

# Investigation of Artificial Intelligence in Testing and its Results Analysis

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## Introduction

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OPNFV Project: **Bottlenecks**

# Investigation of Artificial Intelligence in Testing and its Results Analysis

## Project overview:

- Many artificial intelligence approaches and applications are used to optimize testing resources, predicting system behavior, tuning performance, etc.
- These approaches are used in various processes or phases of testing, quality and reliability engineering in terms of load generation, result pre-processing, automation testing, result analysis, predicting, tuning and report generation, etc.

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## Frameworks and Tools Used:

- › **Scikitlearn:** Open Source machine learning library for the Python programming language. It features various classification, regression and clustering algorithms.
- › **Keras:** is a high-level neural networks API, written in Python and capable of running on top of TensorFlow.
- › **TensorFlow:** is an open source software library for high performance numerical computation. Its flexible architecture allows easy deployment of computation across a variety of platforms (CPUs, GPUs, TPUs).
- › **Jupyter Notebook:** It is an interactive computational environment, in which you can combine code execution, rich text, mathematics, plots and rich media.

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## Project Objectives:

1. To investigate the applications of AI within testing scope comprehensively.
2. To provide report /suggestions of how to incorporate AI into testing for Bottlenecks.
3. To build an application/design of AI in testing for Bottlenecks to Analyse/Detect/Predict based on some sample result.

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## Project Deliverables:

1. Comprehensive report on AI in testing for Bottlenecks.
2. The list of possible tools and framework that can be used for implementing AI in testing for Bottlenecks.
3. Results and inferences on event correlation, anomaly detection and failure prediction on bottlenecks sample test dataset.

# Bottleneck Test case – TC3 Perform Life cycle Events for ping

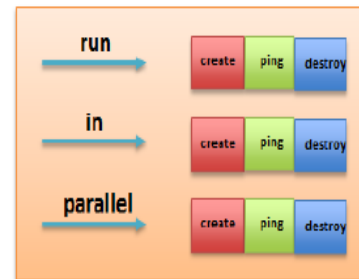
- This test case dataset was downloaded from the OPNFV testing database by using the REST API  
[GET http://testresults.opnfv.org/test/api/v1/results?project=bottlenecks&case\\_name=posca\\_factor\\_ping](http://testresults.opnfv.org/test/api/v1/results?project=bottlenecks&case_name=posca_factor_ping)
- The dataset consist of seven important attributes, start\_date, stop\_Date, duration\_time, success\_time, success\_rate, no\_of\_stacks and results.

## Applications of AI in NFV testing environment

- Fault localization and diagnosis,
- Anomaly Detection,
- Test Case optimization,
- Root Cause Analysis,
- System Identification,
- Network fault prediction,
- Data center energy conservation analysis, etc.

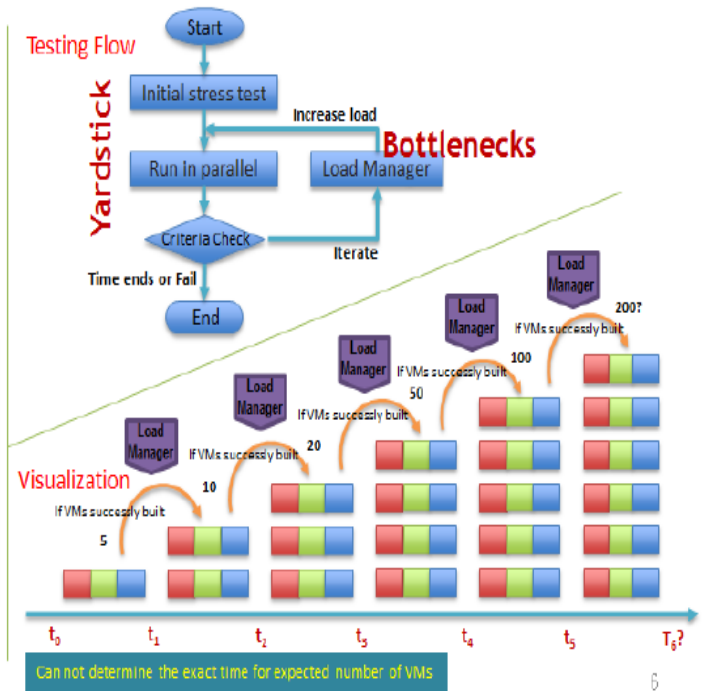
### TC3 – Perform life-cycle events for ping

