demeter

TITLE: DEMETER Advanced Visualisation Tools

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Advanced Visualisation Tools

1   Summary

DEMETER aims to lead the Digital Transformation of the European Agrifood sector based on the rapid adoption of advanced technologies, such as Internet of Things, Artificial Intelligence, Big Data, Decision Support (DSS), Benchmarking, Earth Observation, etc., to increase performance in multiple aspects of farming operations, as well as to assure the viability and sustainability of the sector in the long term. It aims to put these digital technologies at the service of farmers using a human-in-the-loop approach that constantly focuses on mixing human knowledge and expertise with digital information. DEMETER focuses on interoperability as the main digital enabler, extending the coverage of interoperability across data, platforms, services, applications, and online intelligence, as well as human knowledge, and the implementation of interoperability by connecting farmers and advisors with providers of ICT solutions and machinery.

DEMETER focuses on the deployment of farmer-centric, interoperable smart farming-IoT (Internet of Things) based platforms, to support the digital transformation of Europe's agri-food sector through the rapid adoption of advanced IoT technologies, data science and smart farming, ensuring its long-term viability and sustainability.

The data visualisation module presents the user with intuitive meaning thanks to Knowage, with which a catalogue of panels has been developed and with which the DSS-related services are being enhanced.

2   Adaptive Visualisations for Dashboards

During the first phase of the project, the decision was made to use Knowage as a visualisation and adaptive framework for building and developing the DSS user interfaces (business driven and not pilot specific). The first step in the current phase was the collection of the technical and functional requirements for the DSS Pilot visualisation. This produced a wide variety of requirements both in the graphics and in the specific elements of each dashboard and the multiplicity of user visualisation required. Knowage module was able to meet these challenges by leveraging the modular structure of its components and integrated technologies.

This activity saw the collaboration of many partners in a joint work that also produced of a whole series of technical specifications documents. Each DSS area

provided technical content regarding the user requirements, the dashboard mock-up from which to start to implement the DSS user interface with Knowage, the graphical widgets preferred and requested by the user or Pilot technical staff. As a result, a DSS visualisations catalogue for agriculture has been implemented, which is very accurate with respect to the different areas of expertise.

3   Knowage

Knowage is an open-source Analytics and Business Intelligence Suite which is used, in DEMETER, to visualise the output from the DSS components in a way that will be easy to understand by the end-user.

The Knowage module offers different ways to integrate with other platforms or technologies either through an entire set of data connectors or through support of built-in analytical drivers. This module can integrate with a whole series of heterogeneous user interfaces, and DEMETER core enablers such as the Access Control Server Module (ACS), and the Brokerage Service Environment module (BSE) for the dynamic execution of the services exposed through REST endpoints of the analytical components or advanced DEMETER enablers. However, the integration process required some architectural refinements to the original integration flow, established to support the DEMETER DSS visualisation, providing for some additional developments that allowed the Knowage module to be integrated with one of the main DEMETER enablers. This addition did not bring further added value in terms of technological improvements but has improved the integration of this module with the other DEMETER enablers.

3.1   Pilots DSS Integration with Knowage Module

The integration method foreseen from the beginning of this activity will remain active supporting those pilots who want to choose a more direct integration simply by connecting their Dataset to the visualisation framework using the REST Dataset approach natively supported by the module itself. This diversity and heterogeneity ensure that we have the right solution for each individual use case and consider the business needs of the pilots themselves. For this reason, the integration flow has been consolidated on the basis of different integration solutions, made optional from the beginning. The more flexible solution has already been demonstrated and will continue to have a greater impact in the adoption of this technologically advanced module in terms of the ability to aggregate different results together in a single dashboard.

In the first solution, the integration of analytics software components that produce the AIM output data will connect to Knowage through the REST Dataset features; the output values extracted from the algorithms feed the Knowage dashboards for the DSS and the data will be graphically represented inside the cockpit.

This approach involves generating a general-purpose dashboard and not a mirror copy of the DSS interface that the pilot already has, but a common interface as much as possible for the pilots involved in a specific DSS area. The steps to generate these common interfaces are:

1. Pilot produces raw data (static, sensors, files, services, database, broker).
2. Pilot Translators translates raw data into AIM format (INPUT).
3. Analytics service for training/prediction acquires INPUT Data and run their own analysis (Business Logic).
4. Analytics service produces OUTPUT Dataset into AIM format.
5. Knowage REST Dataset technology engages the Dataset.
6. Knowage cockpit technology use this dataset to generate the Dashboard.

