An INFSCI 2711 Lab

by

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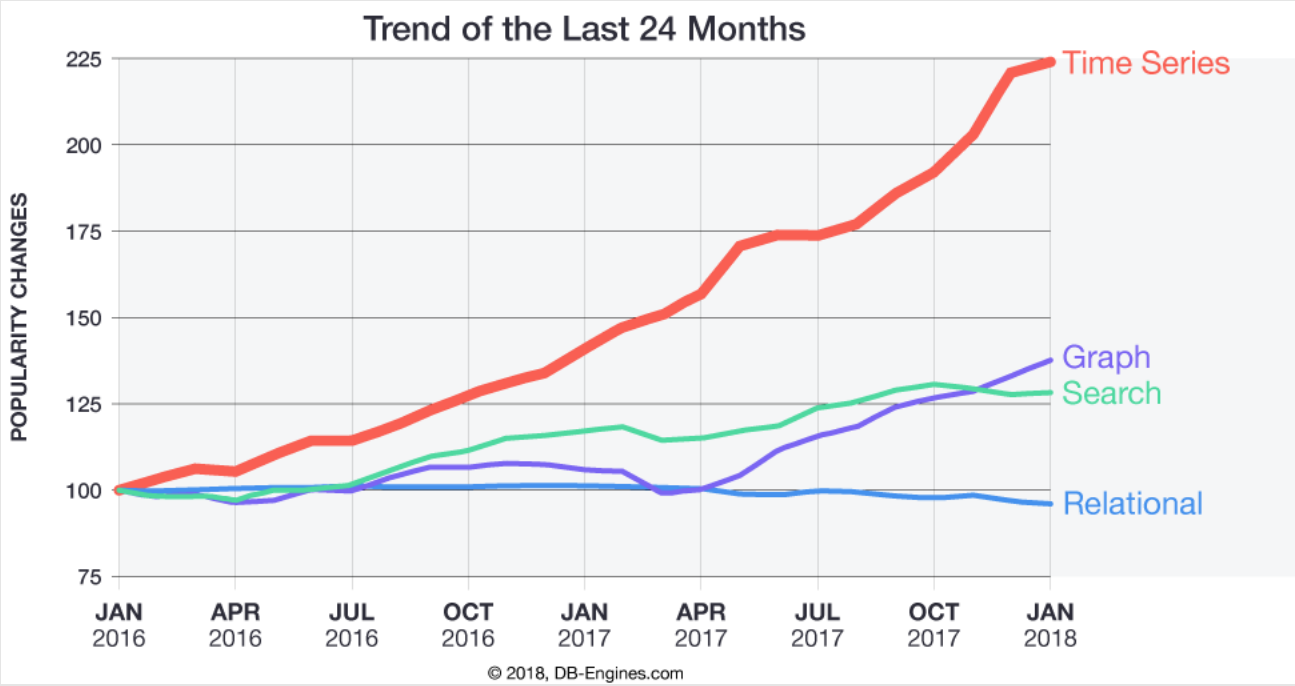
InfluxDB

A State of the Art Time Series Database

Outline

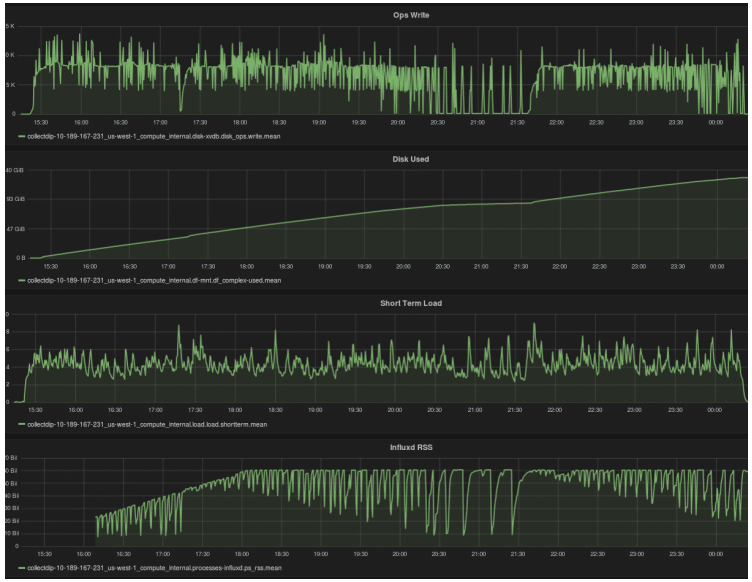
- Intro to Time Series Database
- Intro to InfluxDB
- Installation
- Basic Operations
- Data Analysis with Grafana

Trending in the Database Industry



Time Series Database (TSDB)

- A database optimized for time-stamped or time series data
  - Server metrics
  - Financial data
  - Weather data
  - Industrial machine data
  - Auto-piloting cars

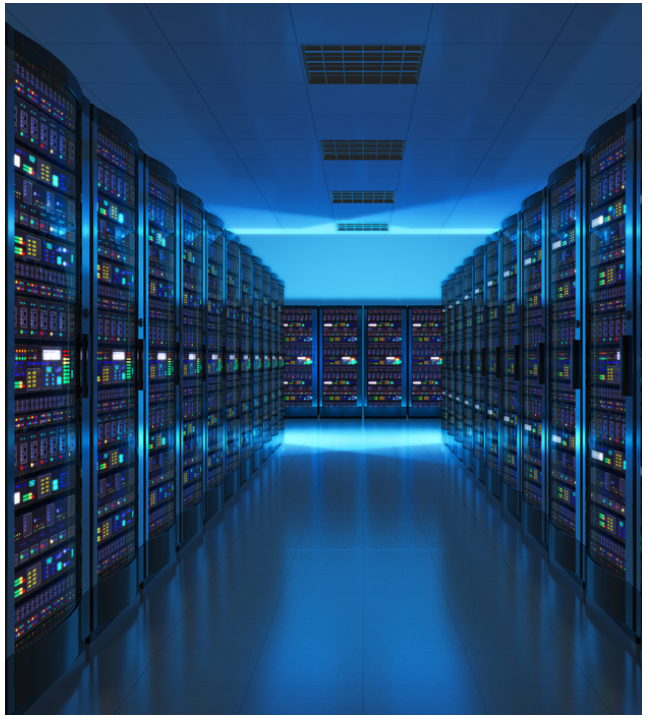


Why TSDB?

- Relational databases are originally designed for OLTP (e.g. bank transactions)
- Strong and useful features of RDBMS
  - Secondary index support
  - Rich query language
  - Multi-table JOINs
- The problems of RDBMS
  - **SCALING**
  - **PERFORMANCE**

Why TSDB?

- Time-series data accumulates very quickly
  - A auto-piloting car collects 25GB of data per hour
  - A 10,000 machine datacenter easily generates 1,000,000,000 system status data points per day



RDBMS vs. TSDB

- **OLTP Writes**
  - Primarily UPDATES
  - Randomly distributed (over the set of primary keys)
  - Often transactions across multiple primary keys

- **Time-series Writes**
  - Primarily INSERTs
  - Primarily to a recent time interval
  - Primarily associated with both a timestamp and a separate primary key (e.g., server ID, device ID, security/account ID, vehicle/asset ID, etc.)