Type 1



Quota	Field	Value
instances	floatingip	-1
cores	network	-1
ram	port	-1
floating_ips	fixed_ips	-1
metadata_items	rbac_policy	10
injected_files	router	-1
injected_file_cont	security_group	1000
injected_file_path	security_group_rule	1000
key_pairs	subnet	-1
security_groups	subnetpool	-1
security_group_rule		
server_groups		10
server_group_members		10

Quotas



Bottleneck Life cycle for Ping- Test case

# Project Execution in A-D-P pattern

<b>Analysis</b>	<b>Event Correlation Analysis</b> <b>Trend Analysis</b> <b>Pattern Analysis</b>	<p>Correlating the events received from the network and cloud system helps in identifying the relationships between the events.</p> <p>AI pattern recognition features will identify and predict performance bottlenecks.</p> <p>Trends indicate a slow change in the behaviour of a variable in time, in its average over a long period. The identified trends can be used to predict the future network statistics.</p>
<b>Detection</b>	<b>Anomaly Detection &amp; Diagnosis</b>	<p>Anomaly detection in traditional approach is done through heartbeat or status check.</p> <p>AI works well with diagnosing anomalies in test data well advance .</p>
<b>Prediction</b>	<b>Failure Prediction</b>	<p>Predicting impending malfunctions in NFV (cloud) environment is hard. Trying to induce them in a system test is even harder.</p> <p>AI can build a usage model for an application under test which can be iteratively applied to predict future behaviour.</p>

