Understanding Rapid Cycling Temperature Logs from the Vulcan Diffractometer
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Introduction
The Spallation Neutron Source (SNS) facility at the Oak Ridge National Laboratory is designed
to generate high-intensity neutron pulses for the study of materials. In recent years, time-resolved
neutron experiments are enabling a broad set of new experiments at the SNS [1]. Often an
external parameter such as temperature is varied as a function of time over the course of a
measurement and then the datasets are sliced up according to that parameter. Using the external
parameter to define the times at which the data is sliced allows the slicing to occur close to the
experiment.

Dataset
The dataset provided is a sample environment log of temperature vs. acquisition time for a
measurement on the Vulcan [2] beamline. The overall purpose of the neutron measurement is to
understand the changes in structure of the material as a function of temperature. To do such a
measurement, the sample is rapidly heated, and then the heat source is turned off so the sample
temperature can relax. After the sample reaches equilibrium, it is rapidly heated again. The
neutron events are acquired over the whole experiment, but we want to associate these events
within a certain temperature bin upon cooling. Furthermore, the data will be time sliced, and then
events of equivalent temperature will be combined. To that end, we need to understand the time
of each temperature bin that we want to combine. This data challenge involves working with this
temperature vs. time data [3] to arrive at information that would later be used for event
processing.

<table>
<thead>
<tr>
<th>File name</th>
<th>Description</th>
<th>Size</th>
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</thead>
<tbody>
<tr>
<td>furnace2c.csv</td>
<td>Columns: (log of temperature, measured value)</td>
<td>1.2 MB</td>
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</table>

Questions/Challenges:
1. Identify the number of heat cycles.
2. Identify the time at which each heat starts (and the previous one stops).
   
   Note: Heat cycles with different heights are included in the dataset. We may decide to
   work with heat cycles of the same height.
3. Provide a function that will find the number of cycles of each height, within a given
   uncertainty.
4. Extend the function to provide the start and stop time for each heat cycle with a given
   height.
5. Provide a function that, for a given height of heat cycle and a temperature step size, will
give a list of times for each temperature that would be used for combining.
   
   Note: We would be interested in some diagnostics to alert the researcher if the dataset
   shows that heat pulses expected to be identical are not.
6. Provide a function that indicates how each identical heat cycle of a given function would
   be helpful for answering the Data Challenge.
7. Devise a function that provides a visualization of the variation from one cycle to the next.
Our preference is for algorithms to be implemented in Python with the use of Numpy or other widely available libraries, although other libraries are welcome.

References: