Intelligent Agriculture in the region of Plovdiv city

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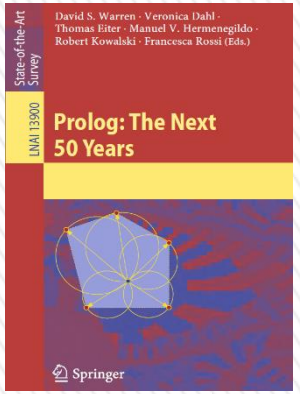
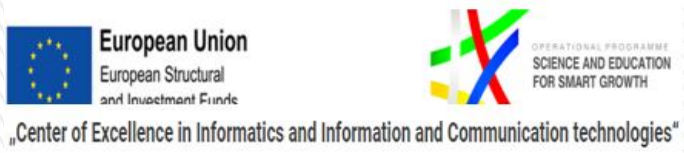
Motivation

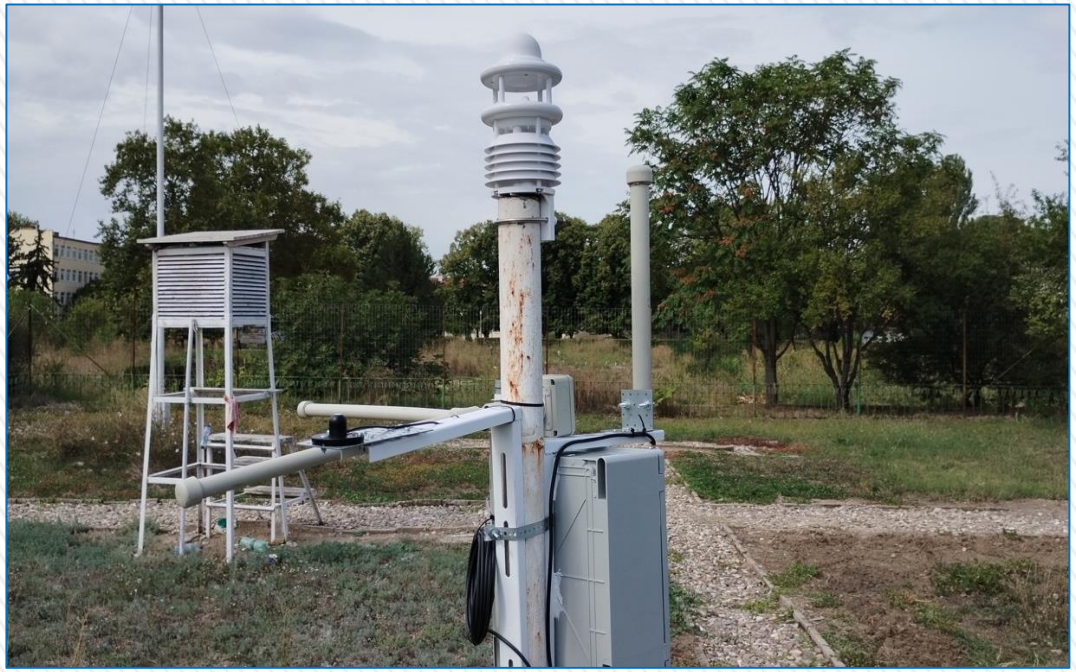


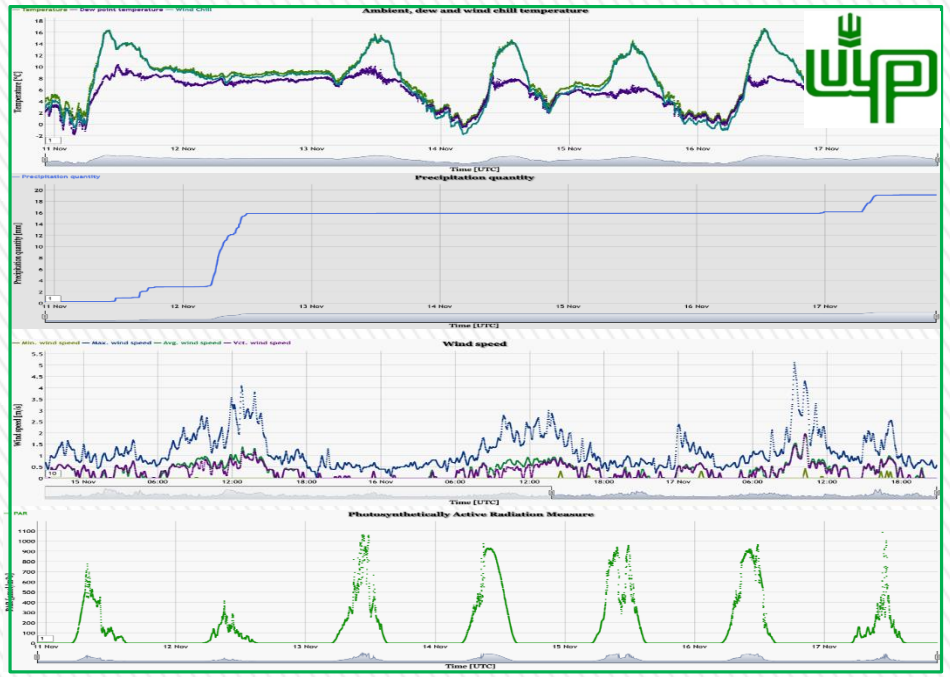
- EU Project: “Center of Excellence in Informatics and Communication Technologies”
  - Goal: Construction of a research infrastructure (mainly hardware)
  - Two levels:
    - National level – a supercomputer
    - Regional level – three server configuration in Plovdiv University



