Alibaba Cloud
Official Cloud Services Partner

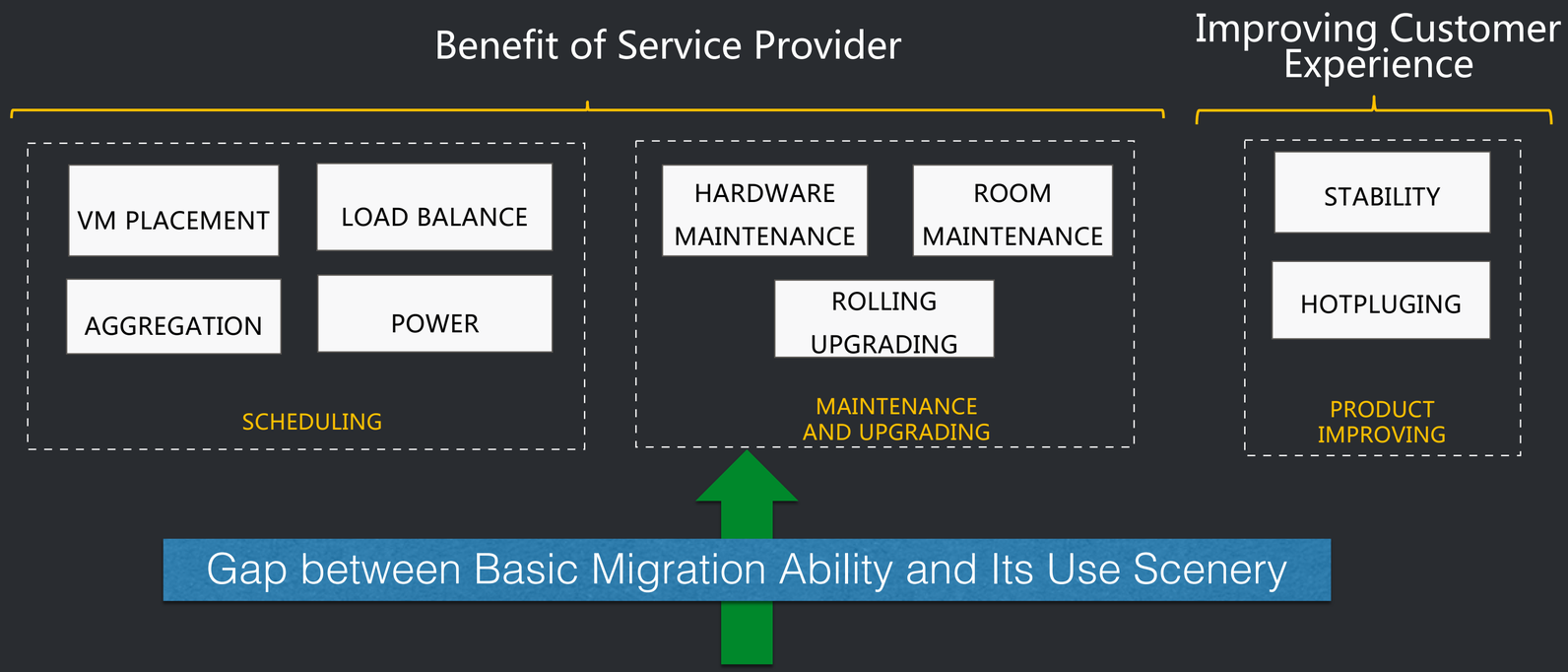
Cloudatlas: Ways to Make Live Migration Easy and Expectable

