Design of a Knowledge Experience based Environment for Museum Data Exploration and Knowledge Creation

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Hoshino Takayuki
The Graduate School of Computer Science and Engineering, University of Aizu. Fukushima, Japan
Nihon Unisys*, Ltd. Technology Research & Innovation. Tokyo, Japan

*April 2022 Changed the company name to BIPROGY Inc.

Yoshioka Rentaro
The Graduate School of Computer Science and Engineering, University of Aizu. Fukushima, Japan
Outline

- Knowledge Experience in the museum
- Knowledge creation and support environment in the museum
  - Sensor Agent
  - Viewing Experience DB
  - Explore Viewing Experience
- Knowledge-creating activity environment framework
- Conclusion
Knowledge Experience in the museum

I. Visitors and curators share their experiences as knowledge with each other.

II. Each person gains awareness and learning about their own activities and improves the quality of their activities.

III. The activity is shared as a new experience.

Curator’s activities (Display planning and design)

Visitor’s experiences

Knowledge of artifacts (Presented as explanation, tips, prompt)

Knowledge of viewing experience (Presented as an impression, awareness/learnings)

Awareness / learnings

Recorded as knowledge

Shared as knowledge

Curator’s Experience

Knowledge of Artifacts
Display Design

Visitor’s Experiences

Viewing Behavior
Impressions, awareness / learnings

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Curator's knowledge creation and support environment

Viewing Experience

1) Sensor Agent
2) Viewing Experience DB
3) Explore Viewing Experience

Knowledge creation support environment

Collect viewing experiences
Explore viewing experience

Execute improvements

Shared as organizational knowledge
Overview of Sensor Agent

- Luminance
- PIR sensor
- Microphone
- Temperature
- Humidity
- Atmospheric Pressure
- Thermography
  - 8x8 resolution
- Camera
  - Object detection by Yolo v3
- 3D printed casing, cabling to blend into exhibit room.
- Tests to demonstrate safety was also necessary.
### Viewing Experience DB

#### Sensed Data

<table>
<thead>
<tr>
<th>Name</th>
<th>Device</th>
<th>Intention of measurement</th>
<th>Measurement-Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>System time</td>
<td>Data collection date and time</td>
<td>The sensor agent records the time when the data was measured.</td>
</tr>
<tr>
<td>agent_serial</td>
<td>Sensor Node</td>
<td>Uniquely identify the sensor agent</td>
<td>The unique number (serial number) of the sensor agent is added at the time of data transmission.</td>
</tr>
<tr>
<td>temperature</td>
<td>Temperature sensor</td>
<td>Temperature (celsius)</td>
<td>Temperature sensor measurements (measured at 1 minute intervals)</td>
</tr>
<tr>
<td>humidity</td>
<td>Humidity sensor</td>
<td>Humidity (%)</td>
<td>Humidity sensor measurements (measured at 1 minute intervals)</td>
</tr>
<tr>
<td>pressure</td>
<td>Barometric pressure sensor</td>
<td>Atmospheric pressure (bar)</td>
<td>Barometric pressure sensor measurements (measured at 1 minute intervals)</td>
</tr>
<tr>
<td>luminance</td>
<td>Illuminance sensor</td>
<td>Illuminance (lux)</td>
<td>Illuminance sensor measurements (measured at 1 minute intervals)</td>
</tr>
<tr>
<td>noise.db</td>
<td>Microphone</td>
<td>Loudness (dB)</td>
<td>The loudness of the sound picked up by the microphone. (The collected data is not saved, and conversations are not recognized or recorded.)</td>
</tr>
<tr>
<td>motion</td>
<td>PIR motion sensor</td>
<td>Probability of having people (%)</td>
<td>It measures once every 0.5 seconds with a motion sensor and calculates the probability of detecting movement in 1 minute.</td>
</tr>
<tr>
<td>presence</td>
<td>Camera</td>
<td>Number of people (people)</td>
<td>Calculate the number of people included in the captured image. (Only the person is judged by machine learning, and the individual is not identified.)</td>
</tr>
<tr>
<td>pXm</td>
<td>Program</td>
<td>Number of people detected (expected value)</td>
<td>The product of the estimated number of people (presence value) based on image recognition and the probability that there are people (motion value) is calculated, and the detected number is calculated as the expected value.</td>
</tr>
<tr>
<td>nvis</td>
<td>Person</td>
<td>Number of visitors per day</td>
<td>The museum staff counts the number of visitors every day.</td>
</tr>
</tbody>
</table>
# Viewing Experience DB