Popular TSDBs

- **InfluxDB**
  - Written in Go
- **OpenTSDB**
  - Built on top of HBase
- **KDB+**
  - Column-based relational TSDB with in-memory capabilities
- **Graphite**
  - Data logging and graphing tool for time series data, numeric data only

Why InfluxDB

- **Most popular Time-series database**

Rank Mar 2018	Rank Feb 2018	Rank Mar 2017	DBMS
1.	1.	1.	InfluxDB
2.	2.	↑ 5.	Kdb+
3.	3.	↓ 2.	RRDtool
4.	4.	↓ 3.	Graphite
5.	5.	↓ 4.	OpenTSDB
6.	↑ 7.	↑ 7.	Prometheus
7.	↓ 6.	↓ 6.	Druid
8.	8.	8.	KairosDB
9.	9.	9.	eXtremeDB
10.	10.	↑ 12.	Riak TS

- **Widely deployed in the industry**
  - https://www.influxdata.com/customers/testimonials/
- **Excellent performance**
  - Top 3 in all categories
  - Write performance
  - Query speed
  - Data compression (Storage)
- **Easiness of use**
  - SQL like queries
  - Best functionality
- **Best Overall Score**

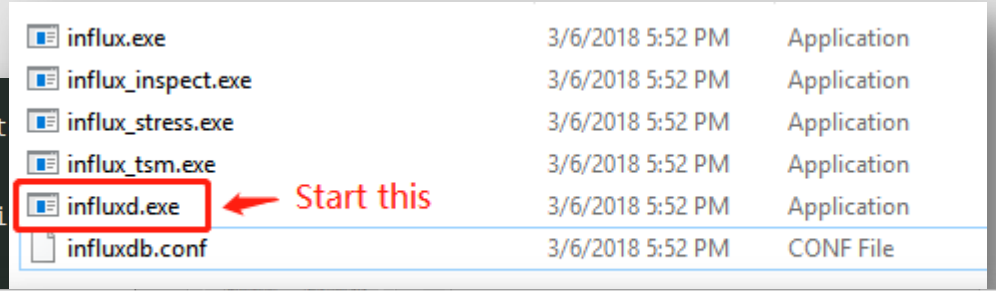
Installation & Starting InfluxDB

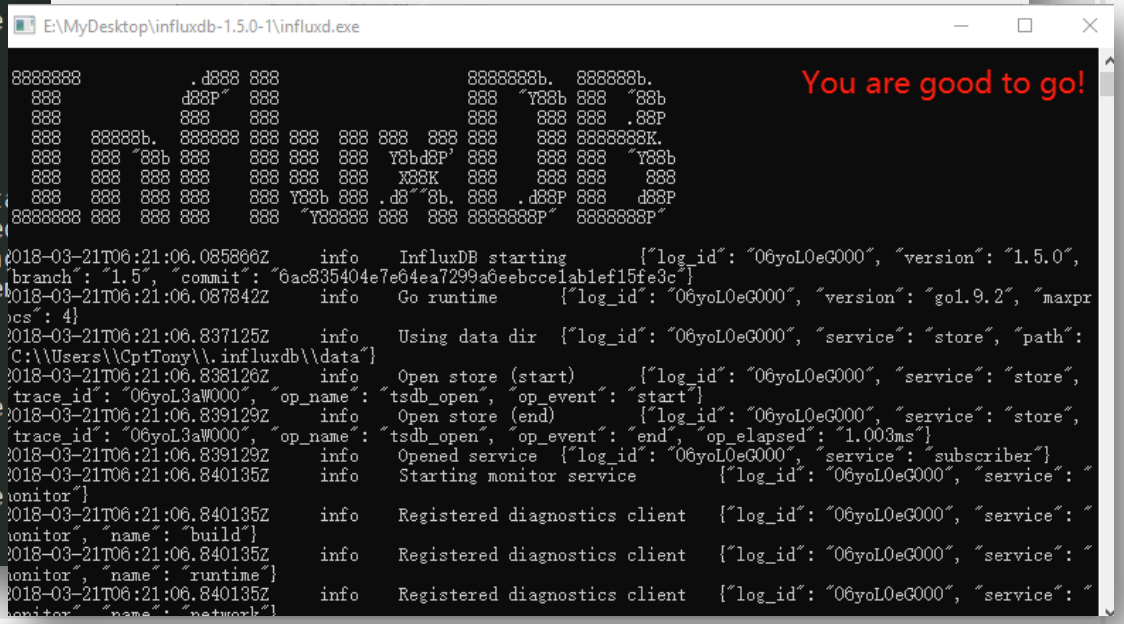
- Mac OS
  - Install Homebrew (if you don't already have it)
    - /usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
  - Update Homebrew repo and install InfluxDB
    - brew update
    - brew install influxdb
- Windows
  - Download and unzip the package from
    - https://dl.influxdata.com/influxdb/releases/influxdb-1.5.0_windows_amd64.zip
- Getting Started
  - From terminal / cmd, start the service with
    - influxd
  - Open another window and connect to the shell with
    - influx -precision rfc3339

Install on Windows OS

- Unzip ‘influxdb-1.5.0_windows_amd64.zip’
- Change ‘influxdb.conf’ if you would like to (e.g. Database location)
- Start ‘influxd.exe’

```
[meta]
  # Where the metadata/raft database is st
  dir = "/var/lib/influxdb/meta"

  # Automatically create a default retenti
  # retention-autocreate = true

  # If log messages are printed for the
  # logging-enabled = true

###
### [data]
###
### Controls where the actual shard dat
### flushed from the WAL. "dir" may nee
### for your system, but the WAL settin
### defaults should work for most syste
###

[data]
  # The directory where the TSM storage
  dir = "/var/lib/influxdb/data"

  # The directory where the TSM storage
  wal-dir = "/var/lib/influxdb/wal"
```



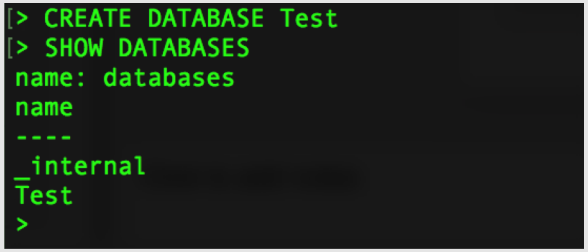


Basic Terminologies of InfluxDB

MySQL	InfluxDB
database	database
table	measurement
row	point / series
index	tag (string)
column	field (string | boolean | integer | float)

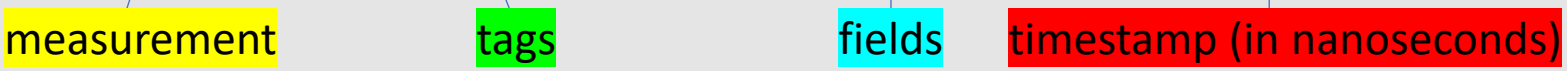
Basic Operations

- Creating a database
  - CREATE DATABASE Test
  - SHOW DATABASES
- Specifying a database for operations
  - USE Test
- InfluxDB has no strict schema, so there is no **CREATE MESUREMENT** statement



Data Insertion

- Insert data
  - INSERT server,region=us_east,host=server_A cpu=0.65,mem=2335
  - INSERT server,region=us_east,host=server_A cpu=0.53 1521028800000000000
  - INSERT server,region=us_east cpu=0.43,mem=3532 1521028800000000000
  - INSERT server,region=us_east,host=server_B cpu=0.33,mem=3323 1521028500000000000



- If no timestamp is specified, the current system time will be used.
- All the syntax (the commas and whitespaces indicating measurement, tags and fields) in the INSERT query should be strictly followed!

