Programming technologies supporting management of linked open data in the domain of cereal grain drying and storage
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Motivation

Agri-services

Cloud processing

Internet of Things

Cloud processing

Motivation

Agri-services

Cloud processing

Internet of Things
Motivation

54,962 Google searches in 1 second.
90% of world's data has been produced in last two years.

"We are drowning in information but starved for knowledge"

(John Naisbitt)

Possible steps:

- linking of data on a global scale,
- free access to data (interoperability),
- advanced software.
Motivation
Programming technologies supporting management of linked open data in the domain of cereal grain drying and storage

**Motivation**

**Problems**

- **Complexity** of handling, drying, heating, cooling and storing agricultural food products.
- **Lack** of reliable data on product properties.
- **Vast amounts** of unstructured data.
- **Fast** changes in ICT – hard to follow technologies to their full advantages.

**Remedies**

- Inverse FE approach to estimate reliable data on properties.
- **Future Internet** infrastructure.
- **Data processing**
  - predictions,
  - visualization,
  - semantics.
- **Advanced programming** technologies for developing semantic Web-based apps.
Programming technologies supporting management of linked open data in the domain of cereal grain drying and storage

**Objective**

- To improve functionality and performance of our software in the domain of drying and storage of agri-food products with respect to:
  - **estimation** of more reliable data on product properties,
  - **visualization** of investigated processes,
  - **development of linked open data approaches**, and
  - **implementation** of advanced programming technologies for multi- and cross-platform data processing.
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**Methods – programming technologies**

**Visual Studio 2017**

- ASP.NET Core MVC
- .NET Core

**Software development supporting Linked Open Data approach**

Visual Studio + Xamarin
.NET Core platform

- **.NET Core**: Cross-platform programming.
  - Runs on Windows, macOS and Linux.
  - Runs on various devices, embedded systems, IoT and cloud.
  - Supported by Microsoft and GitHub hosting servers.
  - **Open source**.

- **ASP.NET Core**: Next generation of the ASP.NET Web framework.
  - Runs either on .NET Framework or .NET Core.
  - Implements MVC templates – **ASP.NET Core MVC**.
Methods – package diagram for the *BioProcessSoft* system

**BioProcessSoft** *(Integrated software system)*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
</table>
| 3DMeshNode           | *(3D geometry data acquisition)*  
  **Input:** images of product sections, STL files, FE mesh parameters.  
  **Output:** coordinates of the FE mesh nodes. |
| BioVis               | *(3D geometry visualization)*  
  **Input:** experimental values of product properties, predicted values of product properties, coordinates of the FE mesh.  
  **Output:** 3D visualization of a product, 3D visualization of property changes. |
| IPS                   | *(Identification of properties and process simulation)*  
  **Input:** selection of mathematical models, approximation algorithms, and optimization algorithms; experimental values of product properties; coordinates of the FE mesh.  
  **Output:** predicted values of product properties (results of coefficient identification and process simulation). |
| ZiarBit              | *(Ontological Web-based DSS)*  
  **Input:** selection of processes and equipment for analysis, selection of data from standard and/or semantic databases.  
  **Output:** results of analysis of processes and equipment. |
| Database and ontology servers |                          |
| Mobile client applications |                          |
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**Visual Studio 2017 – Windows Presentation Foundation**

- Interface of the integrated *BioProcessSoft* system

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![BioProcessSoft Interface](image_url)

**Poznań University of Life Sciences, Poznań, Poland**

Integrated information system supporting bioprocess engineering – for determination and analysis of geometric, thermal and diffusive properties of agri-food and forest products.

Copyright © 2017 Institute of Biosystems Engineering, PULS. All rights reserved.

The work was financially supported by the National Science Centre of Poland under the research grant No. 2011/01/B/NZ9/03169
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**ASP .NET Core MVC**

- Interface of the *Ziarbit* subsystem (Web server)

---

**ZIARBIT WEB**

Aplikacja Ziarbit Web została utworzona z myślą o szybko rozwijających się gałęziach nowoczesnego rolnictwa. Głównym jej celem jest ułatwienie obliczeń związanych z analizą procesów zachodzących podczas suszenia i przechowywania ziarna zbóż, a także - wspomaganie decyzji.

---

**O programie**

Dowiedz się więcej o przeznaczeniu aplikacji Ziarbit Web.

- Zobacz »

---

**Pomoc**

Masz problem z aplikacją? Skorzystaj z bogatej bazy gotowych rozwiązań.

- Zobacz »

---

**Aktualności**

Sprawdź najnowsze informacje o aplikacji.