- National Science Program: ”Intelligent Agriculture”
  - Goal: Conduct research on artificial intelligence approaches for agriculture applications using the research infrastructure
  - Platform ZEMELA (mainly software)
  - Pilot project for the region of the city of Plovdiv
    - Expansion of scientific infrastructure with a local level – sensor networks

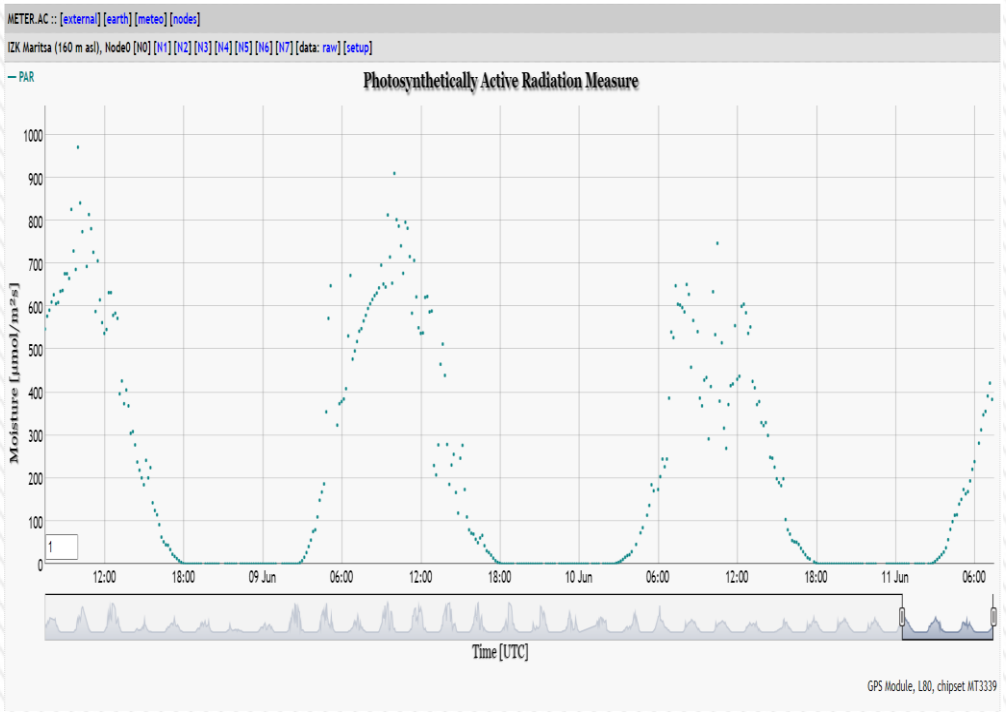
Local Level: INSTITUTE OF PLANT GENETIC RESOURCES, SADOVO, REGION PLOVDIV

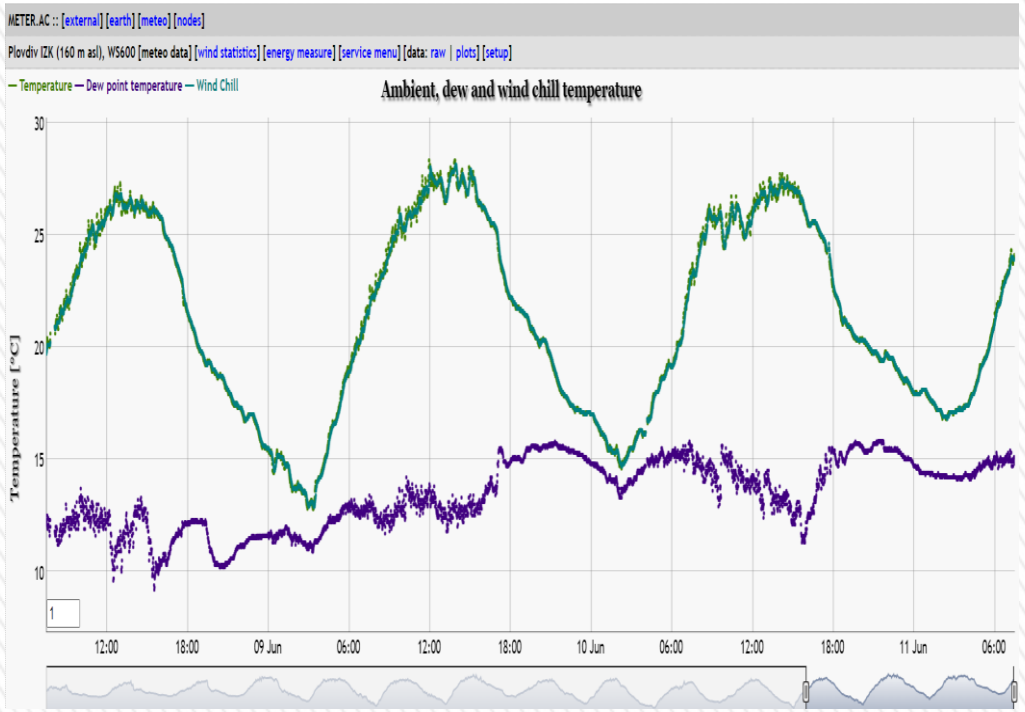




Local Level: MARITSA VEGETABLE CROPS RESEARCH INSTITUTE, PLOVDIV

Sample measurements in Maritsa





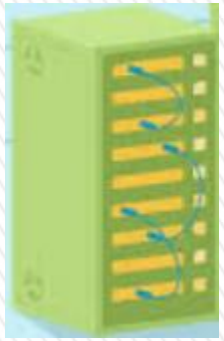
Greenhouse

Outdoor plot of land

Regional Level: hardware configuration

Primary server

Secondary servers 1, 2



„hot" data

„cold" data

Rectorate of PU

FMI of PU

Three powerful server configurations (geographically separated)

Regional Level: software

Specialized site

Specialized components

Platform ZEMELA

GenBank

SensorThings

Block chain

Integrated technology

PAs | AML | Event Engines | ADK Center

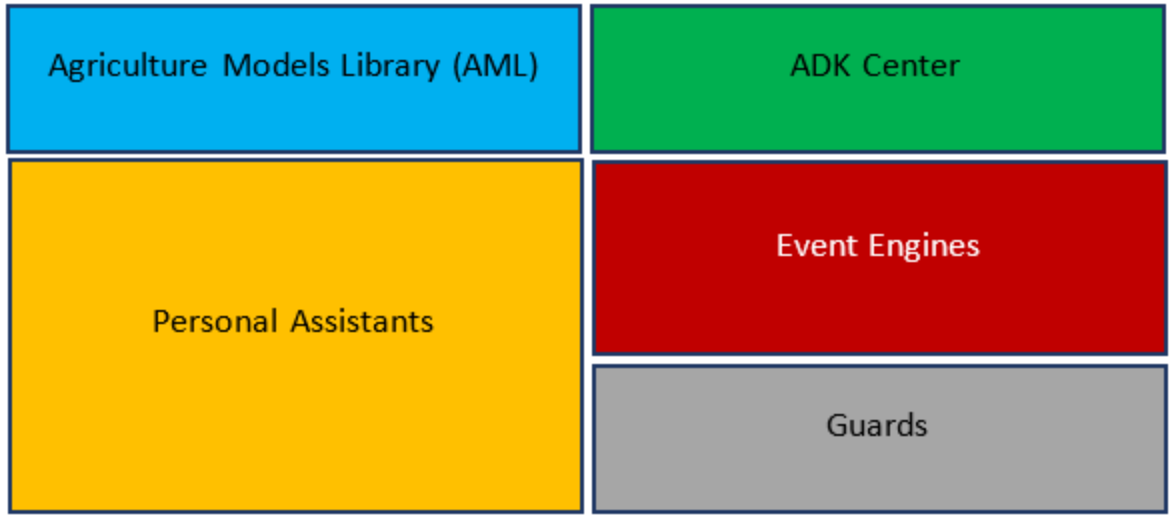
JaCaMo | DEVS | Win-Prolog, Flex, VisRule, Protege | PostgreSQL, MongoDB, Kafka

JVM

python™

TensorFlow

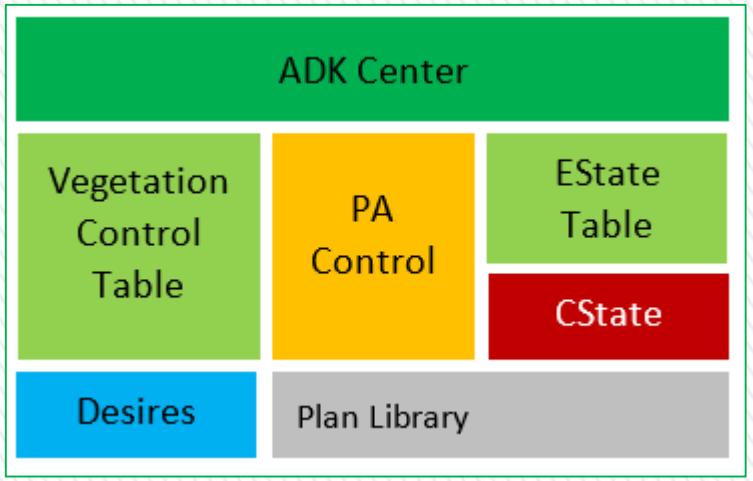
Platform ZEMELA



Personal Assistant

- Core of the platform
- Monitors the course of the vegetation of agricultural crops
- Responsible for detecting anomalies in the vegetation of agricultural crops
- Manages the interaction between components in the platform
- Prepares warnings when anomalies are detected
- Offers solutions to farmers (to be implemented)

