Using Statistical Inference for Capacity Planning

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Agenda:

- Why capacity planning?
- What is a realistic goal?
- Linear regression magic
- Recap

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Why Capacity Planning ?

Avoid possible stability and reliability issues

Elevate performance, identify the bottleneck

Better cost model and saving money, while still meeting the needs of the business

To support SLA that you want to achieve

Simple but Hard

Q: What is the maximum capacity your current system can handle under your SLO?

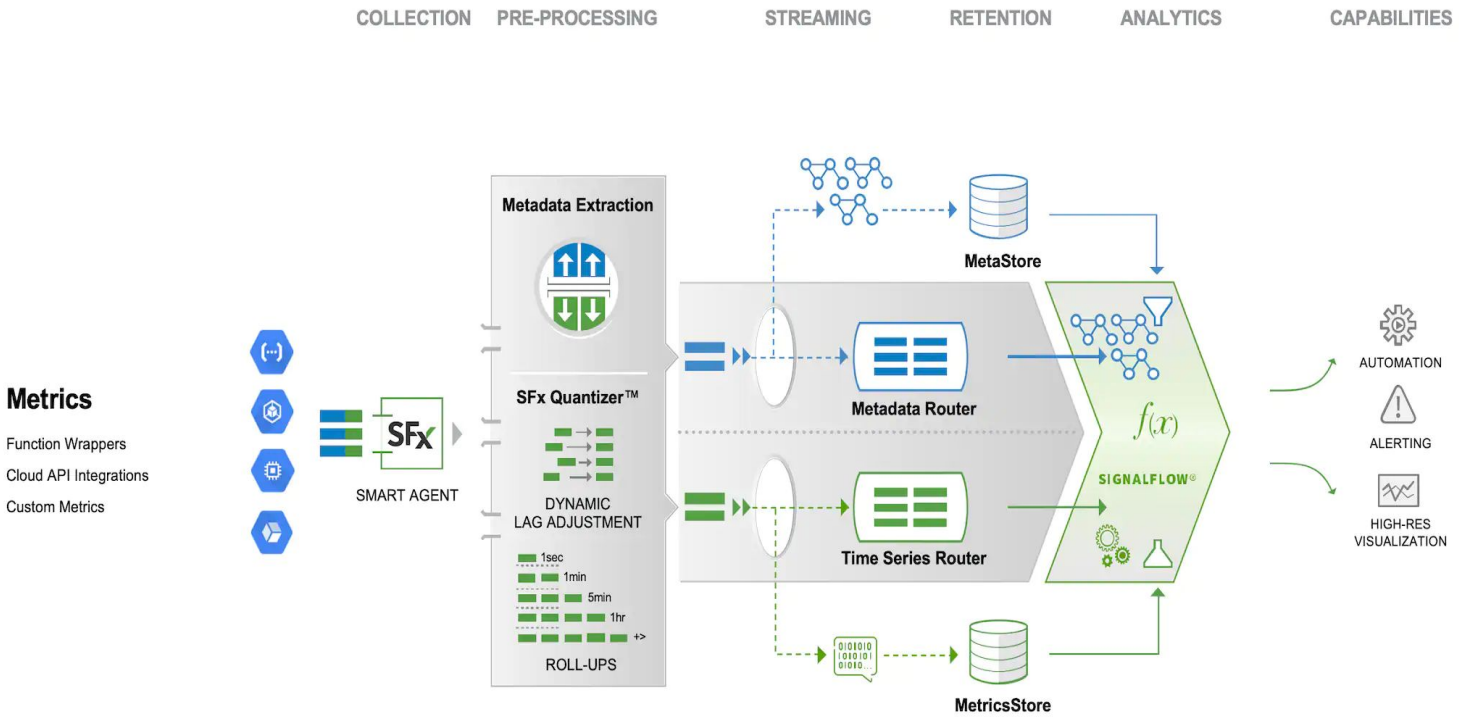
Throughput: QPS / TPS

SLO :
Latency (Mean, P95, P99)
Success/Error Rate (%)

Resource: under its safe threshold
CPU
Memory
Disk
Network

How to do a proper (.*)Test?