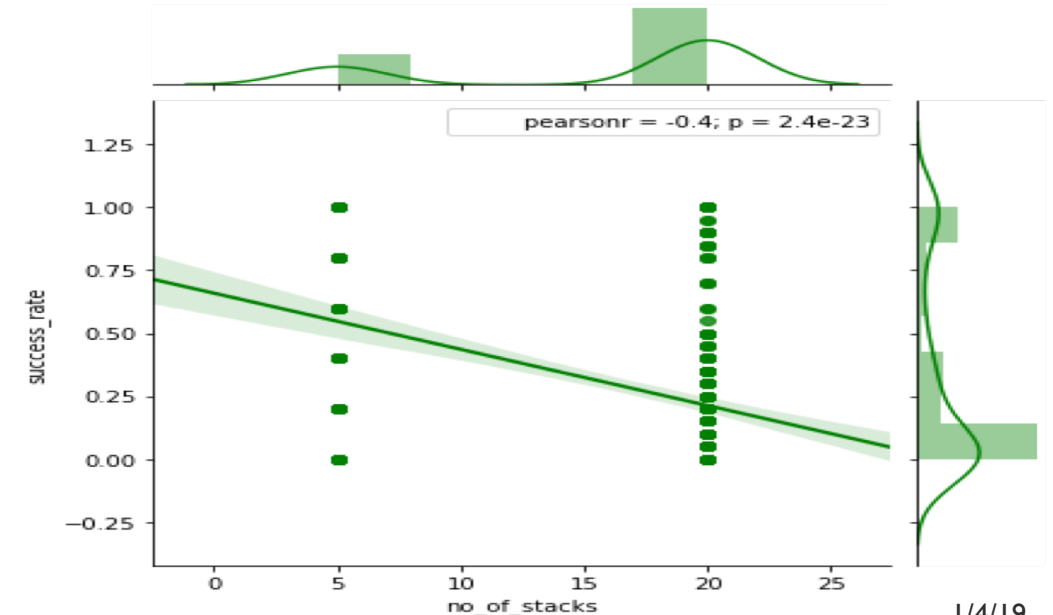
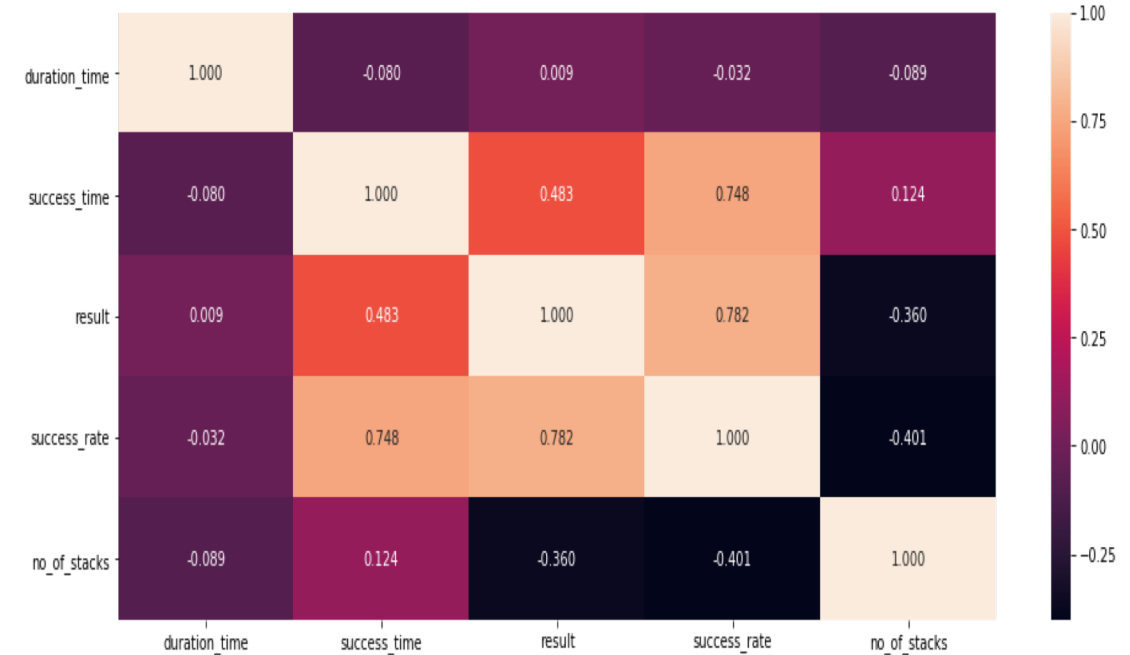
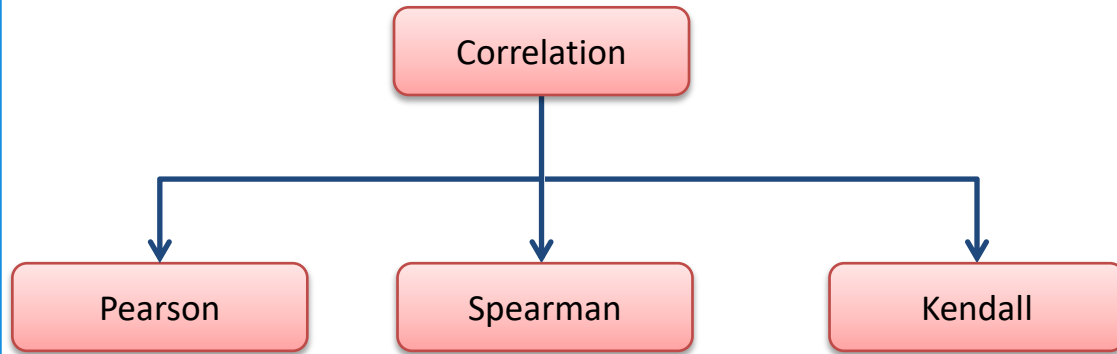


# Event Correlation Analysis

Correlation is a linear association between two random variables.

## Event Correlation in OPNFV testing projects

- The important problem in virtualized environment is handling the faults.
- Examples of these faults are: bottlenecks, virtual machine crashes, and hardware failure and overload conditions.
- Correlation analysis helps in reasoning the VM or VNF test performance faults.
- Example: The throughput, at a particular duration, in the test is low due to low CPU utilization reaching 100% (or CPU availability going to 0).