Personal Assistant




```
+!track_tomato_phases
   <- ?heat_units(D) ;
   if (D>=0 & D<60) {  .wait(3600000); !track_tomato_phases; }
   elif (D>=60 & D<175) { println("It is assumed that the 'Germination' phase has been reached!"); }
   elif (D>=175 & D<275) { println("It is assumed that the 'Seedling' stage phase has been reached!"); }
   elif (D>=275 & D<700) { println("It is assumed that the 'Vegetative growth' phase has been reached!"); }
   elif (D>=700 & D<900) { println("It is assumed that the 'Flowering' phase has been reached!"); }
   elif (D>=900 & D<1500) { println("It is assumed that the 'Fruit set' phase has been reached!"); }
   elif (D>=1500) { println("It is assumed that the 'Maturity' phase has been reached!"); }
   .drop_intention(track_tomato_phases);
   .wait(86400000); !track_tomato_phases.
```

```
public class VCT extends Artifact {

    private OWLOntology ontology;

    void init(String ontologyPath) {
        // Load ontology from file
        try {
            OWLOntologyManager manager = OWLManager.createOWLOntologyManager();
            ontology = manager.loadOntologyFromOntologyDocument(getArtifactURI().resolve(ontologyPath).toURL().openStream());
        } catch (Exception e) {
            e.printStackTrace();
        }
    }

    @OPERATION
    List<String> getInstances(String concept) {
        List<String> instances = new ArrayList<String>();
        OWLClass cls = ontology.getOWLOntologyManager().getOWLDataFactory().getOWLClass(IRI.create(concept));
        NodeSet<OWLNamedIndividual> individuals = reasoner.getInstances(cls, false);
        for (OWLNamedIndividual ind : individuals.getFlattened()) {
            instances.add(ind.getIRI().toString());
        }
        return instances;
    }
}
```

Adaptation of PA for a specific crop

- An essential action to prepare the PA for work
- Retrieves data from the ADK center characterizing the vegetation of the plant to be monitored
- Initializes PA belief structures

Adaptation of PA for weather conditions in the region of Plovdiv

Preliminary test

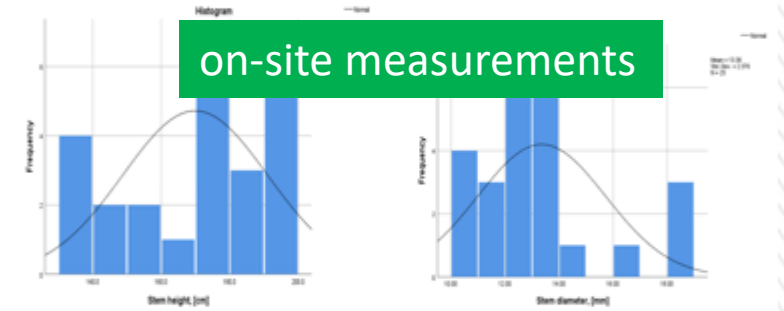
Conditions close to those for the Plovdiv region from the specialized literature (California case)

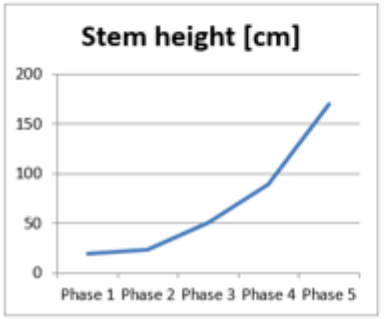
Real tests

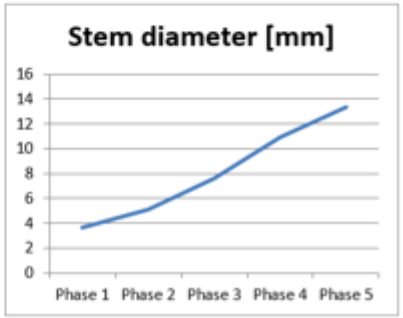
Таблица 16.