Data Insertion

```
> CREATE DATABASE Test
> USE Test
Using database Test
> INSERT server,region=us_east,host=server_A cpu=0.65,mem=2335
> INSERT server,region=us_east,host=server_A cpu=0.53 1521028800000000000
> INSERT server,region=us_east cpu=0.43,mem=3532 1521028800000000000
> INSERT server,region=us_east,host=server_B cpu=0.33,mem=3323 1521028500000000000
> SELECT * FROM server
name: server
time                           cpu  host     mem  region
----                           ---  ----     ---  ------
2018-03-14T11:55:00Z           0.33 server_B 3323 us_east
2018-03-14T12:00:00Z           0.43          3532 us_east
2018-03-14T12:00:00Z           0.53 server_A      us_east
2018-03-22T01:12:12.136057115Z 0.65 server_A 2335 us_east
>
```

Data Exploration

- Import sample data
  - The air quality measure of 5 Chinese cities from 2010 to 2015 (https://archive.ics.uci.edu/ml/datasets/PM2.5+Data+of+Five+Chinese+Cities)
  - Run the shell script provided in terminal: **sh import.sh**
- Data schema exploration
  - USE air
  - SHOW MEASUREMENTS
  - SHOW TAG KEYS
  - SHOW FIELD KEYS

```
> USE air
Using database air
>
> SHOW MEASUREMENTS
name: measurements
name
----
pm
>
> SHOW TAG KEYS
name: pm
tagKey
------
city
>
> SHOW FIELD KEYS
name: pm
fieldKey                fieldType
--------                ---------
cumulative_precipitation float
humidity                float
pm                      float
precipitation           float
pressure                float
temperature             float
wind_direction          string
wind_speed              float
>
```

Data Exploration

- Simple SELECT Queries
  - Select the first 5 records of Beijing
  - SELECT * FROM pm WHERE city = 'Beijing' LIMIT 5

```
> SELECT * FROM pm WHERE city='Beijing' LIMIT 5
name: pm
time                 city    cumulative_precipitation humidity pm precipitation pressure temperature wind_direction wind_speed
----                 ----    ------------------------ -------- -- ------------- -------- ----------- -------------- ----------
2009-12-31T16:00:00Z Beijing 0                        43       0  0             1021     -11         NW             1.79
2009-12-31T17:00:00Z Beijing 0                        47       0  0             1020     -12         NW             4.92
2009-12-31T18:00:00Z Beijing 0                        43       0  0             1019     -11         NW             6.71
2009-12-31T19:00:00Z Beijing 0                        55       0  0             1019     -14         NW             9.84
2009-12-31T20:00:00Z Beijing 0                        51       0  0             1018     -12         NW             12.97
>
```

  - Select all the records of Shanghai where PM2.5 exceeds 600
  - SELECT pm FROM pm WHERE city = 'Shanghai' AND pm > 600

```
> SELECT pm FROM pm WHERE city='Shanghai' AND pm>600
name: pm
time                 pm
----                 --
2011-12-31T07:00:00Z 730
2012-02-19T22:00:00Z 650
>
```

Data Exploration

- Simple SELECT Queries
  - Select the first 5 PM2.5 and humidity of Guangzhou starting from 01/01/2015
  - SELECT pm, humidity FROM pm WHERE city = 'Guangzhou' AND time >= '2015-01-01' LIMIT 5

```
> SELECT pm, humidity FROM pm WHERE city = 'Guangzhou' AND time >= '2015-01-01' LIMIT 5
name: pm
time                  pm                 humidity
----                  --                 --------
2015-01-01T00:00:00Z 51                 68
2015-01-01T01:00:00Z 48                 53
2015-01-01T02:00:00Z 49                 42
2015-01-01T03:00:00Z 45.666666666666664 32
2015-01-01T04:00:00Z 42.333333333333336 31
>
```

- **Important: Tag values and field string values** in WHERE clause should be wrapped by **SINGLE QUOTES**

Data Exploration

- OLAP queries
  - Return the mean and max of PM2.5 by each city from all time
  - SELECT max(pm), mean(pm) FROM pm GROUP BY city