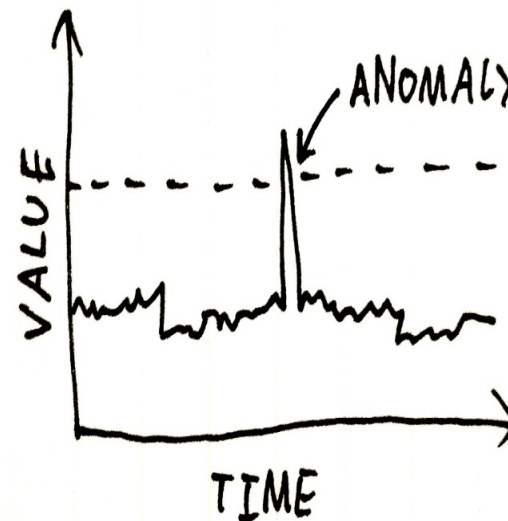


# Anomaly Detection

An anomaly is an observation or event that deviates qualitatively from what is considered to be normal.

## Anomaly in OPNFV testing projects

- Traditional anomaly detection approaches - heartbeats or status request.
- These methods only detect faults after they occur.
- Detecting and handling such anomalies can avoid faults before they happen and this will increase system throughput.
- Artificial intelligence algorithms provide the means to learn from historical observations and use this knowledge to get predictions about the future.



	precision	recall	f1-score	support
0	0.86	1.00	0.92	166
1	1.00	0.15	0.26	33
avg / total	0.88	0.86	0.81	199

0.859296482412

Accuracy of SVM

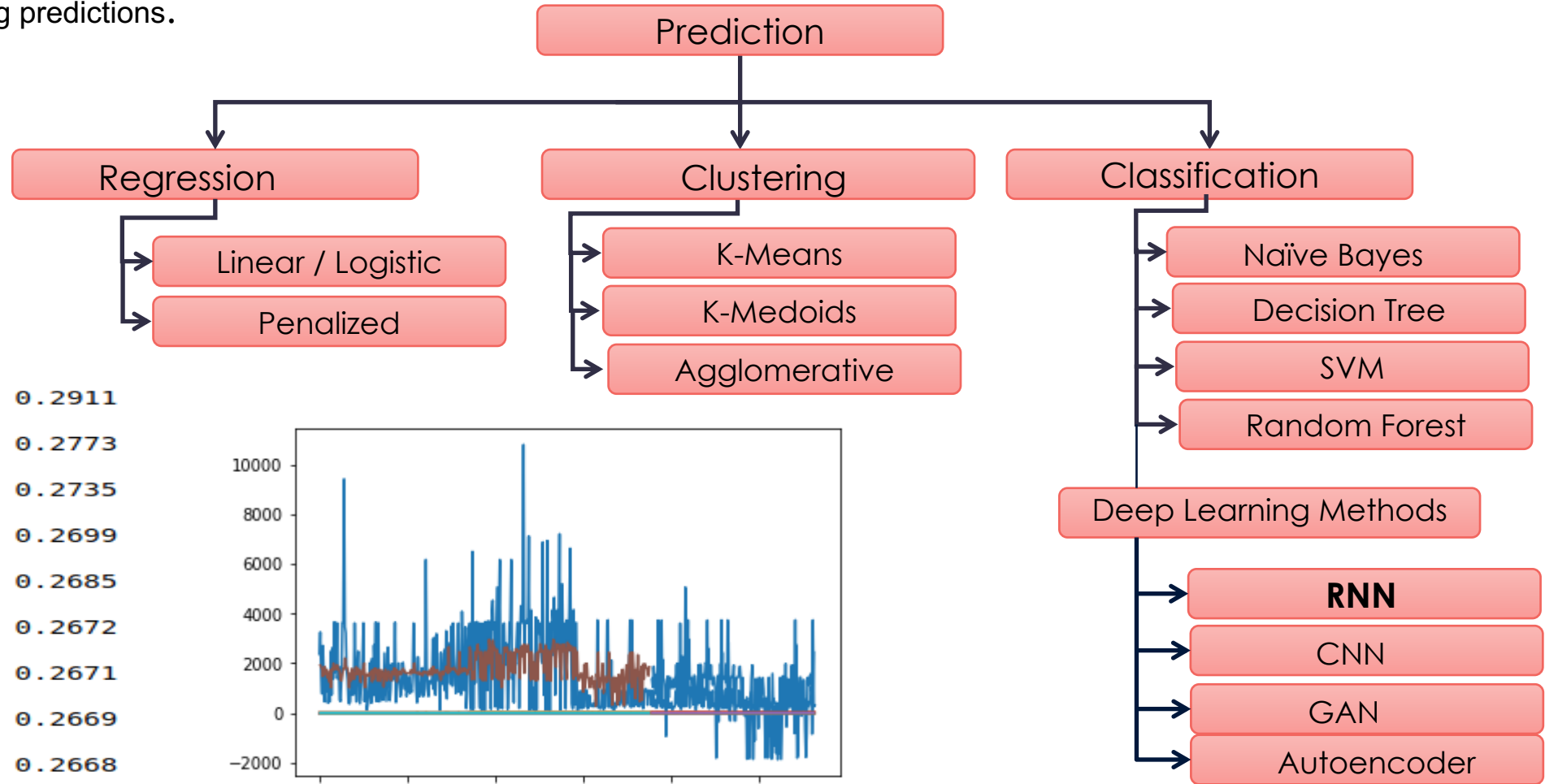
	precision	recall	f1-score	support
0	1.00	0.99	1.00	168
1	0.97	1.00	0.98	31
avg / total	1.00	0.99	1.00	199

