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Idaho National Laboratory

Time Dependent Statistics and Relational Analysis

RAVEN Workshop





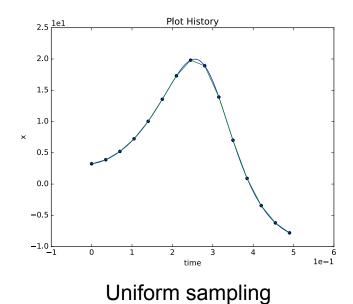
Overview

- Time-series post-processors:
 - Quick overview
- Time dependent basic statistics
 - Scalar FOMs
- Time dependent relational analysis
 - Relational FOMs



Data Pre-Processing: Re-Sampling

- Objective: reduce memory space of each time series
- Method: re-sampling the time series
 - Smartly locate sample points on strategically important regions
 - e.g. high derivative (gradient) regions



2.5 Plot History

2.0

1.5

1.0

×

0.5

-0.5

-1.0

1 2 3 4 5 6

time 1e-1

First-order derivative sampling



RAVEN Time-Series Post-Processors

- Class: Interfaced Post-Processors
 - RAVEN provides a generic interface to create user-defined generic Post-Processors
 - Act on both PointSets and HistorySets



RAVEN Time-Series Post-Processors: Examples

- HSPS: it converts an HistorySet into a PointSet
 - Each history is converted into a multi-dimensional vector
- HistorySetSampling
 - Original HistorySet is re-sampled accordingly to a specific sampling strategy
- HistorySetSync
 - Time series contained in the original HistorySet are synchronized in time
 - Identical initial and final time
 - Identical number of samples
- dataObjectLabelFilter
 - Filter the dataObject for a specific value of the clustering label



RAVEN Example 1 Time Dependent Basic Statistics - Scalar FOMs



RAVEN Scalar FOMs

- Scalar FOMs
 - Expected value
 - Variance
 - Sigma
 - Kurtosis
 - Skewness
 - Variational Coefficient
 - Median
 - Percentile (e.g. 5%, 95%, etc.)
 - Etc.

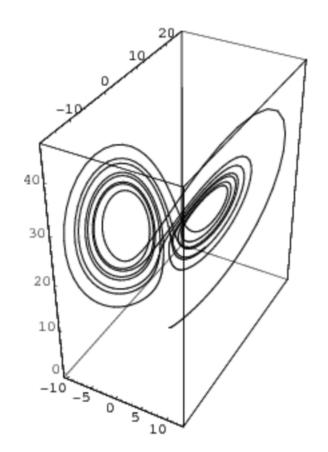


- Steps
 - 1. Generate time-dependent data
 - Post-Process the data (scalar FOMs)
 - 3. Create a DataObject (PointSet) from processed data



| Distributions | Models | Samplers | Databases | DataObjects | Steps |
|---------------|--------|----------|-----------|-------------|-------|
|---------------|--------|----------|-----------|-------------|-------|

```
<Models>
 <PostProcessor name="timeDepBasicStat" subTy
   <pivotParameter>time</pivotParameter>
   <expectedValue>x,y,z</expectedValue>
   <percentile 5>x,y,z</percentile 5>
   <percentile 95>x,y,z</percentile 95>
 </PostProcessor>
 <PostProcessor name="readStats" subType="Rav
   <dynamic>true</dynamic>
   <File ID="0" name="output TD BS.xml">
     <output name="mean"</pre>
                                   >x
                                        expect
     <output name="percentile 5" >x
                                        percen
     <output name="percentile 95" >x
                                        percen
   </File>
 </PostProcessor>
</Models>
```