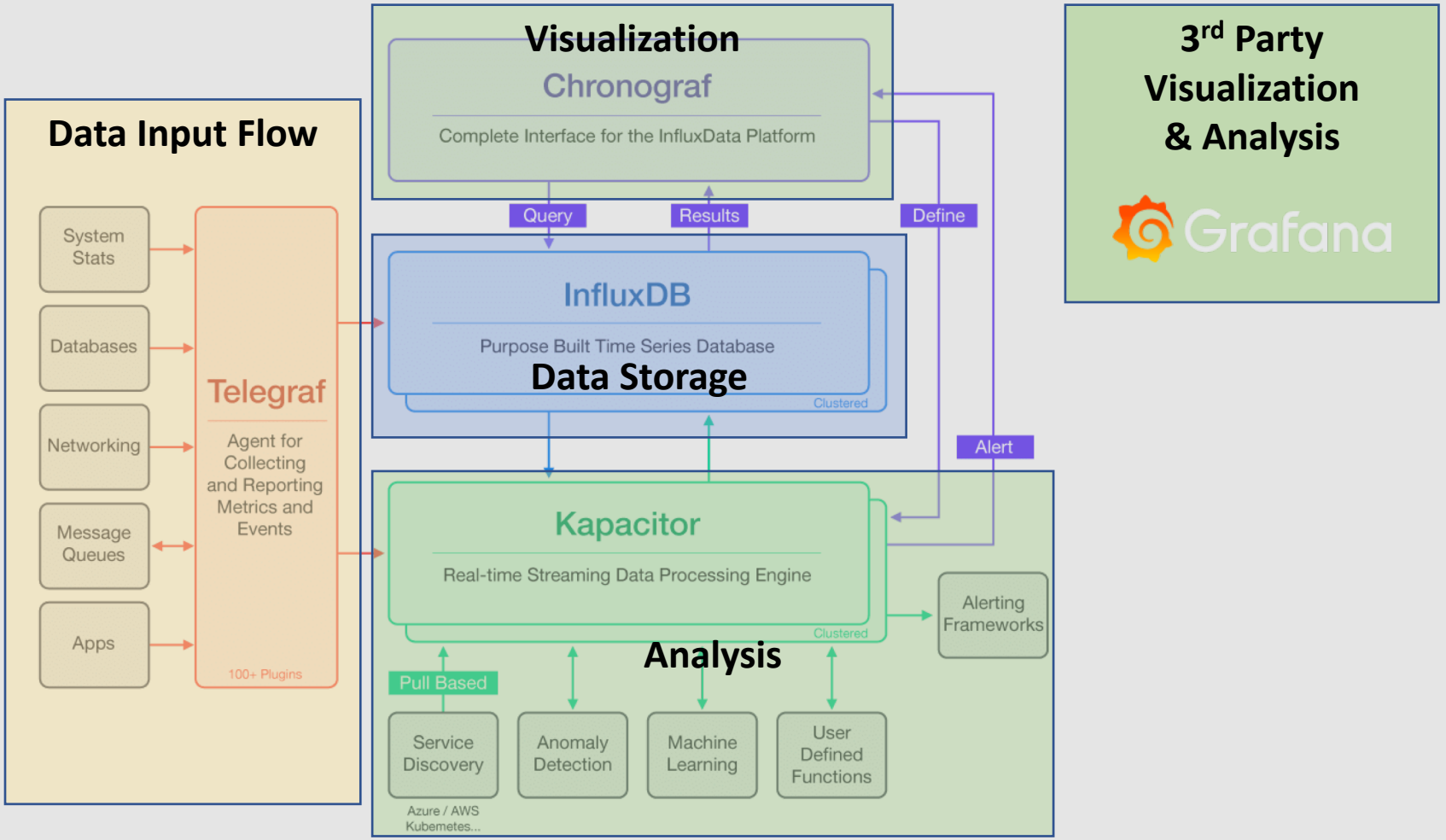
```
> SELECT max(pm), mean(pm) FROM pm GROUP BY city
name: pm
tags: city=Beijing
time                  max mean
----                  --- ----
1970-01-01T00:00:00Z 994 95.18355527059914

name: pm
tags: city=Chengdu
time                  max              mean
----                  ---              ----
1970-01-01T00:00:00Z 600.6666666666666 79.8612003584463

name: pm
tags: city=Guangzhou
time                  max mean
----                  --- ----
1970-01-01T00:00:00Z 387 51.13099411700067

name: pm
tags: city=Shanghai
time                  max mean
----                  --- ----
1970-01-01T00:00:00Z 730 54.838865737414494

name: pm
tags: city=Shenyang
time                  max               mean
----                  ---               ----
1970-01-01T00:00:00Z 1134.6666666666667 78.30155817397484
>
```

Data Exploration

- OLAP queries (GROUP BY time interval)
  - Return the mean of PM2.5 and precipitation in Beijing for every 2 weeks in the year of 2014
  - SELECT mean(pm), mean(precipitation) FROM pm WHERE time >= '2014-01-01' AND time < '2015-01-01' AND city='Beijing' GROUP BY time(7d)

```
> SELECT mean(pm), mean(precipitation) FROM pm WHERE time >= '2014-01-01'
 AND time < '2015-01-01' AND city='Beijing' GROUP BY time(7d)
name: pm
time                 mean               mean_1
----                 ----               ------
2013-12-26T00:00:00Z 82.625             0
2014-01-02T00:00:00Z 93.55357142857143  0
2014-01-09T00:00:00Z 124.92063492063492 0
2014-01-16T00:00:00Z 121.3640873015873  0
2014-01-23T00:00:00Z 95.90178571428572  0
2014-01-30T00:00:00Z 81.47321428571429  0
2014-02-06T00:00:00Z 79.21974206349208  0.03392857142857143
2014-02-13T00:00:00Z 196.41964285714286 0
2014-02-20T00:00:00Z 296.9831349206349  0.006547619047619048
2014-02-27T00:00:00Z 88.57837301587301  0
2014-03-06T00:00:00Z 90.47172619047619  0
2014-03-13T00:00:00Z 63.40029761904762  0
2014-03-20T00:00:00Z 158.99255952380952 0
2014-03-27T00:00:00Z 105.42063492063491 0.0035714285714285713
2014-04-03T00:00:00Z 80.67013888888889  0
```