Performance Test/Load Test/Stress Test



Preparation:

- Identify the product use case
- Identify the upstream/downstream dependency
- Identify the core data pipeline
- Identify the base traffic flow & pattern
- Identify the peak traffic flow & pattern
- Tooling (Load generator/etc)

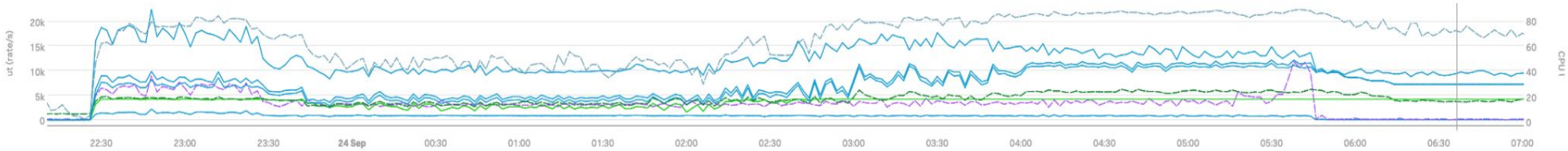
Model:

- Identify the highly-correlated resource (CPU/Mem/Heap) for the service
- Set your target threshold
  - ie, cpu (50%,75%, 95%)
- Setup dashboard and alerts to avoid issue

Test Scenarios:

- Organic Growth
- Durability at high Throughput
- Pulse Throughput with interval

Peek at the Test Result



Environment:
Prod

Testing Window:
4 hour

Testing Load:
20mil AMTS(Active Metric Time Series),
80k mts/min

Screenshot services:
2 stateless - Time series creation
1 stateful - metadata storage

Results:
CPU Util (2% - 90%)
Latency: < 200ms

*R-Squared: > 95%

Pinned Value	Value	Rollup	Plot Name
788.0417	727.0667		tscretion_req
43.03501	19.31761		tscreation_cpu_p95
23.07706	23.44861		metabase_cpu_p95
4,211	4,199		m_index_write
10,668	10,951		m_cass_write
11,395	11,560		cass_writes_cluster
12,825	13,913		cass_reads_cluster
89.00744	84.53919		cass_cpu_p95

R-squared is the percentage of the dependent variable variation that a linear model explains. Usually, the larger the R^2, the better the regression model fits your observations.

Linear regression saves the day!

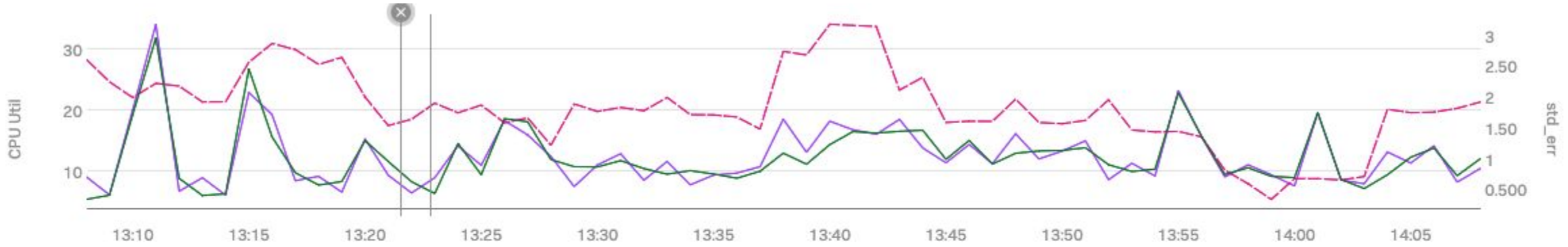
No magic, but statistics

```
#Single Linear Regression - (Req VS CPU )  ; Y = ax + b

Request = data('tscreationservice.createManyTimeSeries.work',
filter=filter('clientType', 'sbingest'), rollup='rate').sum(by=['clientType',
'sfx_instance_name']).sum()
cpu_p95 = data('jvm.cpu.load', filter=filter('sfx_service',
'tscreation*')).percentile(pct=95)


from signalfx.stats.linear_model import regression
solution1 = regression.fit([Request], cpu_p95,
window=duration('5m'),fit_intercept=True)


coefficient=solution1['coef'][0]
intercept_single=solution1['intercept']
std_err=solution1['std_err']
R_square=solution1['R2']

Model1= ((Request * coefficient) +
intercept_single).publish(label='Model1_cpu')
```

```
#Multiple Linear regression - (Read, Write VS CPU)  ; Y = a* x1 + b *x2 + c

cass_read_cluster = data('counter.cassandra.client.read-latency.count',
filter=filter('sfx_cluster', 'cassandra-metabase'), rollup='rate').sum()
cass_write_cluster = data('counter.cassandra.client.write-latency.count',
filter=filter('sfx_cluster', 'cassandra-metabase'), rollup='rate').sum()
cass_cpu_p95 = data('cpu.utilization', filter=filter('sfx_service',
'cassandra-metabase')).percentile(pct=95)

from signalfx.stats.linear_model import regression
solution2 = regression.fit([cass_read_cluster, cass_write_cluster],
cass_cpu_p95, window=duration(5m),fit_intercept=True)

coefficient1=solution2['coef'][0]
coefficient2=solution2['coef'][1]
intercept_multi=solution2['intercept']
std_err=solution2['std_err']
R_square=solution2['R2']

Model2= ((cass_read_cluster * coefficient1) + (cass_write_cluster *
coefficient2) + intercept_multi).publish(label='Model2_cpu')
```

