Neurosolver-Based Brain
The rat with a Neurosolver based brain was demonstrated to navigate T-mazes.
Under certain circumstances, rats face a prediction problem which direction yields a better chance of getting food.
When generalized, this capability can be used for forecasting.

Cortical Hyper-Column
- Maps of the body parts and the corresponding world are created with hyper-columns
- Discovered by Y. Capel (World Price, 1906), Somatotopic, Radial
  Wusal (World Price, 906)
- Artificial Hyper-columns and as Neurosolver, Bieszczad, 1996

Neuromorphic Forecaster
- Created a network which will support the prediction process.
- For each state, we will have a number of connections associated probabilities.
- This will allow the prediction process to determine the most likely state to follow from any given starting point.

Processing Data Sets
Learning case 1: Strengthen existing connection between existing states.
Learning case 2: New state and new connection added to network.
Learning case 3: New connection added between two existing nodes.

Probabilistic learning
- Probabilities are used to determine the strength of the connection between two nodes.
- Two probabilities:
  - \( P_w \): Probability the node will fire from an incoming connection.
  - \( P_t \): Probability the target node will fire from an incoming connection.

Gradient Ascent Learning
- Counts the number of state transitions between two nodes.
- Each state transition strengthens the connection between two nodes.
- Hill Climbing Search Algorithm
  - Finds the local maximum - The node with the strongest connection
  - Nodes with strongest connection is the one that fires next.

Simple Clustering Algorithm for 1-D
1. Declare the number of clusters to be made.
2. Divide the range in two, and count the number of points in each half.
3. Allocate clusters accordingly to the data density in the given range.
4. Recursively call steps 2 and 3, with the allocation number as our new number of clusters.
5. Stop when the number of clusters is equal to 1.

Clustering Example
- Starting with the following set:

<table>
<thead>
<tr>
<th>Neurons</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1, 1, 2, 2, 3, 3, 3, 4, 6, 7, 8, 8, 9, 9, 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1, 1, 2, 2, 3, 3, 3, 4, 6, 7, 8, 8, 9, 9, 10, 10000, 10000, 10002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1, 1, 2, 2, 3, 3, 3, 4, 6, 7, 8, 8, 9, 9, 10, 10000, 10000, 10002, 50000, 55000</td>
<td></td>
</tr>
</tbody>
</table>

Problem Statement
- NNs is a series of forecasting contexts.
  - NNs were held in 2008
  - Long term ATM usage patterns provided as data set to NNs contexts
  - A number of learning set
  - Corresponding number of test sets
- Learning sets used to train forecasting systems.
- Trained systems tested with the test sets.
- Learning sets used to train forecasting systems.

Error (SMAPE) used as a measure
- Symmetric Mean Absolute Percent Error (SMAPE) used as a measure of the quality of forecasting.

Gradients Ascent Learning
- Gradient Ascent Learning
  - Hill Climbing Search Algorithm
  - Counts the number of state transitions between two nodes.

Results: Clustering

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Error Distribution from NN5</th>
<th>Error Distribution from Probabilistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>NN5</td>
<td>913.405457</td>
<td>254.011766</td>
</tr>
<tr>
<td>Gradient Ascent</td>
<td>Not Clustered</td>
<td>254.011766</td>
</tr>
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Results: Summary

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Educational Benefits
- Many lessons learned
  - How to conduct research
  - Collaborate within a research group
  - The value of biological inspirations for computation
  - Foundations of data mining
  - Collect, analyze, and present results of research

Educational Benefits
- We did quite well in comparison with the NN5 contest.
- In the future, we will try to increase the degree above 2.
- Have to balance the gains with speed deterioration.

Conclusions
- We did quite well in comparison with the NN5 contest.
- We will submit reports to select scientific gatherings.
- Incomplete data a problem
- Cycles difficult to simulate
- Adding higher-degree connections helps
- In the future, we will try to increase the degree above 2.
- Have to balance the gains with speed deterioration.