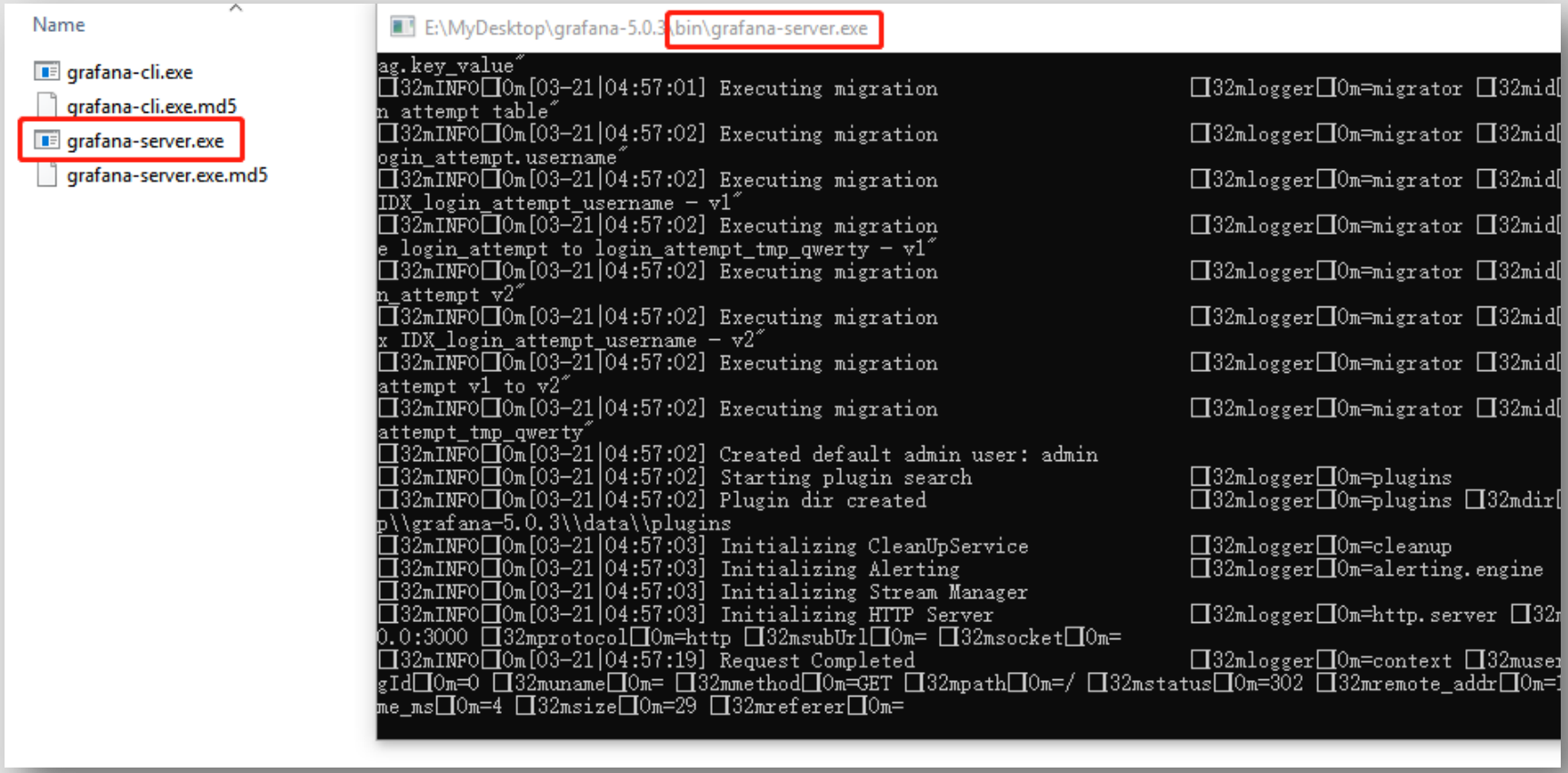
Influx Data **PLATFORM**

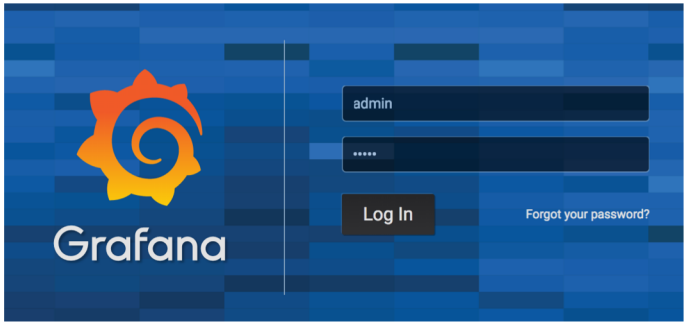


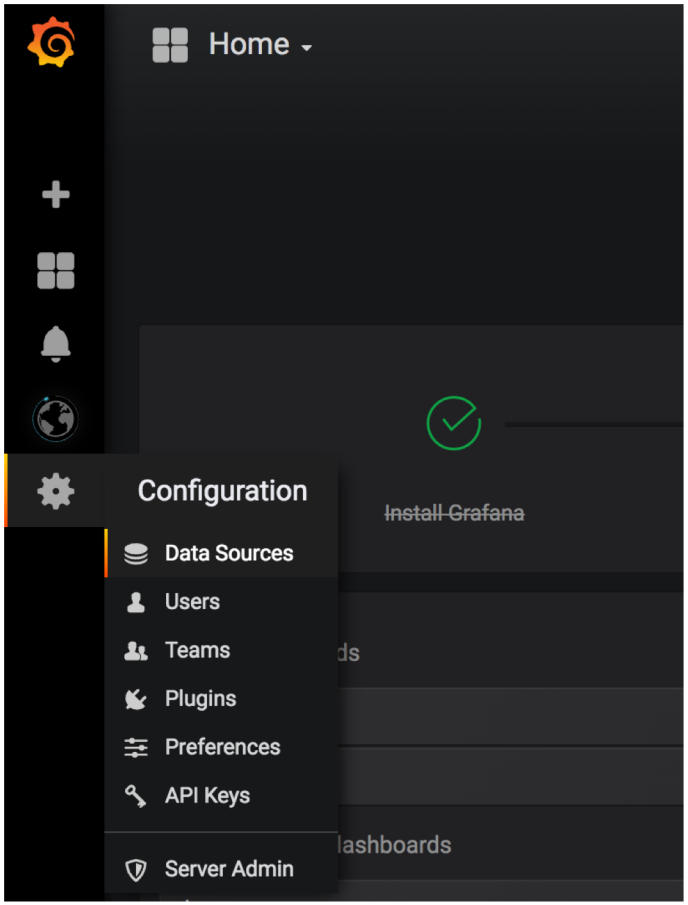
Grafana Installation

- Mac OS
  - Installation
    - brew update
    - brew install Grafana
  - Startup
    - brew services start Grafana
- Window
  - Download Package
    - http://docs.grafana.org/installation/windows/
  - Unzip & Run
    - bin/grafana-server.exe