Model example

Model: Y= a * X + b



Plot Editor | Chart Options | Axes | Data Table | Events (0)

Pinned Valu…	Value	Rollup	Plot Name	sf_metric
26.81235	15.68748	average	Model1_cpu	
22.94180	19.33144		cpu_p95	jvm.cpu.load
2.566115	2.870487	rate/sec	std_err	

CPU ~ coefficient * request + intercept

Is it a mighty model?

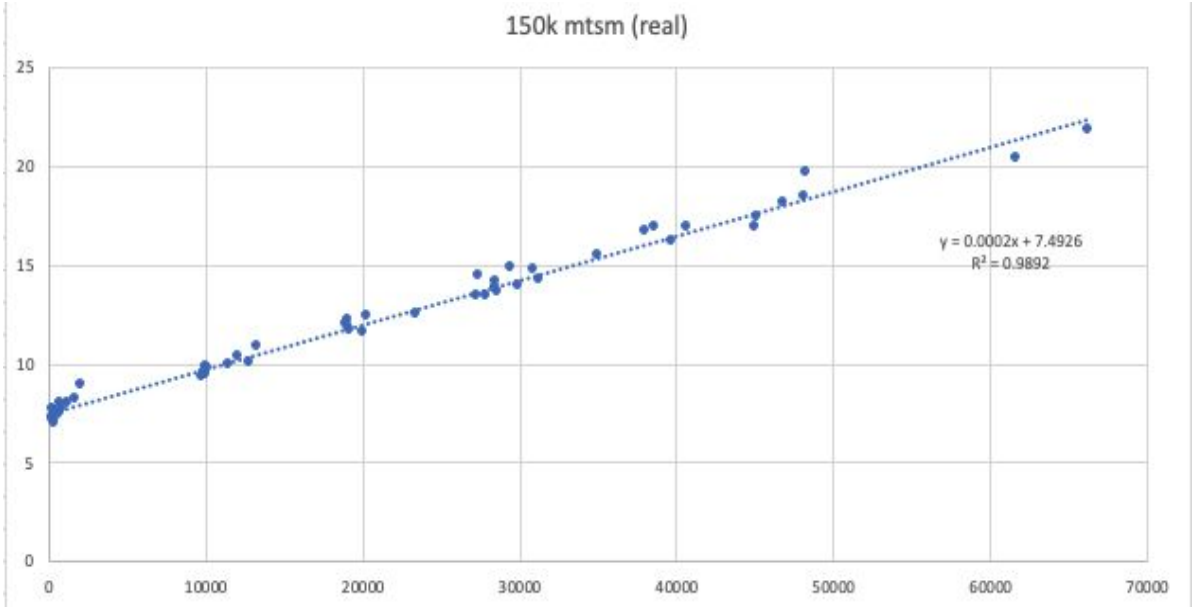
Yes & No

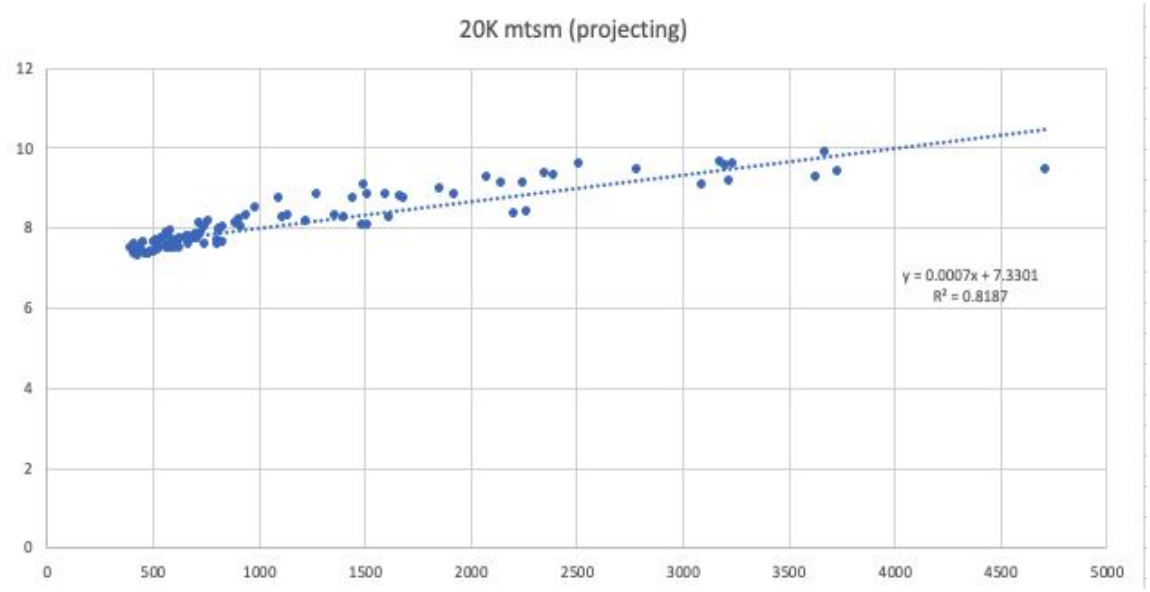
Yes. If your loadtest covered the resource threshold range you want to model on.
Yeah!!!

No, If you are trying to predict the utilization range not covered by the test.
This is not too bad, but your final results might be vary a lot, and do not be surprised if the deviation > 20%.

Projecting CPU

150k(real) VS 150k mtsm (projected without test covered)





	Request	CPU Util	coefficient	intercept	std_err(%)	R^2(%)
Projected	66307	51.7339647	0.0007	7.3301	0.3	0.82
Real	66307	21.7895336	0.0002	7.4926	0.42	0.98

Other limits of a model

Yes & No

Yes, If you are trying to predict capacity on different hardware type(even same cores/mem/etc)
Of course, Diff AWS hardware type have different CPU freq, different architectures.

Yes, If service config/code updated, kernel upgraded, etc any underlying system change.
The butterfly Effect applies there, any change in the underlying system will produce different results to your model!

… Don’t be too greedy!

System is not follow the same linear under different load, make sure your test covered enough range that you need. Do not try to solve your capacity problem using your “perfect” model.

Recap

Last but not least

- A regular loadtest is the key to keep your model updated, might be a “perfect” model.
- It is much easier to perform regression on dashboards and figure out key relationships.
- Production is the ideal place to do the test. However, be careful and be humble!
- Always keep redundancy to provisioning, No test data can compare to real customer traffic.

Please meet me in the chat lounge for the Q&A

Than you !!

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