## Visualization Method

<table>
<thead>
<tr>
<th>Method</th>
<th>Intention</th>
<th>Input</th>
<th>Output</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>MeXpl</td>
<td>Graph by specifying the period (tdt-&gt; tdt) for the two item names (x, y) of the specified data set (sDS) (no agent layer classification)</td>
<td>MeX datasets</td>
<td>Graph</td>
<td>MeXpl(sDS=MEXDS, x=&quot;time&quot;, y=&quot;pXm&quot;, fdt=&quot;2021-06-19&quot;, tdt=&quot;2021-07-03&quot;)&lt;br&gt;For the data of MeXDS from June 19th to July 3rd, 2021, set the x-axis to time and the y-axis to pXm and draw a correlation diagram.</td>
</tr>
<tr>
<td>MeXpl.a</td>
<td>For the two item names (x, y) of the specified data set (sDS), specify the period (tdt-&gt; tdt) and agent, and graph by stratification by agent.</td>
<td>MeX datasets</td>
<td>Graph</td>
<td>MeXpl.a(sDS=MEXDS, x=&quot;time&quot;, y=&quot;pXm&quot;, fdt=&quot;2021-06-19&quot;, tdt=&quot;2021-07-03&quot;)&lt;br&gt;For the data of MeXDS from June 19th to July 3rd, 2021, set the x-axis to time and the y-axis to pXm and draw a correlation diagram. Allows identification for each Agent.</td>
</tr>
<tr>
<td>MeXpl.t</td>
<td>For the item name (y) of the specified data set, specify the period (tdt-&gt; tdt) and agent and graph by stratification on a daily basis.</td>
<td>MeX datasets</td>
<td>Graph</td>
<td>MeXpl.t(sDS=MeXDS, fdt=&quot;2021-06-19&quot;, tdt=&quot;2021-07-03&quot;)&lt;br&gt;For the data of MeXDS from June 19th to July 3rd, 2021, set the x-axis to time and the y-axis to pXm and draw a correlation diagram. Compare the changes in the same time zone on each day.</td>
</tr>
</tbody>
</table>
**Viewing Experience DB**

### Dataset Operation Method

<table>
<thead>
<tr>
<th>Method</th>
<th>Intention</th>
<th>Input</th>
<th>Output</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>MeXsum.at</td>
<td>Aggregate MeX datasets by date and time and Agent by key. The interval is specified in seconds.</td>
<td>MeX datasets</td>
<td>MeX datasets</td>
<td>MeXsum.at(interval=60*60, sDS=MeXDS, fun=mean)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MeXDS (1 minute value) is aggregated into 1 hour value for each Sensor Agent using the average value for 1 hour (60 seconds x 60 minutes).</td>
</tr>
<tr>
<td>MeXsum.t</td>
<td>Aggregate MeX datasets by date and time. The interval is specified in seconds.</td>
<td>MeX datasets</td>
<td>MeX datasets</td>
<td>MeXsum.t(interval=60*60, sDS=MeXDS,)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MeXDS (1 minute value) is aggregated into 1 hour value using the average value for each hour (60 seconds x 60 minutes) throughout the museum.</td>
</tr>
<tr>
<td>MeX.SelectOpenHours</td>
<td>Extract museum opening hours data from the MeX dataset.</td>
<td>MeX datasets</td>
<td>MeX datasets</td>
<td>MeX.SelectOpenHours(sDS=MeXDS, fr=&quot;09:30:00&quot;,to=&quot;17:30:00&quot;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Extract data on opening hours (9:30-17:30) from MeXDS every day.</td>
</tr>
<tr>
<td>MeXtrange</td>
<td>Extract Agent data as a dataset for a specified period from the dataset</td>
<td>MeX datasets</td>
<td>MeX datasets</td>
<td>MeXtrange(fdt=&quot;2021-06-19&quot;, tdt=&quot;2021-07-03&quot;, sDS=MeXDS, agent=Agent)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Extract the data corresponding to the Agent from the data of the period (2021/6/19-2021/7/3) from MeXDS.</td>
</tr>
</tbody>
</table>
**Explore Viewing Experience**

- Dataset Information for curators

**c: Sensor Agent Information**

**b: Sensor Agent Location Map**

**a: Dataset Description**
**Explore Viewing Experience**

- Number of visitors in places (sensor agents)
Explore Viewing Experience

- Recorded and shared awareness and discoveries

<table>
<thead>
<tr>
<th>YMDT</th>
<th>Donator</th>
<th>Intention</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011/7/15</td>
<td>T.Hoshino</td>
<td>Observation of the situation inside the building from June to July</td>
<td>Many people always gather at the locations of sensor agents pos5 and pos3. The values detected by the Agent installed at pos5 on June 24 have a different tendency, and it is assumed that the power was turned off.</td>
</tr>
</tbody>
</table>

Creation Method
```
MeXpl.a(sDS=MeXDS24H7.at, x="time", y="pXm", type="o", agent=Agent[c(1,3,9,4,5,6,7),], fdt="2021-06-19", tdt="2021-07-03")
```
Knowledge-creating activity environment framework
Conclusion

An environment design based on the concept of knowledge experience was presented. The design was also evaluated by demonstrating analysis and interpretation of visitor behavior and the creation of corresponding knowledge based on the data.

The framework derived this time is a design-level reference to realize them. This reference is useful for designing systems that actively promote knowledge creation through trial and error, such as effective data exploration and discovery of combination patterns.

In the future, by adding agents that create new knowledge based on shared knowledge by calculation (statistics, optimization, machine learning, artificial intelligence technology, etc.), humans and computers will be on an equal footing with each other. It is expected that the environment for creating new value will be enhanced by utilizing the results of activities.
Thank you for your attention