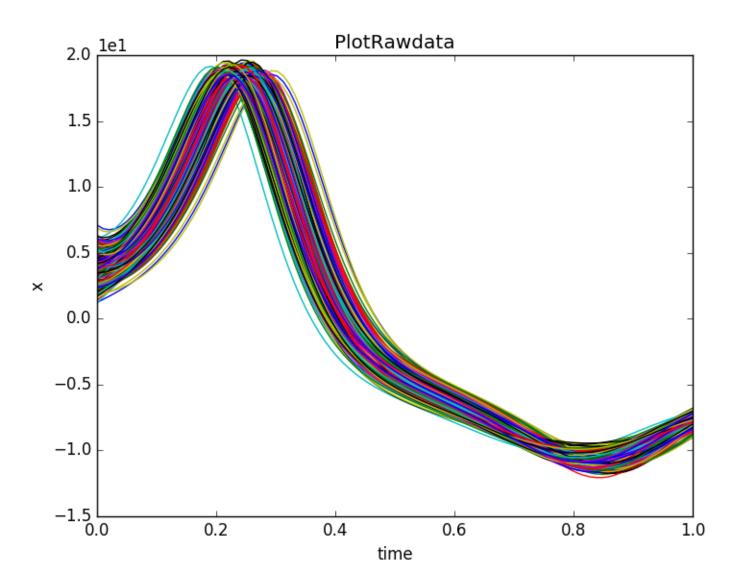


| | Distribution | าร | Models | Sa | mplers | Databases | DataObjects | Steps | |
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| <steps></steps> | | | | | | | | | |
| • | <multirun name="FirstMRun"></multirun> | | | | | | | | |
| | <input< td=""><td colspan="4"></td><td>intSet"</td><td colspan="2" rowspan="4"><pre>>inputPlaceHolder >PythonModule >MC_external >HistorySet</pre></td></input<> | | | | | intSet" | <pre>>inputPlaceHolder >PythonModule >MC_external >HistorySet</pre> | | |
| | <model< td=""><td colspan="3">class="Models"</td><td colspan="2">type="ExternalModel"</td></model<> | class="Models" | | | type="ExternalModel" | | | | |
| | <sampler< td=""><td colspan="3">class="Samplers"</td><td colspan="2">type="MonteCarlo"</td></sampler<> | class="Samplers" | | | type="MonteCarlo" | | | | |
| | <output< td=""><td colspan="3">class="DataObjects"</td><td colspan="2">type="HistorySet"</td></output<> | class="DataObjects" | | | type="HistorySet" | | | | |
| | | | | | | | | | |
| <postprocess name="timeDepBasicStatPP"></postprocess> | | | | | | | | | |
| | <input< td=""><td>cla</td><td>ss="DataObjec</td><td>ts"</td><td>type="Hi</td><td>storySet"</td><td>>HistorySet<!--</td--><td>Input></td></td></input<> | cla | ss="DataObjec | ts" | type="Hi | storySet" | >HistorySet </td <td>Input></td> | Input> | |
| | <model< td=""><td colspan="2"><model <="" class="Models" td=""><td></td><td colspan="2">type="PostProcessor"</td><td colspan="2" rowspan="2"><pre>>timeDepBasicStat</pre></td></model> >output TD BS.csv</td></model<> | <model <="" class="Models" td=""><td></td><td colspan="2">type="PostProcessor"</td><td colspan="2" rowspan="2"><pre>>timeDepBasicStat</pre></td></model> >output TD BS.csv | | | type="PostProcessor" | | <pre>>timeDepBasicStat</pre> | | |
| | <output< td=""><td colspan="2"><pre><0utput class="Files"</pre></td><td></td><td colspan="2">type=""</td></output<> | <pre><0utput class="Files"</pre> | | | type="" | | | | |
| | <output< td=""><td colspan="3">class="Files"</td><td colspan="2">type=""</td><td>>output TD BS</td><td>.xml</td></output<> | class="Files" | | | type="" | | >output TD BS | .xml | |
| | <output< td=""><td colspan="2">class="DataObjects"</td><td>ts"</td><td colspan="2">type="HistorySet"</td><td colspan="2">>HistorySet</td></output<> | class="DataObjects" | | ts" | type="HistorySet" | | >HistorySet | | |
| • | | | | | | | | | |
| | <pre><postprocess< pre=""></postprocess<></pre> | s na | me="readStats | "> | | | | | |
| | <input< td=""><td>cla</td><td>ss="Files"</td><td></td><td>type=""</td><td></td><td>>output TD BS</td><td>.xml</td></input<> | cla | ss="Files" | | type="" | | >output TD BS | .xml | |
| | <input< td=""><td>cla</td><td>ss="DataObjec</td><td>ts"</td><td>type="Hi</td><td>storySet"</td><td>>HistorySet<!--</td--><td></td></td></input<> | cla | ss="DataObjec | ts" | type="Hi | storySet" | >HistorySet </td <td></td> | | |
| | <model< td=""><td>cla</td><td>ss="Models"</td><td></td><td></td><td>stProcessor"</td><td>>readStats<td>-</td></td></model<> | cla | ss="Models" | | | stProcessor" | >readStats <td>-</td> | - | |
| | <output< td=""><td>cla</td><td>ss="DataObjec</td><td>ts"</td><td>type="Po.</td><td></td><td>>stats<!--0utput</td--><td>t></td></td></output<> | cla | ss="DataObjec | ts" | type="Po. | | >stats 0utput</td <td>t></td> | t> | |
| | <output< td=""><td></td><td>ss="OutStream</td><td></td><td>type="Plo</td><td>ot"</td><td>>Plotdata<!--0u</td--><td>tput></td></td></output<> | | ss="OutStream | | type="Plo | ot" | >Plotdata 0u</td <td>tput></td> | tput> | |
| | <pre><output <="" class="OutStreams" pre=""></output></pre> | | | s" | type="Plot" >PlotRawdata | | | - | |
| | | | | | | | | | |

