Object Store Based Simulation Interworking
CoSMoS Project

www.cosmos-research.org
Simulation for Scientific Research
Process
Technology
Simulations
occoids
Granuloma Formation
Household Power Consumption
CoSMoS

Agile - small point solutions
No framework
CoSMoS Driver
Integrate simulations (multi-lingual)
Connect analysis and visualisation (to simulations)
Store parameters and simulations results
Thermo

House

Weather

Store

Analysis

Visualisation
Basic Protocol
create (name, start time)
delete (name)
update (name, field, value)
publish (name, time)
read (name, field, time)
query (regular expression)
Object Timelines
Separate simulation time steps
<table>
<thead>
<tr>
<th>Time</th>
<th>X</th>
<th>Y</th>
<th>Nectar</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>r0</td>
<td>r0</td>
<td>r0</td>
</tr>
<tr>
<td>1.0</td>
<td>r1</td>
<td>r1</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>r2</td>
<td>r2</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td>r1</td>
<td></td>
</tr>
</tbody>
</table>

[Y_r1]
Time

<table>
<thead>
<tr>
<th>X</th>
<th>r0</th>
<th>r1</th>
<th>r2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>r0</td>
<td>r1</td>
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<tr>
<td>Nectar</td>
<td>r0</td>
<td></td>
<td>r1</td>
</tr>
</tbody>
</table>

read Y at 3.5
read Y at 3.5
Storage and Architecture

Inspiration from web services
Client => Frontend => Database
Key-Value Store
Key-Value Store

Big hash table / dictionary

O(1) access, replication, etc

Keys, e.g. obj_1:field_1:r0
Versioning
Repeat runs based on stored data
Analysis of multiple data sets
Prefix/postfix keys
Weather Model

r0

House (Param 1) → r1.0
House (Param 2) → r1.1

Analysis
Case Study

Boids (occoids)

Flocking emergence (depending on parameters)
Retasking
Visual demo
Different dynamics: Bees
Not scientific
Modifications
Record simulations
Analyse agent movement
System Entropy

Singular Value Decomposition
\[ Z = \begin{bmatrix}
Boid_1 & \cdots & Boid_n \\
 \frac{P.x_1}{V.x_1} \frac{P.y_1}{V.y_1} & \cdots & \frac{P.x_n}{V.x_1} \frac{P.y_n}{V.y_1} \\
\vdots & \ddots & \vdots \\
Boid_1 & \cdots & Boid_n \\
\frac{P.x_m}{V.x_1} \frac{P.y_m}{V.y_1} & \cdots & \frac{P.x_n}{V.x_1} \frac{P.y_n}{V.y_1}
\end{bmatrix}
\]

\[
\bar{P}_{\text{group}_n} = \frac{\sum_{i \in \text{group}_n} P_t^i}{n} \text{ and } \bar{V}_{\text{group}_n} = \frac{\sum_{i \in \text{group}_n} V_t^i}{n}
\]

\[
\forall_i Z.P_t^i \leftarrow \bar{P}_t - Z.P_t^i \text{ and } \forall_i Z.V_t^i \leftarrow \bar{V}_t - V.P_t^i
\]

\[
\Sigma_t = \text{SVD}(Z_t)
\]

\[
\Sigma_t' = \frac{\Sigma_t}{\left(\sum_i \sigma_{i,t}\right)} \text{ where } \sigma_{i,t} \in \Sigma_t
\]

\[
S_t = -\sum_i \sigma_{i,t} \cdot \log_2(\sigma_{i,t})
\]
vision.radius=0.20
vision.radius=0.40
vision.radius=0.80
Summary
Loose coupling - synchronisation when required
On data, not explicit lock step
Coarse-grain to fine-grain support
Future Work
Performance
Time fuzziness
Questions?

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