Фази	Параметри											
	Stem height [cm]				Stem diameter, [mm]				Leaves number			
	Mean Value	Min	Max	Std. Dev.	Mean Value	Min	Max	Std. Dev.	Mean Value	Min	Max	Std. Dev.
1	18.97	16.0	24.3	1.87	3.65	3.04	4.33	0.39	5	4	6	0.59
2	23.66	20.0	27.0	1.65	5.14	4.13	6.78	0.83	8	6	9	0.71
3	50.64	41.8	56.3	3.09	7.61	6.28	8.54	0.62	12	9	14	1.34
4	88.81	74.0	103.7	7.44	10.9	8.27	12.84	1.04	18	17	20	1.05
5	169.9	132.7	198.5	21.1	13.35	10.04	18.95	2.37	29	23	34	2.82

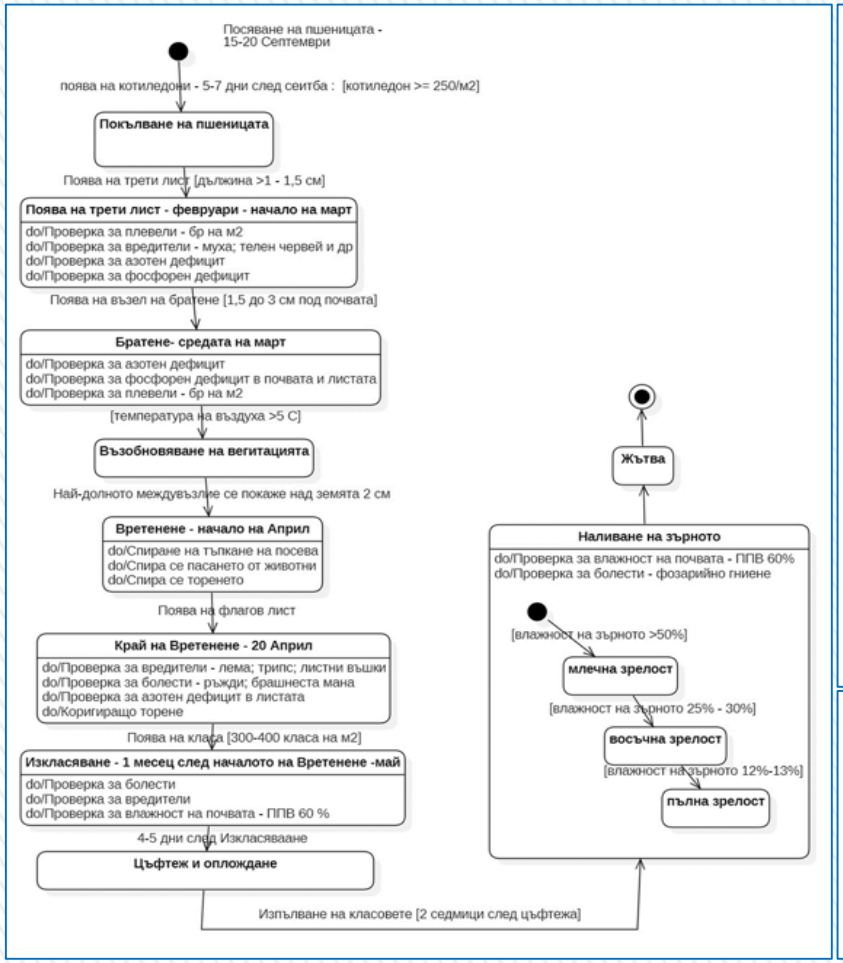
on-site measurements

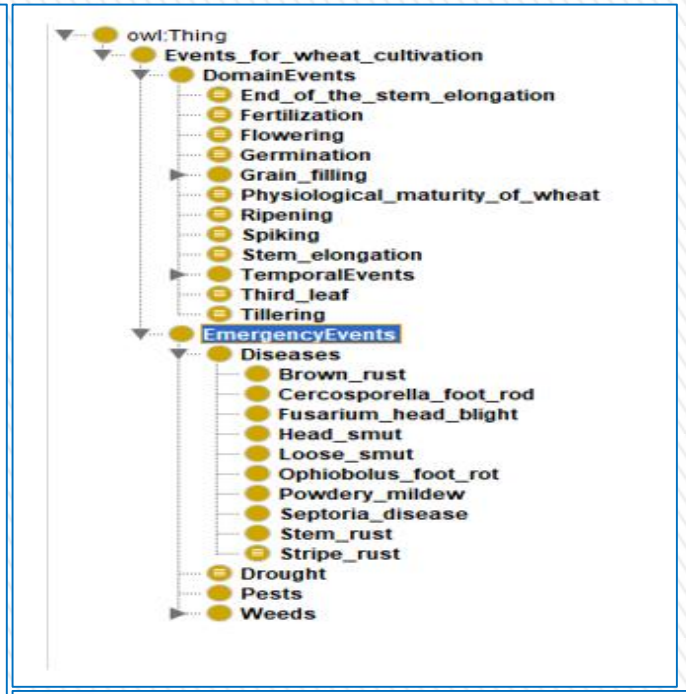






ADK Center (ontologies, rules, frames)






```
rule detect_an_anomaly
if the climate's temperature not equal
instance_climate's temperature
   or climate's humidity not equal
instance_climate's humidity
   or …
then the anomaly is true.
```

