitoring.



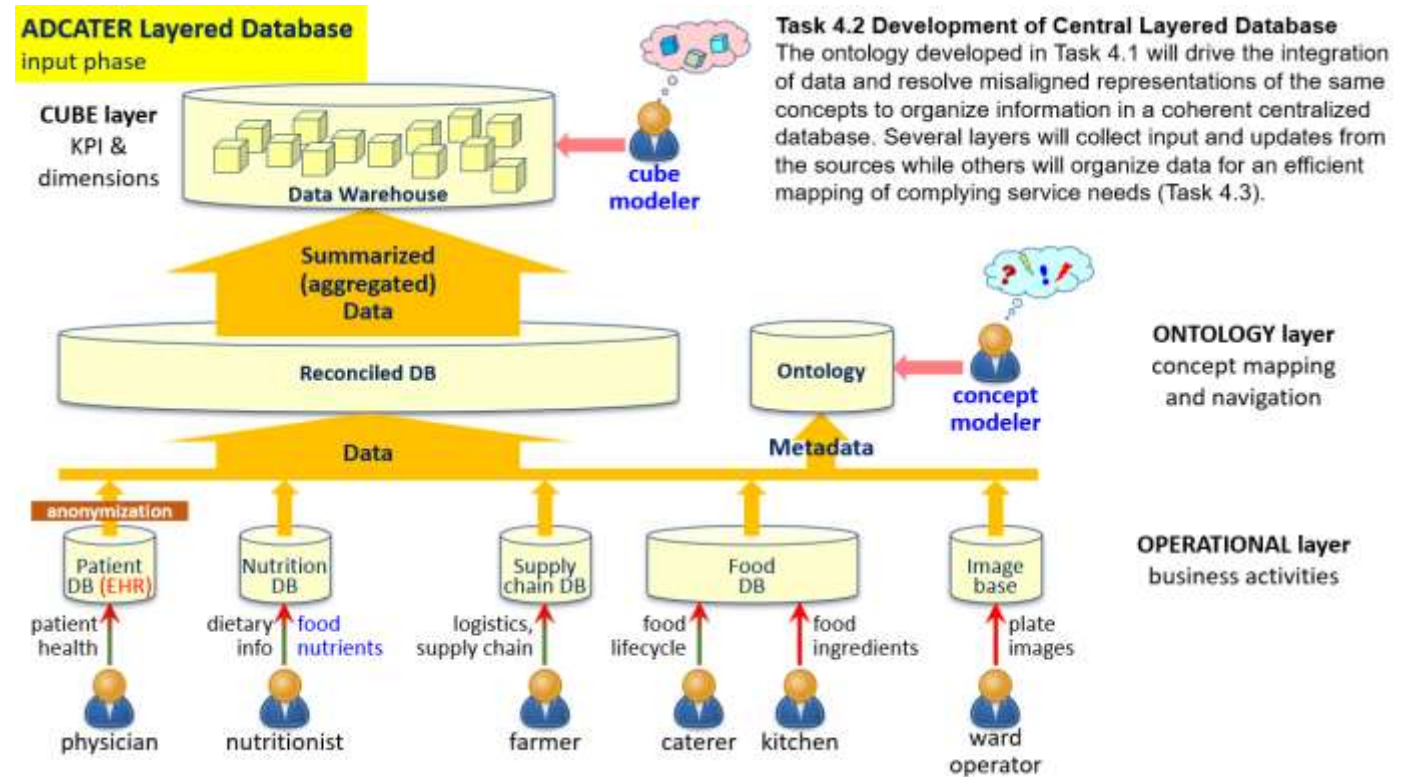
## Uni.Roma: Ontology-driven analytical Module Knowledge Import

### AI and Ontology-driven analytical decision support tool - In Progress -

**Deliverable 4.1**

**Food Ontology Specification and Documentation**

Marco Di Rocco  
 Domenico Lembo  
 Umberto Nanni  
 Federico Maria Scafoglieri **43 Pages**