- Zobacz »

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Xamarin

Client mobile apps (C# - Xamarin - VS 2017) for the Ziarbit Web server
Linked open data technologies

Construction of ontologies in RDF/Turtle – RDF/Turtle Triple Generator
Selection of a database file.
**Linked open data technologies**

Construction of ontologies in RDF/Turtle – **RDF/Turtle Triple Generator**
Choice of serialization method and data entry.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td><a href="http://Cereal/Moisture">http://Cereal/Moisture</a></td>
<td>20</td>
</tr>
<tr>
<td>Predicate</td>
<td><a href="http://Cereal/Moisture">http://Cereal/Moisture</a></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>Add</td>
<td>Library</td>
</tr>
<tr>
<td>Object</td>
<td>Library</td>
<td></td>
</tr>
</tbody>
</table>

Add triple

Library
Cereal
Linked open data technologies

Construction of ontologies in RDF/Turtle – *Protégé*

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Linked open data technologies

Construction of ontologies (Web Ontology Language) – Fluent Editor

Document

```
every bucket-elevator is a transporter.
every screw-conveyor is a transporter.
every chain-conveyor is a transporter.
every redder is chain-conveyor.
every bucket-elevator have-capacity-rpm(some integer value ) and have-length(some integer value ) and have-min-electric-power(some integer value ) and have-max-electric-power(some integer value ) and have-chain-speed(some integer value ) and have-dimension(some integer value ) and have-turns-frequency(some integer value ).

Every chain-conveyor has-capacity-rpm(some integer value ) and has-chain-speed(some integer value ) and has-dimension(some integer value ) and has-max-electric-power(some integer value ) and has-min-electric-power(some integer value ) and has-turns-frequency(some integer value ) and has-length (some integer value ).

every screw-conveyor has-capacity-rpm(some integer value ) and has-dimension(some integer value ) and has-max-electric-power(some integer value ) and has-min-electric-power(some integer value ) and has-length(some integer value ) and has-chain-speed(some integer value ) and has-turns-frequency(some integer value ).
every grain is transported by a transporter.
every grain is dry by a dryer.
```

Reasoner

Who-Or-What is a silo.

<table>
<thead>
<tr>
<th>&lt;?&gt; is a silo. Total: 3 instances found.</th>
<th>Every &lt;?&gt; is a silo. Total: 0 subconcepts found Every silo is a &lt;?.&gt; Total: 1 superconcepts found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spa-50</td>
<td>warehouse-device</td>
</tr>
<tr>
<td>Spa-100</td>
<td></td>
</tr>
<tr>
<td>Spa-35</td>
<td></td>
</tr>
</tbody>
</table>
Linked open data technologies

Loading ontologies into a graph database – AllegroGraph
Linked open data technologies

Repository creation – AllegroGraph

Catalog | Scripts | Admin | User Kamil

Catalogs

- java-catalog
- python-catalog
- system

Repositories

- Dryer ×
- Silo ×
- Transporter ×
- Warehouse ×

Create new repository

- Name: ____________________________
- Restore from a backup
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Ontology visualization - grain storage system in Kołybki – Gruff
Linked open data technologies

Conveyors, RDF notation – Gruff

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Conveyors, OWL notation – *Gruff*
Linked open data technologies

Conveyors, OWL notation – OntoGraf

Programming technologies supporting management of linked open data in the domain of cereal grain drying and storage...
## Linked open data technologies