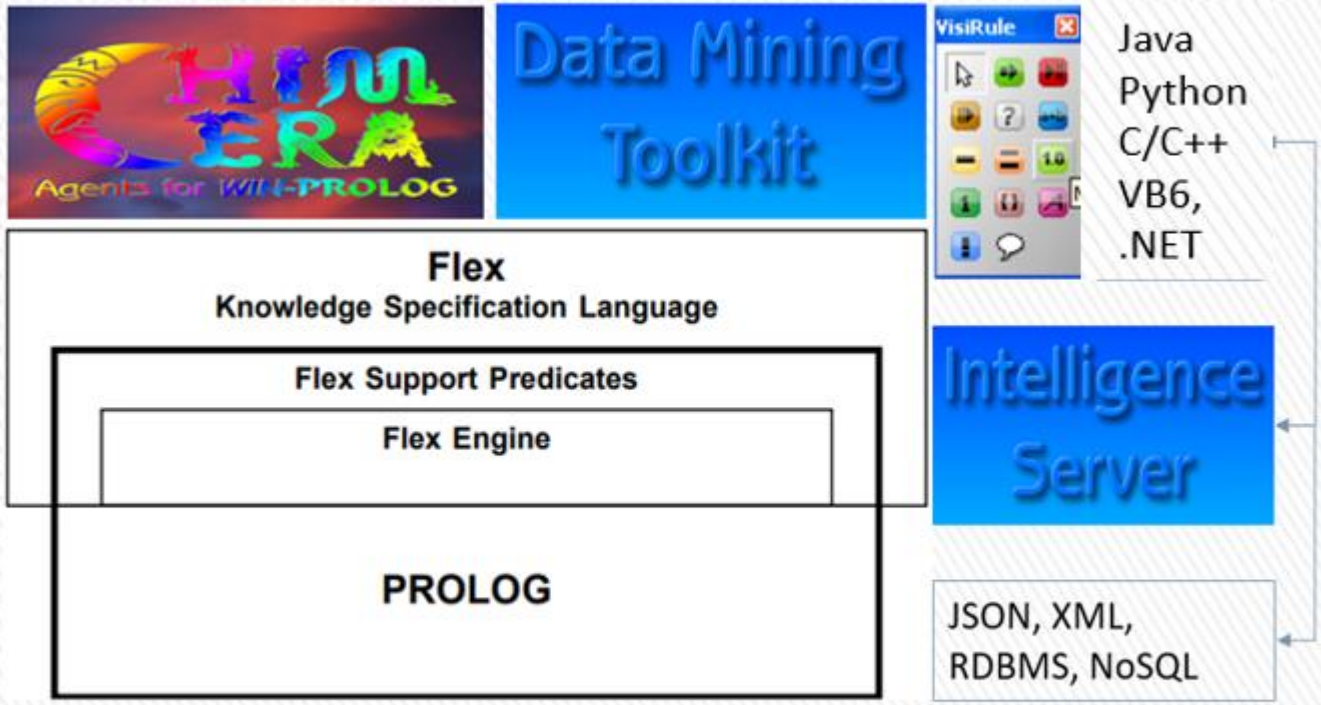
```
frame sensor is a kind of device;

  default type is SenType and
  default id is DevNumber and
  default location is Loc and
  default measurement is SV

  …
```

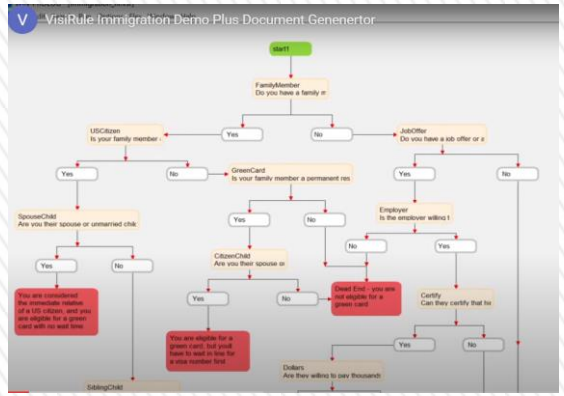
GeneBankOntology
EventOntology
SoilOntology
PlantOntology

KSL-Based Technology



» 3 levels:

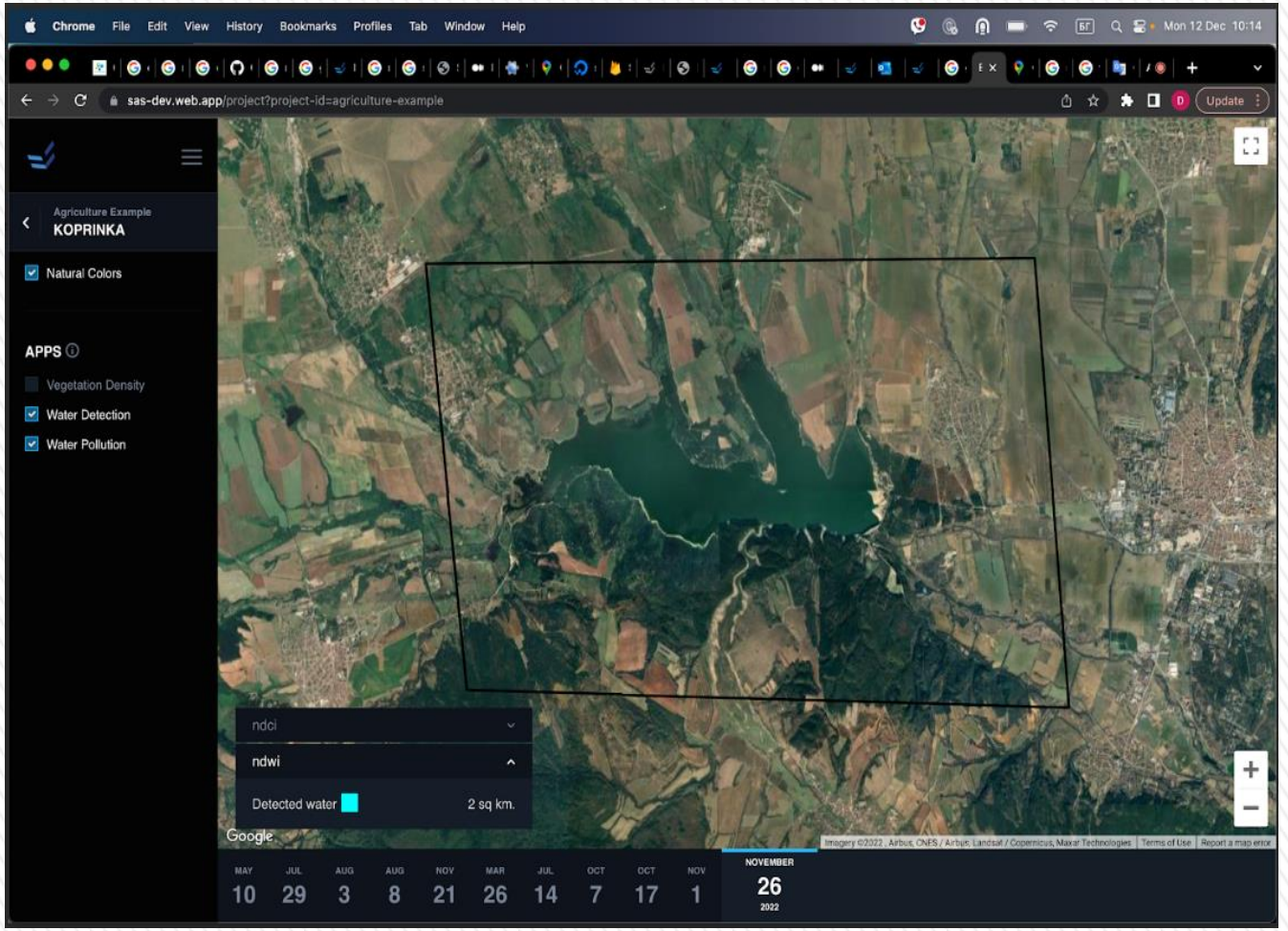
- > Prolog
- > Flex – expert system framework
- > VisiRule – visual editor for building expert systems with a structured decision tree.