Integration of heterogeneous technologies and information sources:

- an ontology established knowledge concerning the nutritional concepts and relations of these with the individual patient state
- business intelligence, providing reporting over individual and aggregate KPI's, as well as customized services (e.g., active warning)
- artificial intelligence techniques, providing computer vision support, inferential capabilities, and advanced query environment



### Central reconciled database

- Implementation of a **methodology** for the development of a validated database as a starting point for the development of all ADCATER services.
- A well-designed database that allows **expansion** and **integration** of new data, as support for the development of additional services.
- Adoption of an **innovative methodology** driven by **artificial intelligence** based on the use of ontologies that help in the planning phase and the ability to align it to an existing medical vocabulary



## State of the art innovation

The innovative features brought in by ADCATER:

- **Combined use of business intelligence, artificial intelligence, ontologies, and computer vision in a single software system.**
- **Reports are presented through user interfaces suitable by end users - nutritionists, physicians, caregivers - and include configurable active warning conditional triggers, messages and delivery channels.**

We have no knowledge of other Information Systems providing physicians and nutritionists with a detail of the actual food consumption by the patients: this information - reported properly - provides an unprecedented tool to tackle the problem of insufficient food intake in health care, and its consequences, and possibly to save lives and reducing human suffering



# Structure

# ONTOLOGY

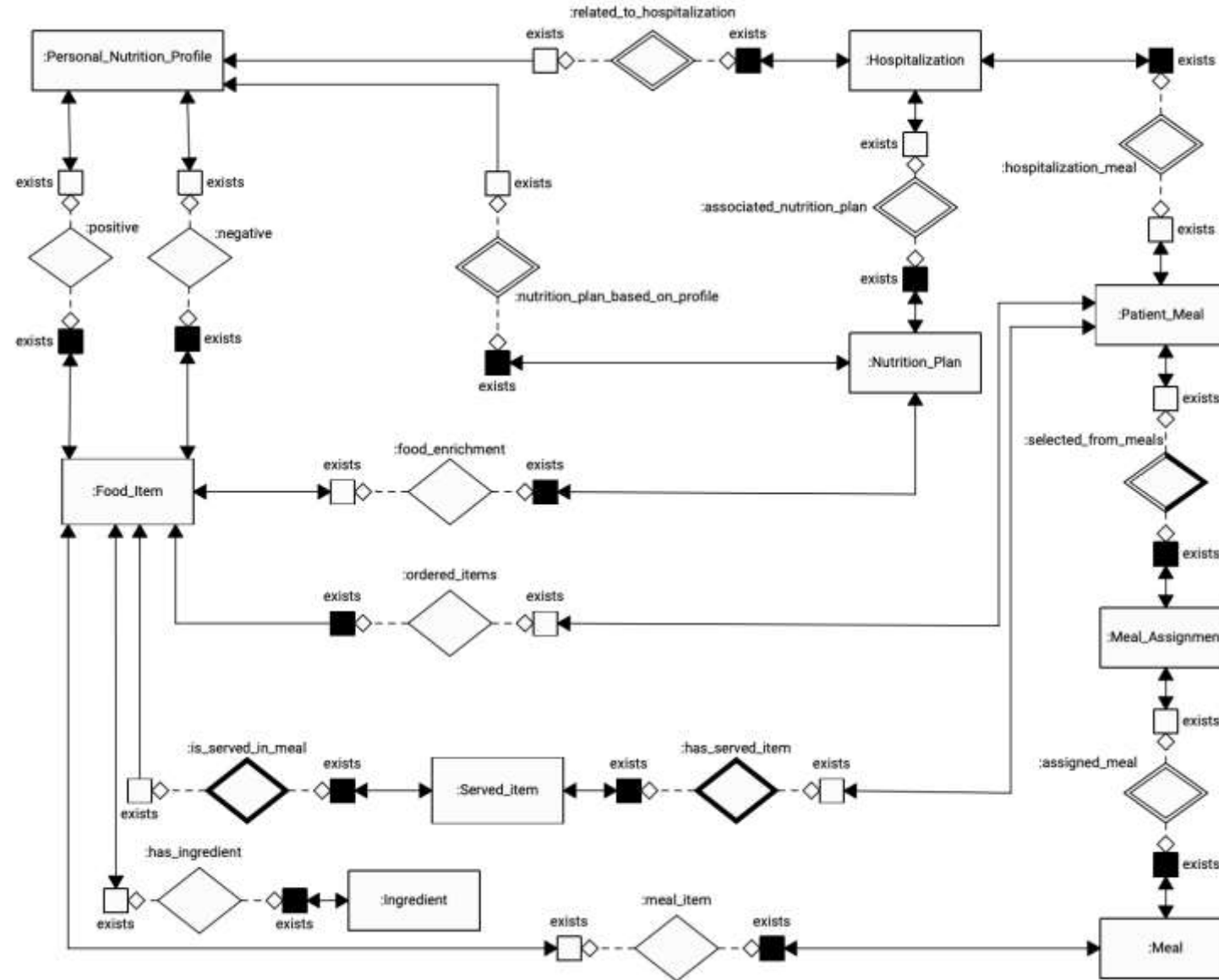
## Four main modules:

- Patient's details
- Analysis assessment
- Measurements and diagnoses
- Patient nutrition

Written in the OWL standard (rendered through **Graphol** diagrams)

Ready to incorporate other Ontologies and Vocabularies (eg, **SNOMED**)

Used to design database and processed and to specify user requests to enable inferential reasoning





# Working Prototype

## B.I - Analytical DSS

Patient's Nutrition Control  
Models of: Screening & Assessment  
**[Food Items]**

ADCATER Alerts | Alerts - Nutrition plan | Food Items | GLIM | MNA SF | MUST | SNAQ | Nutritional Recommendations

### Food Items

X axis

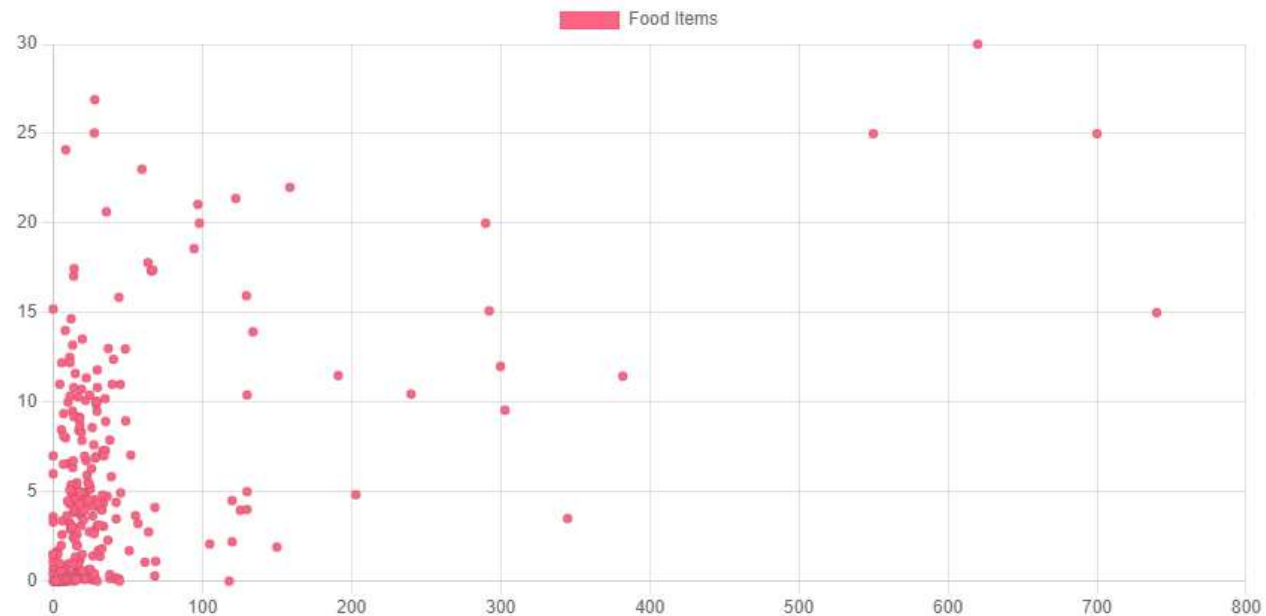
Calcium (mg) ▾

Y axis

Fats (gr) ▾

1 points (name)

Vegetable soup with carrots, beets, cabbage, green beans, onions, beet leaves, without added fat



Uni.Roma  
Demo



# Working Prototype

# B.I - Analytical DSS

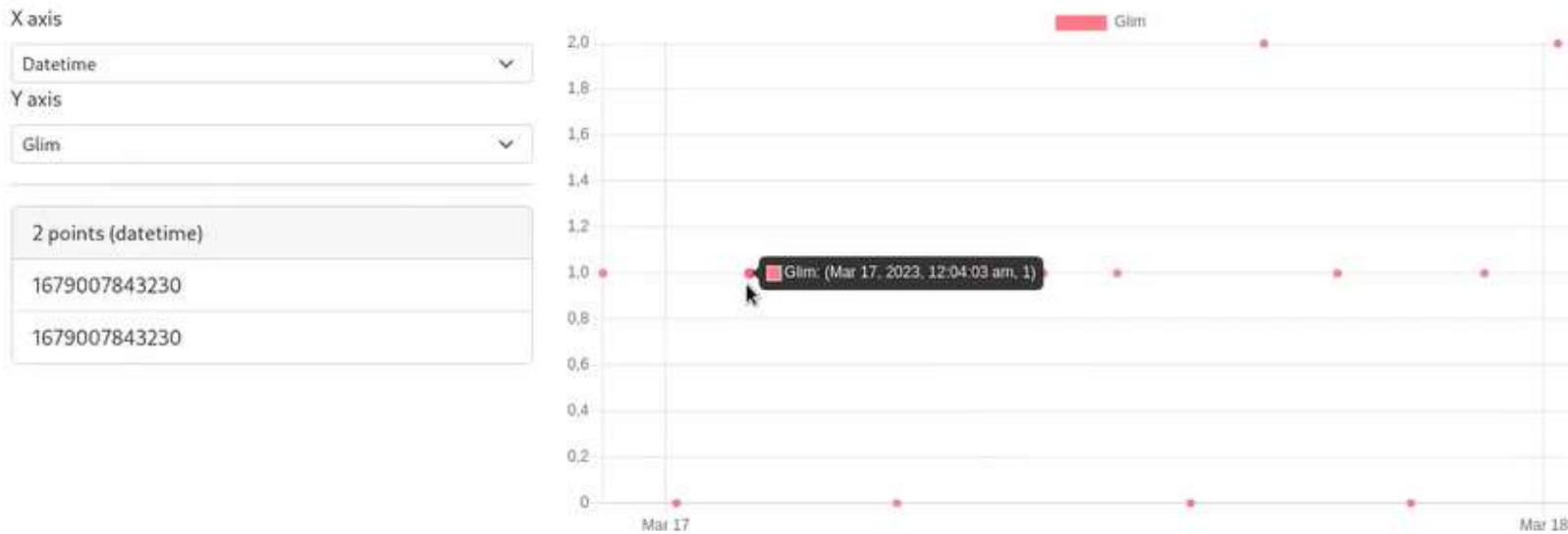
Patient's Nutrition Control

Models of: Screening & Assessment

[Scripts: Glim, Must, SNAQ, MNA-SF]

ADCATER | Food Items | GLIM | MNA SF | MUST | SNAQ | Nutrition check

## Glim



Datetime

Min 16/03/2023 23:45

Max 18/03/2023 03:49

Glim

Min 0

Max 2

Uni.Roma Demo



# Working Prototype

# B.I - Analytical DSS

Patient's Nutrition Control  
 Structured data exploration  
 [Active warning; Advanced queries]

PatientMeal\_Repo - Visualizzator X

Patient Code	Gender	Date	Meal Type	Consumption Percentage(vol ume)	Consumed / Served Kcals	Consumed / Served B12(µg)	Consumed / Served Calcium(g)	Consumed / Served Carbohydrate(g)	Consumed / Served Fat(g)	Consumed / Served Fiber(g)	Consumed / Served Folic Acid(mg)	Consumed / Served Iron(mg)	Consumed / Served Potassium(g)	Consumed / Served Prote	
6	M	2022-03-04	breakfast	50%	250/500	1.15/2.3	0.4/0.8	32.5/65	10/20	6/12	0.2/0.4	0.02/0.04	0.05/0.1	7.5	
			dinner	20%	120/600	0.48/2.4	0.18/0.9	20/100	7/35	2.4/12	0.1/0.5	0.01/0.03	0.24/1.2	5.6	
			lunch	30%	252/840	0.75/2.5	0.21/0.7	48/160	4.5/15	3.6/12	0.09/0.3	0.02/0.05	0.36/1.2	6/	
		2022-03-05	breakfast	90%	315/350	1.89/2.1	0.63/0.7	38.7/43	13.5/15	7.2/8	0.27/0.3	0.03/0.03	0.45/0.5	9/	
			dinner	30%	180/600	0.57/1.9	0.24/0.8	22.5/75	7.5/25	2.4/8	0.12/0.4	0.01/0.04	0.27/0.9	5.4	
			lunch	60%	420/700	0.12/0.2	0.36/0.6	60/100	6/10	4.8/8	0.12/0.2	0.03/0.05	0.54/0.9	8.4	
		2022-03-06	breakfast	80%	400/500	1.84/2.3	0.64/0.8	52/65	16/20	9.6/12	0.32/0.4	0.03/0.04	0.08/0.1	12	
		Daily Averages				830,14	2,91	1,14	117,30	27,64	15,43	0,52	0,06	0,85	23