Grafana on Windows

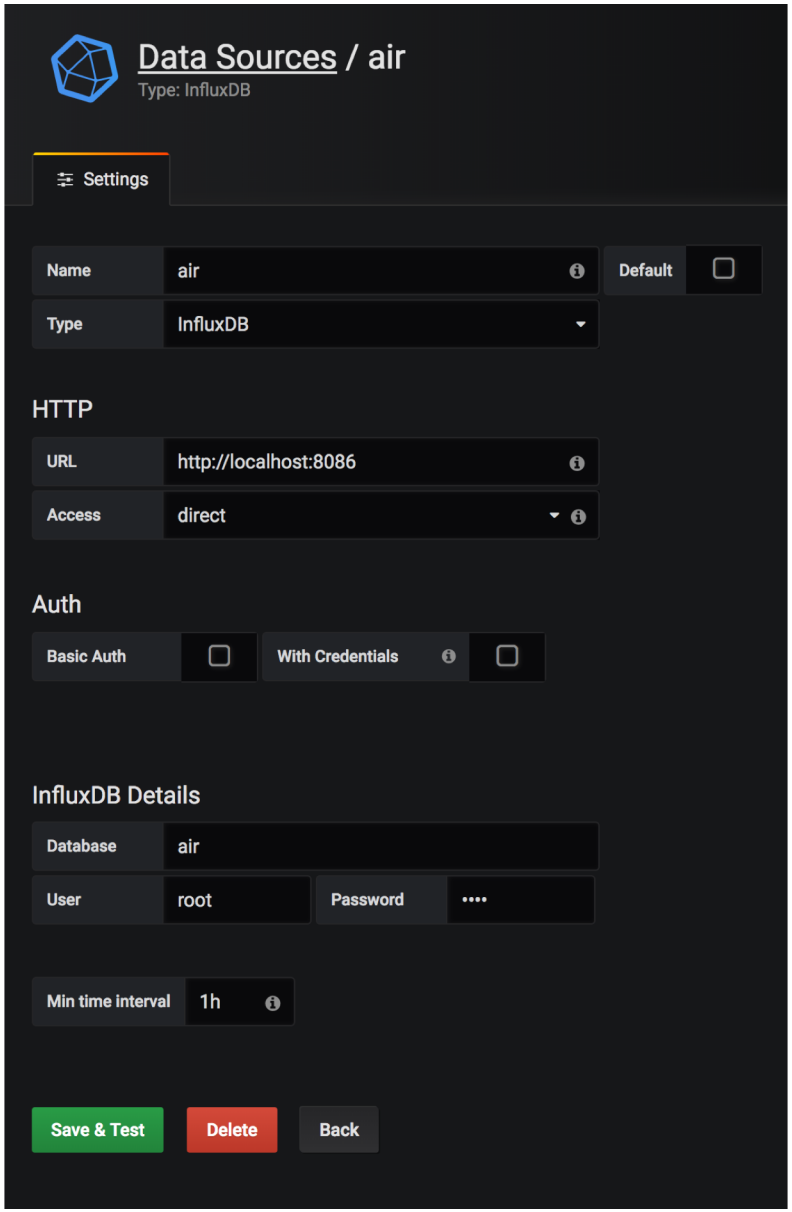






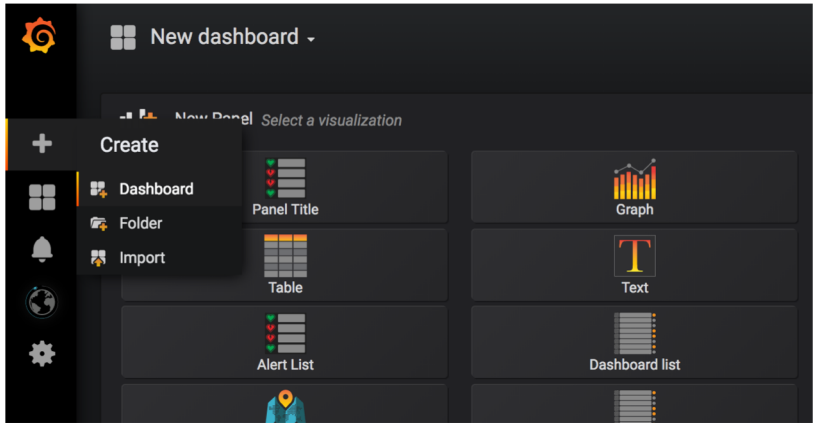
Visualize Data with Grafana

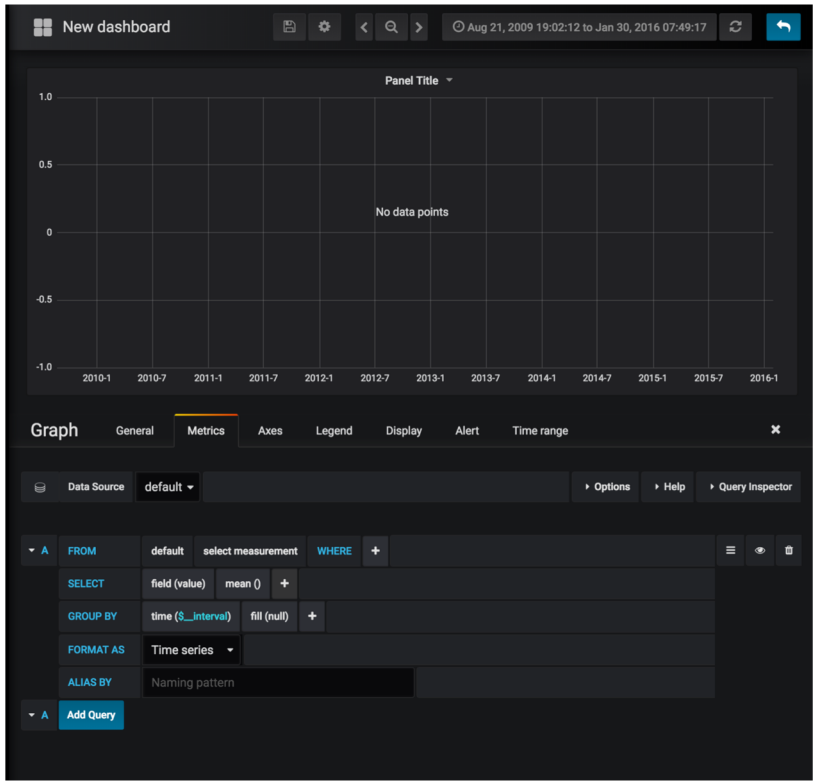
- Access the web interface
  - localhost:3000
  - Login with admin/admin



Visualize Data with Grafana

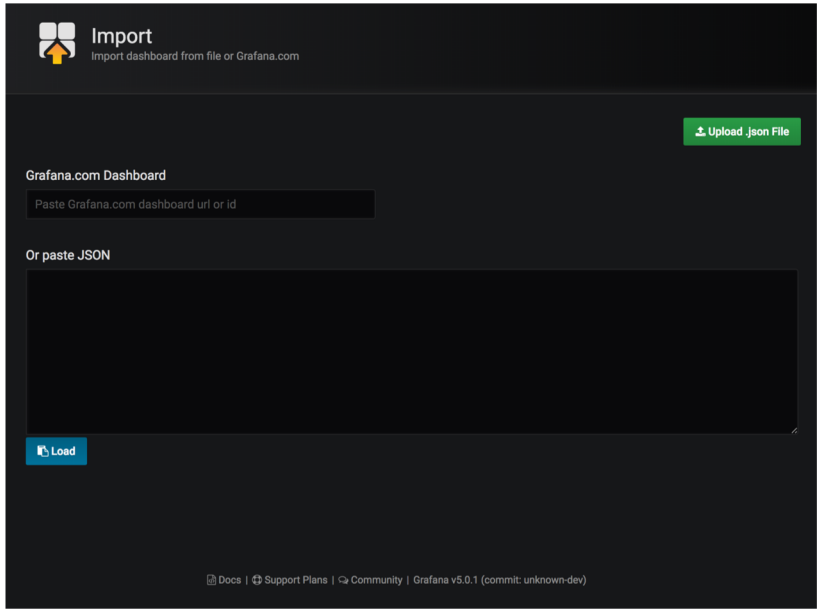
- Access the web interface
  - localhost:3000
  - Login with admin/admin
- Set up data source
  - User: root
  - Password: root
  - Database: air

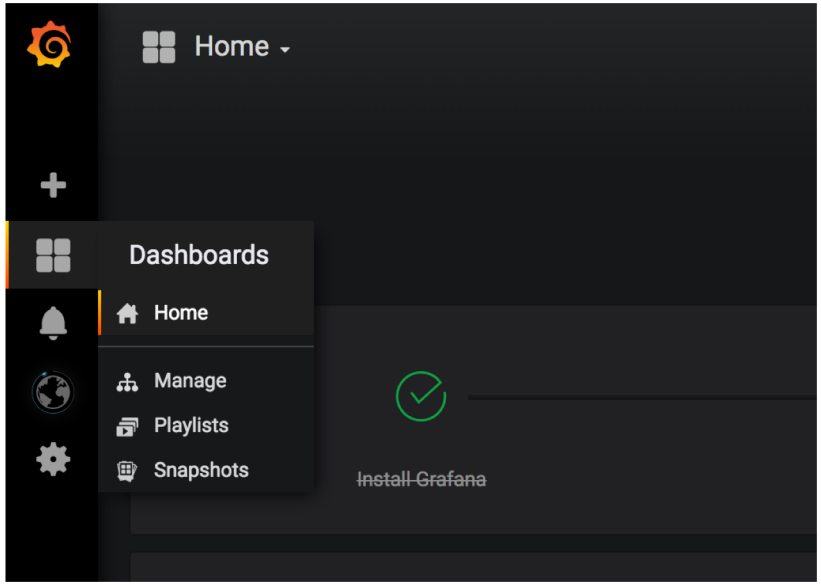




Visualize Data with Grafana

- Access the web interface
  - localhost:3000
  - Login with admin/admin
- Set up data source
  - User: root
  - Password: root
  - Database: air
- Create a new dashboard
  - Add a new graph panel
  - Start editing panel