The pilots run the analytical components in their environment, covering both the training phase and the prediction phases, feeding them with the raw data coming from the available sources (sensors, databases, static data, etc.). Knowage REST dataset services hook the output of the data produced by the algorithms in AIM format. Knowage shows the end user the result of the processing using the most appropriate DSS interface or dashboard.

The second option integrates the DEMETER core enabler or Brokerage Service Environment; taking a further step towards simplifying and improving the relationship between Knowage and analytics components. This evolution assumes that the analytics services are reachable from Knowage (exposed on the internet or using local pilot network) and that they are registered on Brokerage Service Environment (BSE) and on the DEMETER Enabler Hub (DEH). This allows Knowage to discover this service using the "DEHId" information, which interconnects the resource defined on DEH with the actual service execution on BSE. This process is managed by the Knowage module through a web proxy features that is placed between Knowage and the analytics component. Knowage in this case, will not have to worry about calling the service through the native features or REST Dataset but simply using the proxy service that will perform this operation in its place. The proxy is responsible for discovering the service parameters on demand using the BSE facilities' services. By extracting the right parameters for each analytics service, such as endpoint, ports, protocol, and information related to the security of the

component itself, the proxy can make the request and receive the response from the service or the output of the AIM model which is then internally used by Knowage for data visualisation. The proxy must be able to connect to the DEMETER cloud instance of the ACS via https protocol to first obtain an authentication token, and then obtain a capability token. The proxy is an additional module, developed for the DEMETER project, which is released as an optional service together with the core functionalities of the visualisation framework and contained in the Knowage docker image.

The raw data from the DEMETER pilot is translated into the AIM format and then sent to the analytics component or DEMETER advanced enablers. These components have previously registered their execution information (like endpoint and metadata) at the BSE. At this point, the service REST endpoint is ready to be consumed by Knowage module to read the dataset produced by each component. However, Knowage does not hook the endpoint exposed by the analytics service directly using the native REST Dataset feature, but by connecting to the BSE and discovering the services to get information such as the endpoint to invoke it. Knowage consumes the data produced by each analytics component using AIM format, to get the data needed for the visualisation for each dashboard developed.

As for the main steps, to allow integration between pilot DSS and Knowage module, they remain the same as defined previously and can be summarised as follows:
- Pilot selection: Make an analysis of possible DSS that may have common views (involving Pilot Technology Providers).
- Merging data visualisation UI: Make a match between the proposed user interface (mock-up) to standardise the DSS view in a single general-purpose dashboard.
- Dataset selection: Selection of datasets to feed models and dashboards.
- Widgets and charts selection: Selection of widgets and graphs/charts that are shaping the dashboards (by using Knowage suite primitives).
- Inserting the dashboard: Finally, inserting the dashboard into the DSS catalogue which contains all technological details about the visualisation UI produced. In other words, the analytical software components for training and prediction phase, and user DSS dashboard used to feed algorithm data output in AIM format for end-user visualisation.

3.2 Knowage Deployment
There are two options for the deployment of the Knowage module in the DEMETER context: centralised on the DEMETER cloud or on-premises at pilot site.

Finally, the option selected for the deployment was to deliver Knowage instance decentralised (in each pilot) and not on DEMETER cloud. Each pilot has the ability to deploy an instance of Knowage on-premises, choose the DSS visualisation they need by having a complete catalogue available, and also choose the analytical services to produce the data. The instance is released as a docker image.

The following is an overview of the main information about Knowage deployment, that each pilot has to complete to install and configure the Knowage docker instance in their production environments.

First it is necessary to register an account in the Access Control DEMETER server, and perform a basic configuration using its interfaces, to obtain a basic configuration between the Knowage instance and the ACS server. This kind of configuration is common when a third-party service wants to put web applications in communication (using OAuth20 protocol) with ACS identity provider.