Uni.Roma  
 Demo

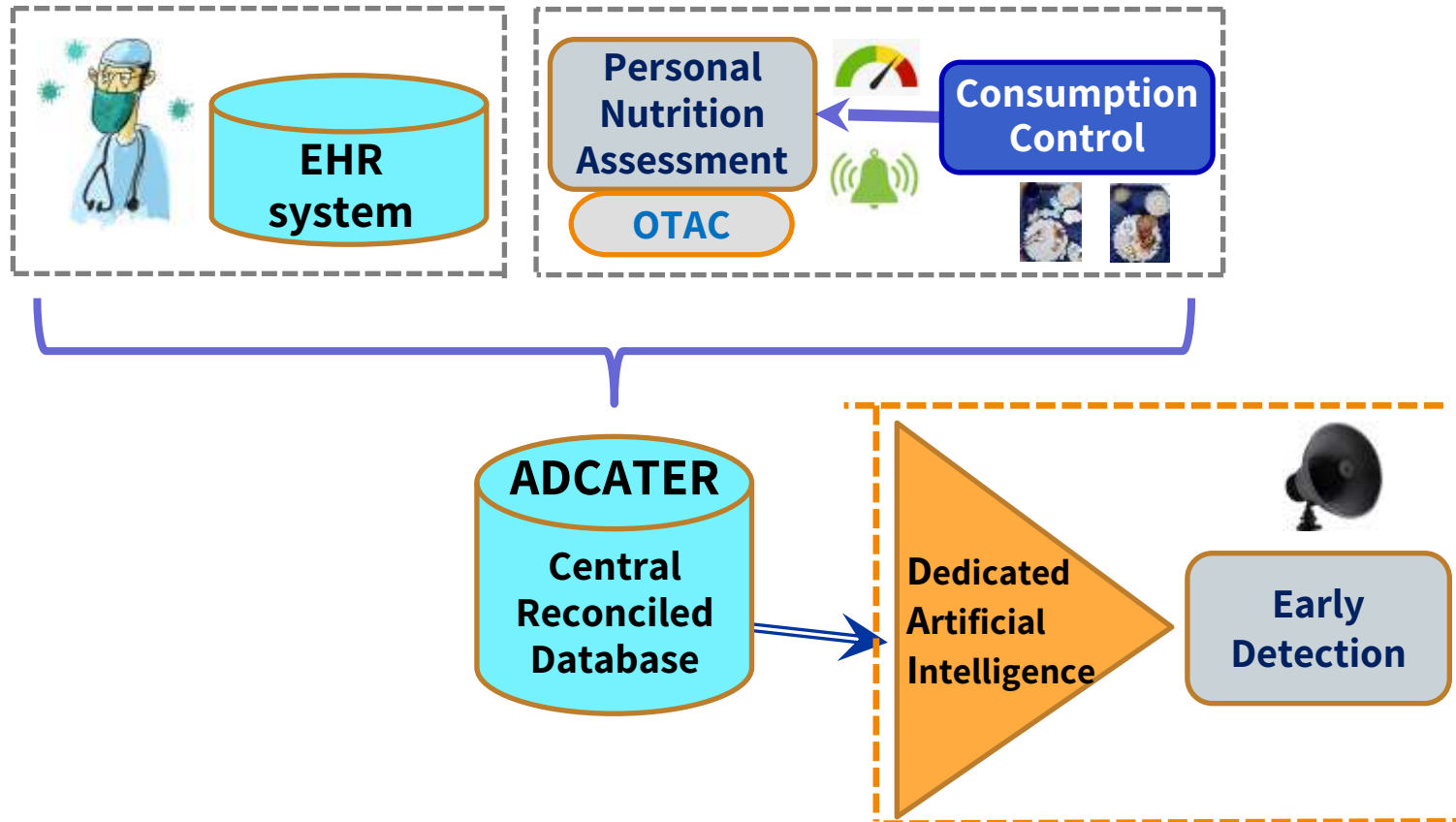
Patient Code	6
Gender	M
Age	70
Hospital Code	6
Hospitalization Code	0
Start Day	2022-03-04
End Day	2022-03-06

AMOUNT OF KCALS



## AI and Ontology-driven analytical decision support tool

- Research approach -





## Efficient & Effective Monitoring & Control for each Patient

**Reducing:**

### Patient's

- Medical Complications
- Mortality
- Hospitalization days
- Re-hospitalization

### Hospital's

- Risks
- Food Waste
- Care Expenses
- Health average KPIs

**Providing:**

### Medical Team's

- Active warnings (call for action)
- Actual nutrients intake
- Effects of healing actions
- Allergens' evidence



## The services

One of the main goals was to obtain nutritional indicators for each patient, as well as to monitor the nutrition status of patients.

We test these services on some selected patients from the data available in the project.

The main data source [Real Data]:

- **Patient's clinical information derived from the interface with the EHR system at the medical center**
- **Actual food consumption is derived from a visual analysis of the images of the meal trays**

- 1. Up-to-Date Nutritional indicators for each patient**
- 2. Monitoring of the nutritional status**
- 3. Gap's Flags** [Motivation for action and prioritization]
- 4. Monitoring the response rate to meal components** [Motivation for nutrition plan intervention]
- 5. Early detection of nutritional deterioration** [Dedicated Artificial Intelligence]
- 6. Harnessing the food system for a personalized nutritional service**



# ADCATER

# Thanks !



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