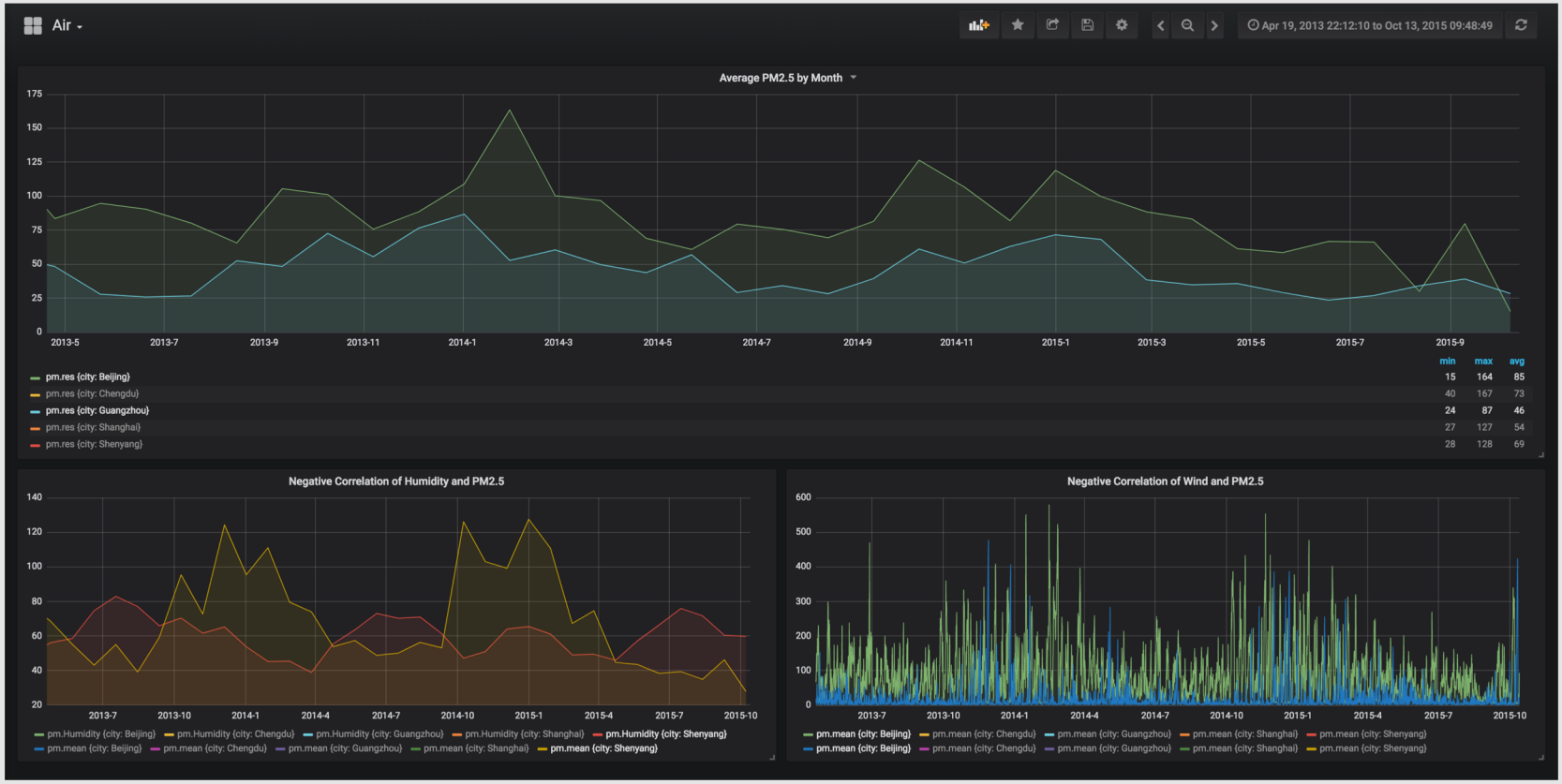




Visualize Data with Grafana

- Access the web interface
  - localhost:3000
  - Login with admin/admin
- Set up data source
  - User: root
  - Password: root
  - Database: air
- Create a new dashboard
  - Add a new graph panel
  - Start editing panel
- Import dashboard from a JSON file
  - Import air_dashboard.json

Visualize Data with Grafana



Advanced Functionality - Retention Policy (RP)

- Manages how long InfluxDB keeps the data on certain measurement.
- After data expires duration set in retention policy, InfluxDB automatically drops the data.
- Every time a database is created, InfluxDB generates a default RP called *autogen*, which has no duration time (data never dropped)
- Create a user defined RP
  - CREATE DATABASE realtime
  - USE realtime
  - CREATE RETENTION POLICY "one_hour" ON "realtime" DURATION 1h REPLICATION 1
  - SHOW RETENTION POLICIES

```
> CREATE DATABASE realtime
> USE realtime
Using database realtime
> CREATE RETENTION POLICY "one_hour" ON "realtime" DURATION 1h REPLICATION 1
> SHOW RETENTION POLICIES
name     duration shardGroupDuration replicaN default
----     -------- ------------------ -------- -------
autogen  0s       168h0m0s           1        true
one_hour 1h0m0s   1h0m0s             1        false
>
```