After the ACS configuration has been performed, the next step is to use the docker-compose file supplied with the Knowage docker image, which allows the installation and configuration of the Knowage docker containers in the target environment. The contents of the docker-compose YAML file will be similar for most installations though the pilot's technical staff may wish to make changes e.g., if the specified network port is already in use. After installing the docker-compose file, a new configuration file, *KnowageParameters.env,* containing all the environment variables for the Knowage docker instance can be set up in the same folder. The installation can then be executed by running the docker-compose command.

Once the command has been executed, the next step is to open an instance of a web browser and connect a URL of the form:

http://docker_host_ip_address:8080/knowage/servlet/AdapterHTTP?PAGE=LoginPage&NEW_SESSION=TRUE

One last tip is to use the docker host IP address where the Knowage instance is installed. Appropriate tuning configurations will be performed by the technical staff in each pilot to have the more appropriate deployment solution in terms of networking configuration.

3.3   Knowage Dashboard Catalogue
The requirements for visualisation of the output of DSS components resulted in the creation of a complete catalogue of dashboards for DSS on agriculture.

The partners developing the advanced enablers defined data models based on the DEMETER AIM model and then the most appropriate visualisation solution was applied to the output data. This collaborative work will continue in the coming period as the AIM data models will be further refined and the DSS visualisation graphical interfaces will be aligned as a result of comments received after deployment on pilot sites.

The dashboard catalogue currently contains over 20 dashboards constructed from a number of different types of widgets. The following images shows an example of a dashboard using a variety of different widgets.
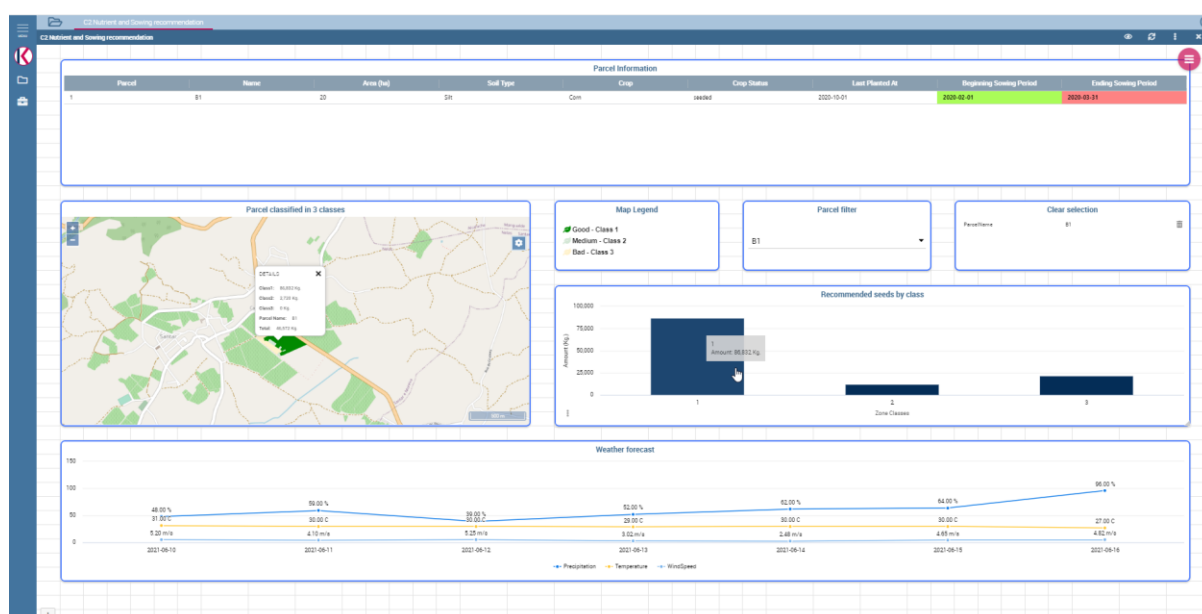
4   Conclusions

The choice of Knowage for the visualisation module for DEMETER has proven to be a success. It has been integrated with the core enablers and pilots and suitable widgets have been produced all the varied types of data required by the dashboards for the DSS enablers.

The catalogue of dashboards provided by Knowage for the DSS enablers has greatly enhanced the usability of the DEMETER system by clearly displaying the results from the DSS enablers. The combination of data processing by the analytic and decision support enablers with the visualisation by the dashboards results in an interpretation of the raw data that will be more meaningful to the end users.

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