### R30 Conveyor, RDF and OWL notation

<table>
<thead>
<tr>
<th>RDF</th>
<th>OWL</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;rdf:Description rdf:about=&quot;http://up.poznan.pl/s&quot;</code></td>
<td><code>&lt;DataPropertyAssertion&gt;</code></td>
</tr>
<tr>
<td><code>&lt;li0:Capacity_rpm&gt;</code>30<code>&lt;li0:Capacity_rpm&gt;</code></td>
<td><code>&lt;DataProperty IRI=&quot;hasCapacityRpm&quot;/&gt;</code></td>
</tr>
<tr>
<td><code>&lt;li0:Chain_Speed&gt;</code>0.5<code>&lt;li0:Chain_Speed&gt;</code></td>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
<td><code>&lt;li0:Dimension&gt;</code>159<code>&lt;li0:Dimension&gt;</code></td>
<td><code>&lt;Literal datatypeIRI=&quot;http://www.w3.org/2001/XMLSchema#double&quot;&gt;30.0&lt;/Literal&gt;</code></td>
</tr>
<tr>
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<td><code>&lt;DataPropertyAssertion&gt;</code></td>
</tr>
<tr>
<td><code>&lt;li0:Maximum_Lenght&gt;</code>21000<code>&lt;li0:Maximum_Lenght&gt;</code></td>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
<td><code>&lt;li0:Min_Electric_Power&gt;</code>3000<code>&lt;li0:Min_Electric_Power&gt;</code></td>
<td><code>&lt;Literal datatypeIRI=&quot;http://www.w3.org/2001/XMLSchema#double&quot;&gt;0.5&lt;/Literal&gt;</code></td>
</tr>
<tr>
<td><code>&lt;/rdf:Description&gt;</code></td>
<td><code>&lt;DataPropertyAssertion&gt;</code></td>
</tr>
<tr>
<td><code>&lt;DataProperty IRI=&quot;hasDimension&quot;/&gt;</code></td>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
<td><code>&lt;Literal datatypeIRI=&quot;http://www.w3.org/2001/XMLSchema#double&quot;&gt;219.0&lt;/Literal&gt;</code></td>
</tr>
<tr>
<td><code>&lt;DataProperty IRI=&quot;hasMaxElectricPower&quot;/&gt;</code></td>
<td><code>&lt;DataPropertyAssertion&gt;</code></td>
</tr>
<tr>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
<td><code>&lt;DataProperty IRI=&quot;hasMaxElectricPower&quot;/&gt;</code></td>
</tr>
<tr>
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<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
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</tr>
<tr>
<td><code>&lt;DataPropertyAssertion&gt;</code></td>
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<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
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<tr>
<td><code>&lt;DataPropertyAssertion&gt;</code></td>
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</tr>
<tr>
<td><code>&lt;DataProperty IRI=&quot;hasMinElectricPower&quot;/&gt;</code></td>
<td><code>&lt;DataProperty IRI=&quot;hasMinElectricPower&quot;/&gt;</code></td>
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<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
</tr>
<tr>
<td><code>&lt;NamedIndividual IRI=&quot;R30&quot;/&gt;</code></td>
<td><code>&lt;Literal datatypeIRI=&quot;http://www.w3.org/2001/XMLSchema#double&quot;&gt;4000.0&lt;/Literal&gt;</code></td>
</tr>
</tbody>
</table>
Linked open data technologies

Grain storage bins produced by Araj, RDFS notation – *Gruff*
Linked open data technologies

Simple query for RDF – **SPARQL Query Generator**
Linked open data technologies

Complex query for RDF – **SPARQL Query Generator**

- **Generator zapytań SPARQL 1.0**
- **Szkaj dla:** Suszarki
- **Prefix:** http://up.poznan.pl/ser

**Zapytania proste:** Zapytania złożone

**Predykat:** Bacrckthrough_Capac >= 1000

**Predykat:** Blowing_Rate = 4698

**Wyświetl:**
- Breakingthrough_Capacity
- Blowing_Rate

**Opcje dodatkowe**
- **Sortowanie wg:** Bacrckthrough
- **Wyniki:** 100

**CZYŚĆ**  **KOPIUJ DO SCHOWKA**  **DO .TXT**
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Query for RDFS – **SPARQL Query Generator**

<table>
<thead>
<tr>
<th>Generuj zapytanie:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pokaż wszystko</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pokaż wszystkie</td>
<td>subClassOf</td>
</tr>
<tr>
<td></td>
<td>pokaż wszystkie instancje</td>
<td></td>
</tr>
</tbody>
</table>

**Programming technologies supporting management of linked open data in the domain of cereal grain drying and storage**

**Query for RDFS**

**SPARQL Query Generator**

<table>
<thead>
<tr>
<th>Generator zapytań SPARQL 1.5</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plik</td>
<td>Autorach</td>
<td></td>
</tr>
<tr>
<td>Zapytania SPARQL dla RDF</td>
<td>Zapytania SPARQL dla RDF Schema</td>
<td></td>
</tr>
</tbody>
</table>

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**Query for RDFS – SPARQL Query Generator**

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<td></td>
<td>pokaż wszystkie instancje</td>
<td></td>
</tr>
</tbody>
</table>
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Presentation of query results (json) – ShowAnswer

```json
{
  "x": {"type": "uri", "value": "http://up.poznan.pl/semantic/500-180_5"},
  "Belt": {"type": "literal", "value": "built-up"},
  "Bucket": {"type": "literal", "value": "metal"},
  "Capacity": {"type": "literal", "value": "80"},
  "Cross_Section": {"type": "literal", "value": "octagon"}
}
```
Conclusions

1. Advanced programming technologies (*WPF, ASP.NET Core MVC, Xamarin, multi- and cross-platform data processing*) were implemented to improve functionality and performance of the software for analyzing drying and storage of agri-food products.

2. Estimation of geometric and thermo-mechanical properties of agri-food products, and also visualization of processes were improved in the software.

3. Applications for constructing, storing and querying ontological models for grain drying and storage enhanced the system. It facilitated access to the linked open data sets for users.

4. Future research: to expand the scope of the ontologies to better represent the problem domain.
Thank you for your attention!