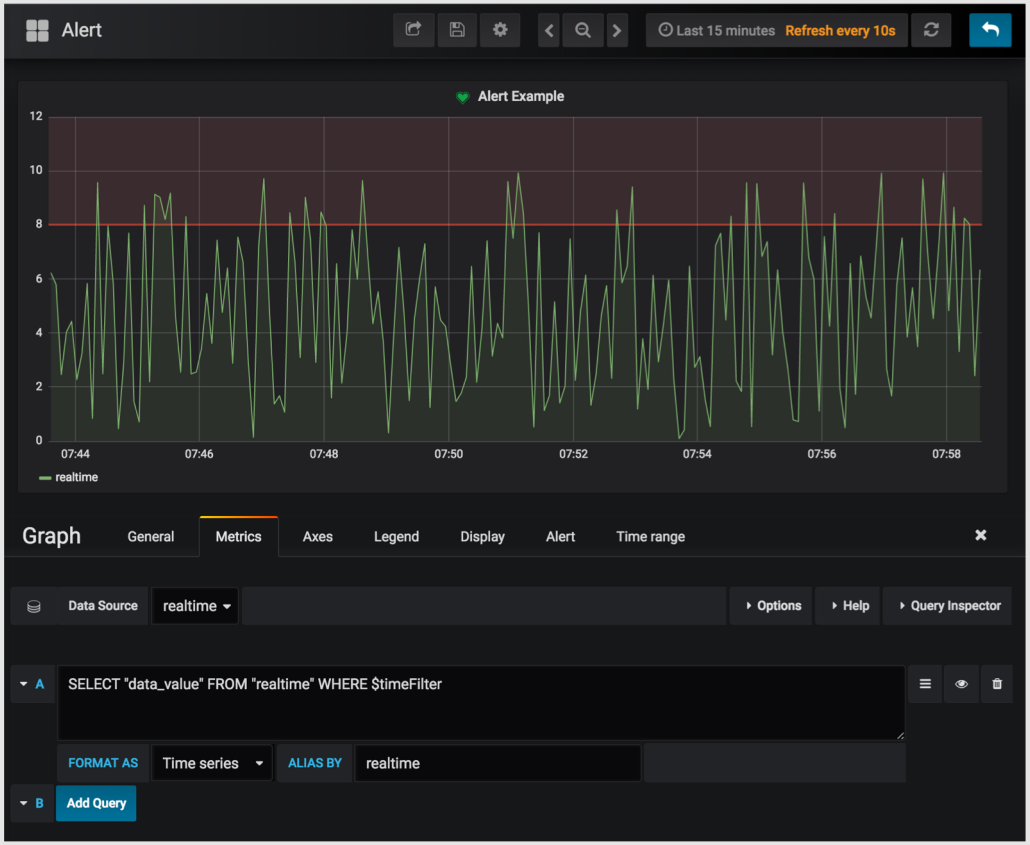
Advanced Functionality - Continuous Query (CQ)

- A query that runs automatically and periodically within a database.
- Normally used for automatically down sampling data.
- Continuous queries require a function in the SELECT clause and must include a GROUP BY time() clause.
- Create a CQ
  - CREATE CONTINUOUS QUERY "cq_one_min" ON "realtime" BEGIN SELECT mean(data_value) INTO realtime.autogen.realtime_mean FROM realtime.one_hour.realtime GROUP BY time(1m) END
  - SHOW CONTINUOUS QUERIES

```
CREATE CONTINUOUS QUERY "cq_one_min" ON "realtime"
BEGIN
    SELECT mean(data_value)
        INTO realtime.autogen.realtime_mean
        FROM realtime.one_hour.realtime
        GROUP BY time(1m)
END
```

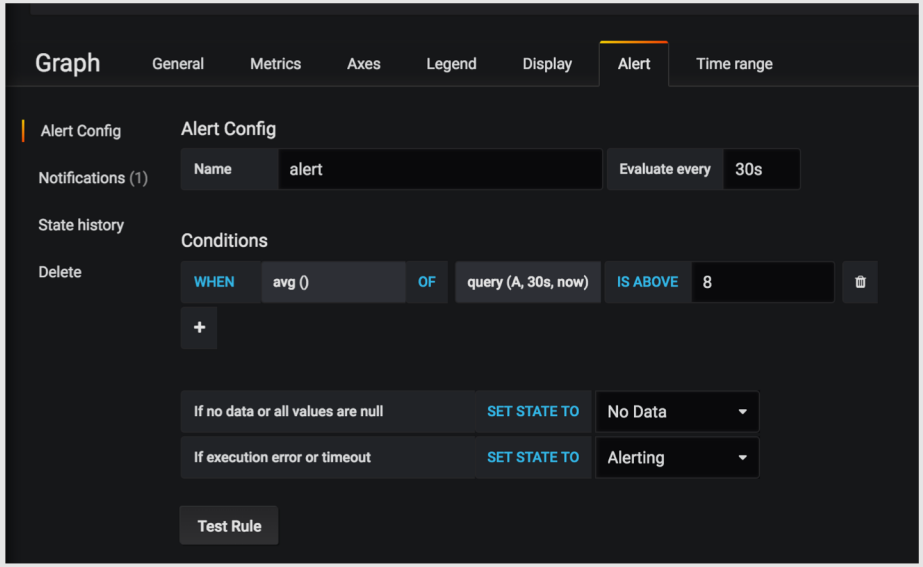
Monitor Realtime Data with Grafana

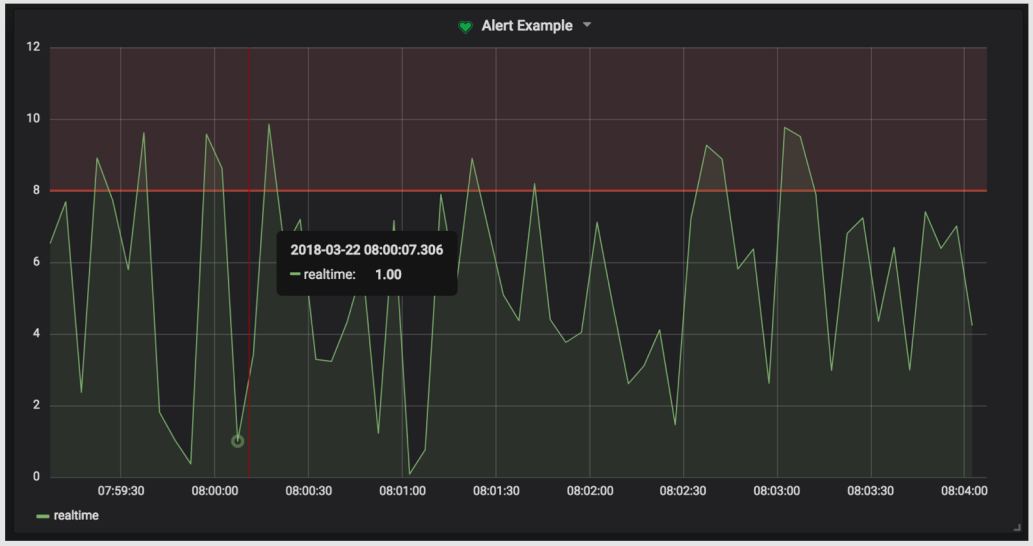
- Run realtime data insert script
  - pip install influxdb
  - python realtime.py
- Create a new data source that links to the database realtime
- Create a new dashboard
- Create panel with query
  - SELECT "data_value" FROM "realtime" WHERE $timeFilter



Alerting with Grafana

- Edit the Alert tab and be notified by mail if certain criteria has been met





References

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- http://docs.grafana.org/
- https://blog.timescale.com/time-series-data-why-and-how-to-use-a-relational-database-instead-of-nosql-d0cd6975e87c
- https://blog.timescale.com/what-the-heck-is-time-series-data-and-why-do-i-need-a-time-series-database-dcf3b1b18563