0.994974874372

Accuracy of Random Forest

# Failure Prediction

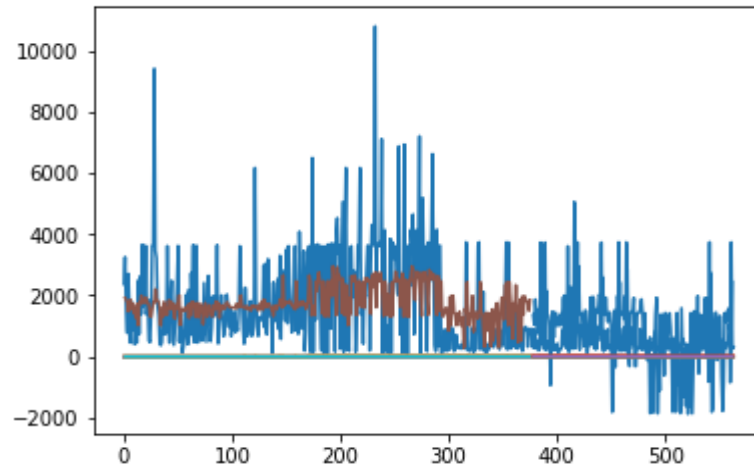
- Failure prediction system help the Cloud/NFV system to avoid the unexpected failure in advance.
- User/admin can define what failure should be detected and which data is used for prediction. The predictor will perform corresponding predictions.



```

Epoch 2/1000
- 1s - loss: 0.2911
Epoch 3/1000
- 1s - loss: 0.2773
Epoch 4/1000
- 1s - loss: 0.2735
Epoch 5/1000
- 1s - loss: 0.2699
Epoch 6/1000
- 1s - loss: 0.2685
Epoch 7/1000
- 1s - loss: 0.2672
Epoch 8/1000
- 1s - loss: 0.2671
Epoch 9/1000
- 1s - loss: 0.2669
Epoch 10/1000
- 1s - loss: 0.2668
  
```

Training of the Neural Network



Predictions of Training and Test Data

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## Recommendations for Future Work:

- › In this work, we have made an effort to use artificial intelligence techniques to analyze the test results of OPNFV testing project like bottlenecks.
- › We can also extend the experiments to other OPNFV testing projects like Functest, Yardstick and Vsperf.
- › Since, Artificial Intelligence is a very promising technique to achieve the better performance in testing, we plan to continue the work to carry out different experiments on testing and draw inferences from these experiments to improve the results.

Thank you