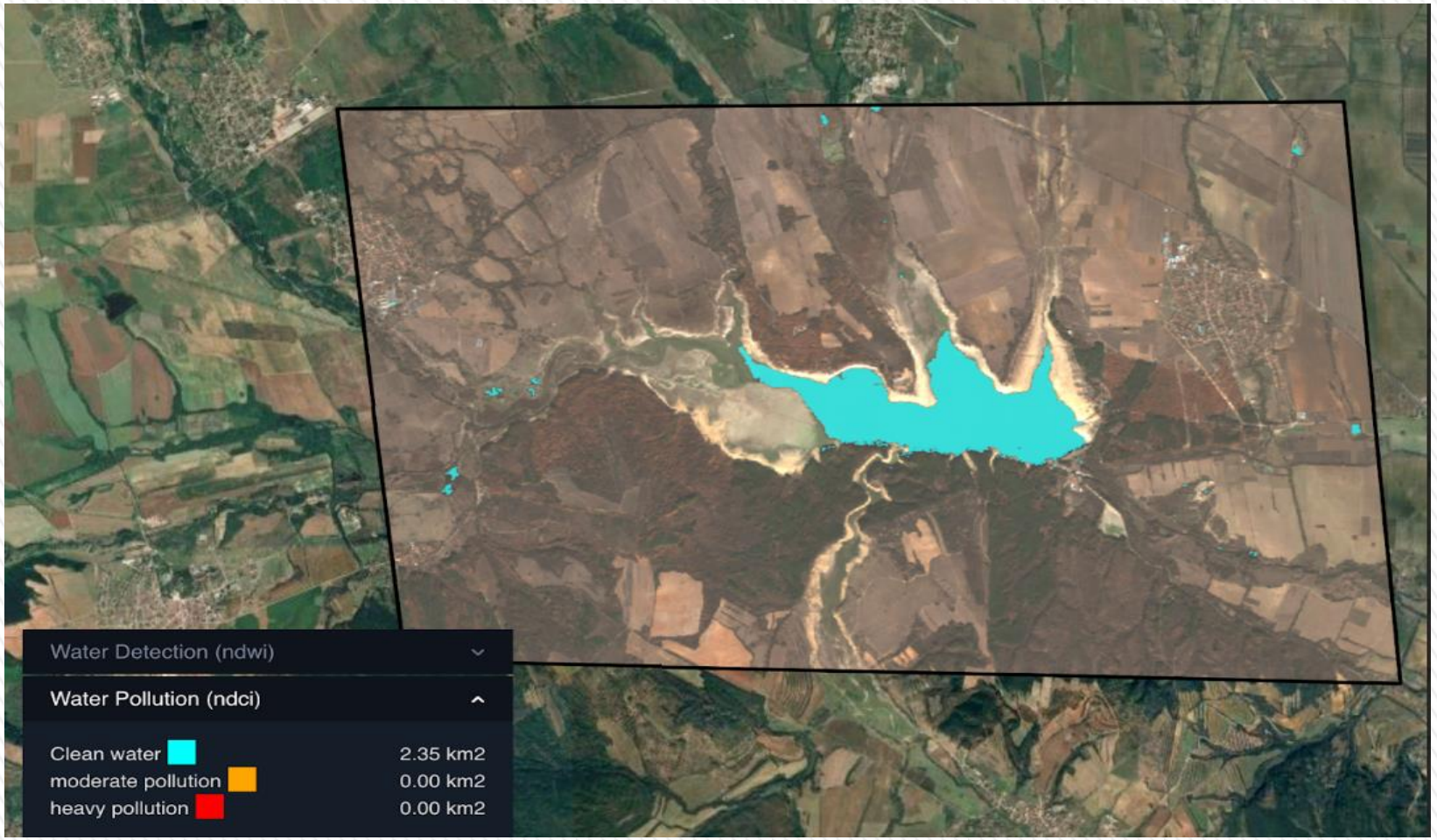
Next works

- We continue:
  - The expansion of sensor networks
  - The implementation of the platform ZEMELA
- We are starting to develop a concept for the national level - for now, the following two tasks are planned:
  - Recognizing and analyzing objects from space photographs
  - Advisory system for small and medium-sized farmers applying for financing under various European grants

Water pollution



Water pollution



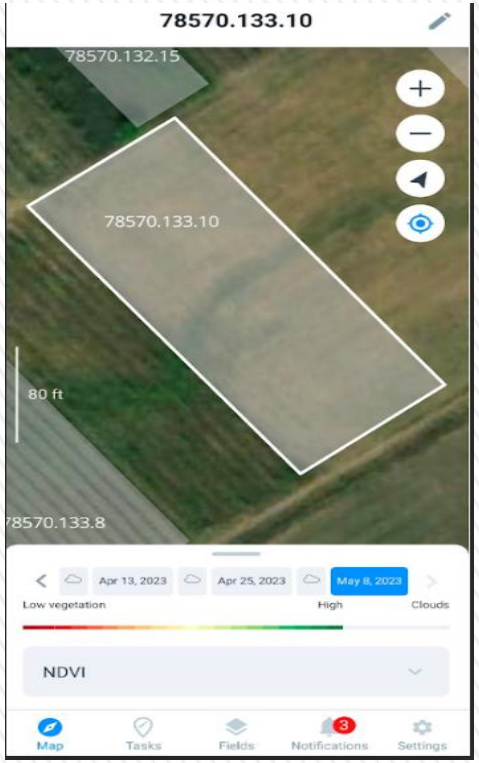
Vineyards


Click on a location
Options
Options
Y-axis index (bands are LC08)
NDVI
RGB visualization
SWIR1/NIR/GREEN
Map
Satellite
Google
Keyboard shortcuts
Imagery ©2022 CNES / Airbus, Maxar Technologies
Terms of Use
Report a map error
2019
2020
2021
2022
NDVI
0.525
0.520
0.515
0.510
A S O N D 2020 F M A M J J A S O N D 2021 F M A M J J A S
Date

Vineyards


ВИ ЦАРИНА
My Fields (33)
55556.167.20
78570.141.69
78570.132.1
55556.167.9
78570.133.10
testing-field
78570.132.15
Create field through cadastre
+ Save Field

Agricultural plots




Thank you for your attention!