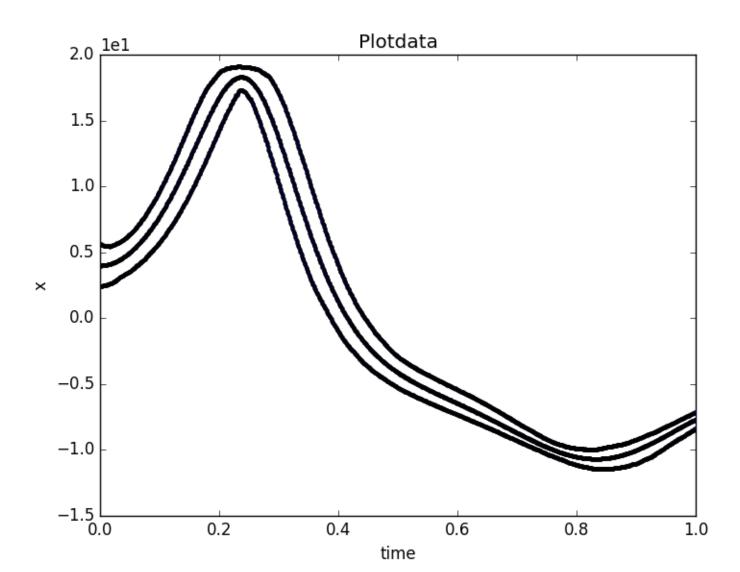
Input file name: time_dep.xml

</Steps>











RAVEN Example 2 Time Dependent Basic Statistics - Relational FOMs



RAVEN Scalar FOMs

Relational FOMs

- Sensitivity (linear regression) coefficients
- Covariance coefficients
- Correlation coefficients (Pearson)
- Normalized sensitivity coefficients
- Variance Weighted Sensitivity coefficients
- Etc.



- Steps
 - 1. Generate time-dependent data
 - Post-Process the data (relational FOMs)
 - 3. Create a DataObject (PointSet) from processed data



| Distributions | Models | Samplers | Databases | DataObjects | Steps |
|---------------|--------|----------|-----------|-------------|-------|
|---------------|--------|----------|-----------|-------------|-------|

```
<Models>
 <PostProcessor name="timeDepBasicStat" subType="BasicStatistics">
   <covariance>
     <features>x0,y0,z0,x,y,z</features>
     <targets>x,y,z</targets>
   </covariance>
   <pearson>
     <features>x0,y0,z0,x,y,z</features>
     <tarqets>x,y,z</tarqets>
   </pearson>
   <--! We are going to build the sensitivity block -->
   <sensitivity>
     <features>x0,y0,z0,x,y,z</features>
     <tarqets>x,y,z</tarqets>
   </sensitivity>
 </PostProcessor>
</Models>
```



Distributions Models Samplers Databases DataObjects Steps

```
<Models>
<PostProcessor name="readStats" subType="RavenOutput">
  <dynamic>true</dynamic>
  <File ID="0" name="output TD BS.xml">
                                 > x0
    <output name="pearson x0 x"</pre>
                                                  x </output>
                                        pearson
                                       pearson | y </output>
    <output name="pearson y0 y" > y0
                                        pearson | z </output>
    <output name="pearson z0 z" > z0
    <output name="pearson x y" > x
                                        pearson
                                                  y </output>
                                                  z </output>
    <output name="pearson x z" > y
                                        pearson
    <output name="covariance x0 x" > x0
                                           covariance | x </output>
    <output name="covariance y0 y" > y0 | covariance | y </output>
    <output name="covariance z0 z" > z0 | covariance | z </output>
    <output name="covariance x y" > x | covariance y </output>
    <output name="covariance x z" > y
                                           covariance | z </output>
   <!-- we are going to add the sensitivity here-->
  </File>
</PostProcessor>
</Models>
```



