4-18-2012

Artificial Neural Networks and Their Use in Process Monitoring and Diagnosis of an Industrial Injection Molding Process

Follow this and additional works at: https://ecommons.udayton.edu/stander_posters

Recommended Citation

"Artificial Neural Networks and Their Use in Process Monitoring and Diagnosis of an Industrial Injection Molding Process" (2012). Stander Symposium Posters. 73.
https://ecommons.udayton.edu/stander_posters/73
Artificial Neural Networks and Their Use in Process Monitoring and Diagnosis of an Industrial Injection Molding Process

Rebecca L. Greider
Advisor Michael Elsasser, PhD
Chemical Engineering
April 2012

ANNs in Injection Molding
• Midwest Molding, Inc., provided annotated process data
• Five variables of importance
  • Fill time
  • Charge time
  • Cycle time
  • Actual cushion
  • Max injection pressure
• All variables related to production with unknown connection weights

EasyNN-Plus Software
• Software used to create artificial neural networks to analyze data
• Potentially predict when a malfunction is imminent
• Import actual process data into software to train network
• Additional data imported to test efficiency of network
• Training method used by software is back-propagation

Results

### Basic Networks

<table>
<thead>
<tr>
<th>Artificial Neural Network Type</th>
<th>Number of Nodes</th>
<th>% Accurate</th>
<th>True Positives</th>
<th>True Negatives</th>
<th>False Positives</th>
<th>False Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Data 1</td>
<td>5</td>
<td>86.0</td>
<td>239</td>
<td>7</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Original Data 2</td>
<td>5</td>
<td>99.0</td>
<td>279</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Original Data 3</td>
<td>5</td>
<td>91.3</td>
<td>254</td>
<td>7</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Pattern One 1</td>
<td>10</td>
<td>100.0</td>
<td>136</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pattern One 2</td>
<td>10</td>
<td>100.0</td>
<td>136</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Two</td>
<td>15</td>
<td>100.0</td>
<td>88</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 1</td>
<td>20</td>
<td>91.5</td>
<td>64</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 2</td>
<td>20</td>
<td>91.5</td>
<td>64</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 3</td>
<td>20</td>
<td>95.8</td>
<td>64</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 4</td>
<td>20</td>
<td>95.8</td>
<td>64</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 5</td>
<td>20</td>
<td>95.8</td>
<td>64</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Three 6</td>
<td>20</td>
<td>94.4</td>
<td>64</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

### Prediction Networks

<table>
<thead>
<tr>
<th>Artificial Neural Network Type</th>
<th>Number of Nodes</th>
<th>% Accurate</th>
<th>True Positives</th>
<th>True Negatives</th>
<th>False Positives</th>
<th>False Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern Four 1</td>
<td>15</td>
<td>49.3</td>
<td>31</td>
<td>4</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>Pattern Four 2</td>
<td>15</td>
<td>95.1</td>
<td>64</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Four 3</td>
<td>15</td>
<td>95.1</td>
<td>64</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Pattern Four 4</td>
<td>15</td>
<td>95.1</td>
<td>64</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

Injection Molding
• Industrial process using molten thermoplastic material
• Used to produce plastic parts in many fields
• Screw-type ram forces plastic through heated cylinder into mold cavity
• Plastic cools and hardens into shape of cavity
• Part is ejected from machine and process begins again

Process Monitoring and Diagnosis
• Use recorded process variables to determine if process is behaving normally or abnormally
• Artificial neural networks can analyze an event and predict the probability of a similar one happening again
• ANN can find connections between seemingly unrelated variables
• ANN used for fault diagnosis by storing data of past faults
  • Used because of size and complexity of process data to be captured and stored
  • No explanation capabilities

Structure of ANNs
• Synthetic neurons connected by series of weights, one weight per connection between neurons
• Weights and input signal combine with activation function in node to produce output signal
• Weights adapted to achieve desired output signal
• Signal connections can go through hidden layers to increase efficiency of network

What is an ANN?
• Modeled after biological neural networks found in human brain
• Advanced modeling tools that learn while operating and adapt
• Model complex relationships between input and output data or find patterns in data
• Simultaneously infer function being used on data and implement it on next data set

Additional data imported to test accuracy.