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Performance Monitoring using Pecos

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Overview

- What is Pecos?
 - Performance monitoring for time series data
- Why use Pecos?
 - Collect large amounts of data on multiple systems and locations
 - Run automatic quality control tests on that data
 - Alert system operators when the system has changed
 - Generate reports
 - Collect performance statistics to track long term system health
 - Compare system performance across sites
- Pecos was developed specifically for solar photovoltaic system monitoring, but it can be customized for other applications

TOA5	CR1000	46385	CR1000.Std.24	CPU:ABQ_RTC_M ET_2013_03_21.C R1	58869	DataOut
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3/26/2013 0:04	-1.14918	-0.45458	0	832.0799	6.825	136.8
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3/26/2013 0:14	-1.14921	-0.28791	0	832.0098	7	137.1
3/26/2013 0:15	-1.14921	-0.45459	0	832.0153	6.738	138.6
3/26/2013 0:16	-1.1492	-0.45459	0	831.9963	6.613	141.1
3/26/2013 0:17	-1.1492	-0.60612	0	832.0099	6.125	139.8
3/26/2013 0:18	-1.1492	-0.84099	0	832.0046	6.113	139.9



Software Framework

- Open-source python package
 - Revised BSD License
- Software repository
 - https://github.com/sandialabs/pecos
- Documentation
 - <u>http://pecos.readthedocs.io</u>
 - Includes API documentation
- Software testing results
 - https://travis-ci.org/sandialabs/pecos
 - https://coveralls.io/github/sandialabs/pecos
- 'Getting started' examples included with the software
 - simple
 - pv
 - metrics
 - dashboard







O Edit on GitHub

Performance Monitoring using Pecos

Advances in sensor technology have rapidly increased our ability to monitor natural and human-made physical systems. In many cases, it is critical to process the resulting large volumes of data on a regular schedule and alert system operators when the system has changed. Automated quality control and performance monitoring can allow system operators to quickly detect performance issues.

Pecos is an open source python package designed to address this need. Pecos includes builtin functionality to monitor performance of time series data. The software can be used to automatically run a series of quality control tests and generate customized reports which include performance metrics, test results, and graphics. The software was developed specifically for solar photovoltaic system monitoring, but it can be customized for other applications.

Citing Pecos

To cite Pecos, use the following reference:

 K.A. Klise and J.S. Stein (2016), Performance Monitoring using Pecos, Technical Report SAND2016-3583, Sandia National Laboratories.



Installation

- Required dependencies
 - Python 2.7
 - pandas
 - numpy
 - Matplotlib
- Optional dependencies
 - pvlib
 - pyyaml
 - win32com
 - nose

Building pecos from source

git clone https://github.com/sandialabs/pecos
cd pecos
python setup.py install

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Installing the latest release

pip install pecos

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Directories

- · pecos python package
- documentation user manual
- examples examples

Contact

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Basic Workflow





Basic Example



- simple_example.py
 - The data includes missing timestamps, duplicate timestamps, nonmonotonic timestamps, corrupt data, data out of expected range, data that doesn't change, and data that changes abruptly.
 - A = elapsed time in days
 - B = uniform random number between 0 and 1
 - C = sin(10*A)
 - D = C+(B-0.5)/2



PV Workflow





PV Examples

- pv_example.py
 - YAML configuration file
 - Electrical and weather data
 - Time filter based on sun position
 - pvlib performance model and metric
- metrics_example.py
 - Track long term system health
 - Performance metrics from daily analysis



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Dashboard Example

- dashboard_example.py
 - Compare performance of several systems
 - Generic dashboard
 - Includes text, graphics, table and link



Pecos Dashboard



This report was generated by Pecos 0.1.1, 05/02/2016

Dashboard Example



Pecos Dashboard for 2016-03-28



Future Development



- Tighter integration with IEC 61724
 - Photovoltaic system performance monitoring Guidelines for measurement, data exchange and analysis
 - Four types of filters
 - Range, missing data, dead value , abrupt change
 - Example quality control tests
 - Power sensor is out of range if the value < -0.01*rating or > 1.02*rating
 - Irradiance sensor is dead if the derivative < 0.0001 W/m2 while value > 5 W/m2 (15 minute data)
 - Temperature sensor is erratic if the derivative > 4 C (15 minute data)
 - Bounds depend on precision requirements (Class A,B,C) and calibration accuracy
 - Data binned into times when inverters are on and off line
 - Integrated performance model and performance metrics
- Community input