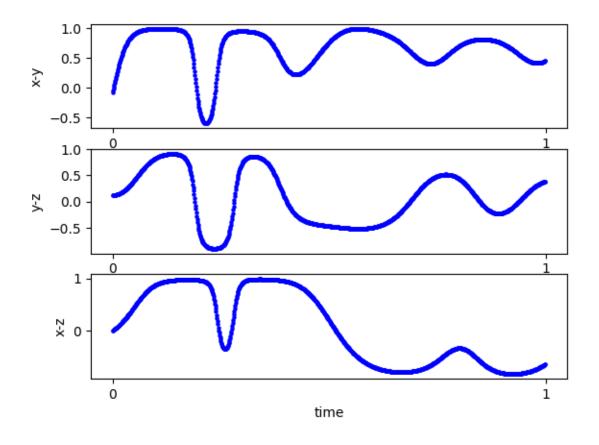
| | Distributions | s Models | Samplers | ; | Databases | DataObjects | Steps | | |
|--|---|---|-----------|--------------------------|--------------|---|---------|--|--|
| | | | | | | | | | |
| | <steps></steps> | | | | | | | | |
| | | me="FirstMRun"> | , ,, | <i>!!</i> | | - ' - ' - ' - ' - ' - ' - ' - ' - ' - ' | 7.1/- | | |
| | <pre><input <="" class="DataObjects" pre=""/></pre> | | | type="PointSet" | | >inputPlaceHolder | | | |
| | | class="Models" | | type="ExternalModel" | | >PythonModule | | | |
| | - | - | | | nteCarlo" | >MC_external | | | |
| | <pre><0utput class="DataObjects"</pre> | | | "HistorySet" >HistorySet | | | Output> | | |
| | | | | | | | | | |
| | <postprocess name="timeDepBasicStatPP"></postprocess> | | | | | | | | |
| | <pre><input <="" class="DataObjects" pre=""/></pre> | | ts" type= | type="HistorySet" | | >HistorySet | | | |
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| | <output< td=""><td colspan="2"><output <="" class="Files" td=""><td colspan="2">type=""</td><td colspan="2">>output_TD_BS.csv</td></output></td></output<> | <output <="" class="Files" td=""><td colspan="2">type=""</td><td colspan="2">>output_TD_BS.csv</td></output> | | type="" | | >output_TD_BS.csv | | | |
| | <output< td=""><td colspan="2"><output <="" class="Files" td=""><td colspan="2">type=""</td><td>>output_TD_BS</td><th>.xml</th></output></td></output<> | <output <="" class="Files" td=""><td colspan="2">type=""</td><td>>output_TD_BS</td><th>.xml</th></output> | | type="" | | >output_TD_BS | .xml | | |
| | <output< td=""><td colspan="2"><pre><output <="" class="DataObjects" pre=""></output></pre></td><td colspan="2">type="HistorySet"</td><td colspan="2">>HistorySet</td></output<> | <pre><output <="" class="DataObjects" pre=""></output></pre> | | type="HistorySet" | | >HistorySet | | | |
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| | <postprocess< td=""><td>name="readStats</td><td>"></td><td></td><td></td><td></td><th></th></postprocess<> | name="readStats | "> | | | | | | |
| | <input< td=""><td>class="Files"</td><td>type=</td><td>11 11</td><td></td><td>>output_TD_BS</td><th>.xml</th></input<> | class="Files" | type= | 11 11 | | >output_TD_BS | .xml | | |
| | <input< td=""><td>class="DataObjec</td><td>ts" type=</td><td>"His</td><td>storySet"</td><td>>HistorySet<!--</td--><th>Input></th></td></input<> | class="DataObjec | ts" type= | "His | storySet" | >HistorySet </td <th>Input></th> | Input> | | |
| | <model (<="" td=""><td>class="Models"</td><td>type=</td><td>"Pos</td><td>stProcessor"</td><td>>readStats<th>odel></th></td></model> | class="Models" | type= | "Pos | stProcessor" | >readStats <th>odel></th> | odel> | | |
| | <output< td=""><td colspan="2"><pre><output <="" class="DataObjects" pre=""></output></pre></td><td colspan="2">type="PointSet"</td><td colspan="2">>stats<!--0utput--></td></output<> | <pre><output <="" class="DataObjects" pre=""></output></pre> | | type="PointSet" | | >stats 0utput | | | |
| | <output< td=""><td>class="OutStream</td><td>s" type=</td><td colspan="2">type="Plot"</td><td colspan="2">>Plotdata</td></output<> | class="OutStream | s" type= | type="Plot" | | >Plotdata | | | |
| | <output< td=""><td colspan="2"></td><td colspan="2">cype="Plot"</td><td colspan="2">>PlotRawdata</td></output<> | | | cype="Plot" | | >PlotRawdata | | | |
| | | | | | | | | | |

Input file name: time_dep_relational.xml

</Steps>

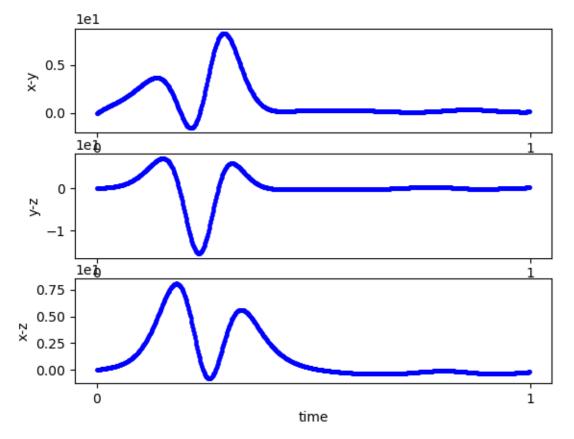


Pearson





Covariance





Questions?