Zhang Chao, Xie Feng
Alibaba Cloud

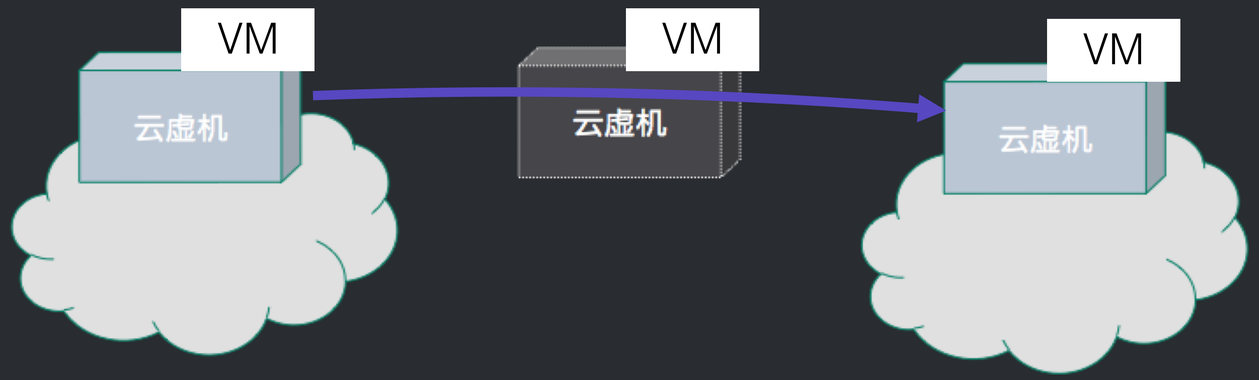
Migration Use Case：

Alibaba Cloud
Official Cloud Services Partner

Product Ability



Migration Optimization



Migration Performance & Cost

- CPU Usage
- Network Usage

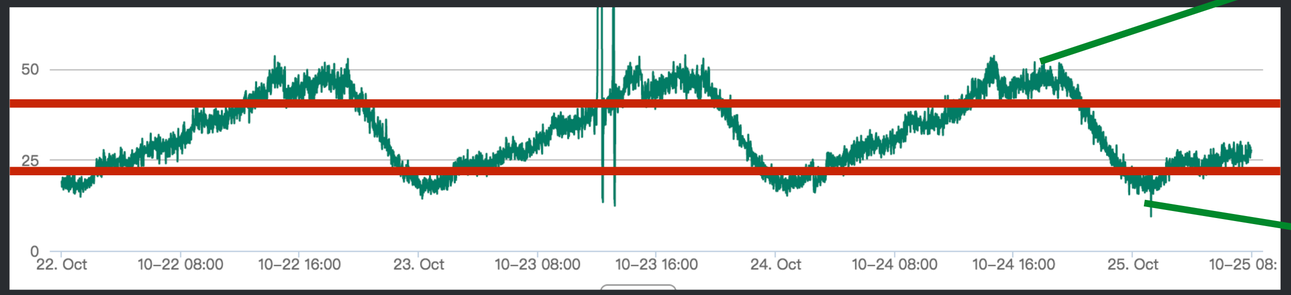
- Migration Totaltime
- Migration Downtime
- Success Rate

What we should do as our customers are demanding more Vcpu and Memory every day?

Just assign more cpus to our migration thread ?

Example of Migration Cost

VM configuration:
32 vcpu 128G MEM



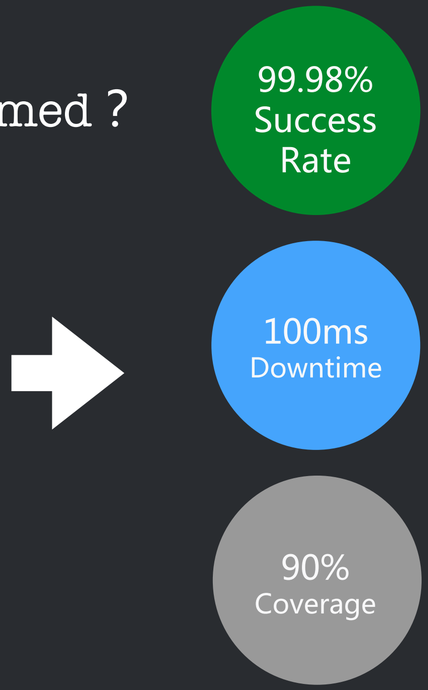
Dirty Rate > 600K pages per seconds
Resource: 6 CPU: compression + decom

Dirty Rate < 200K pages per seconds
Resource: 1 CPU: sometimes no compression

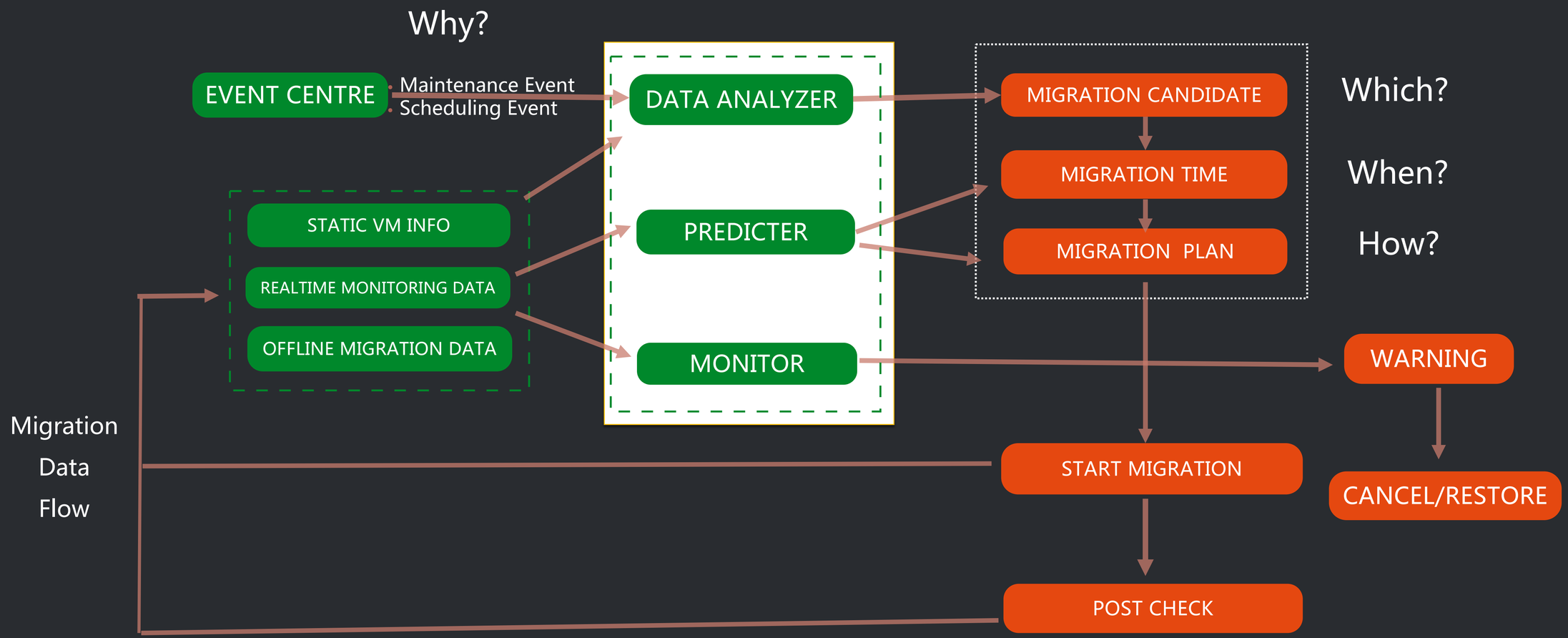
The dirty page rate difference between peak load period and low peak period may reach 5 times

Challenges

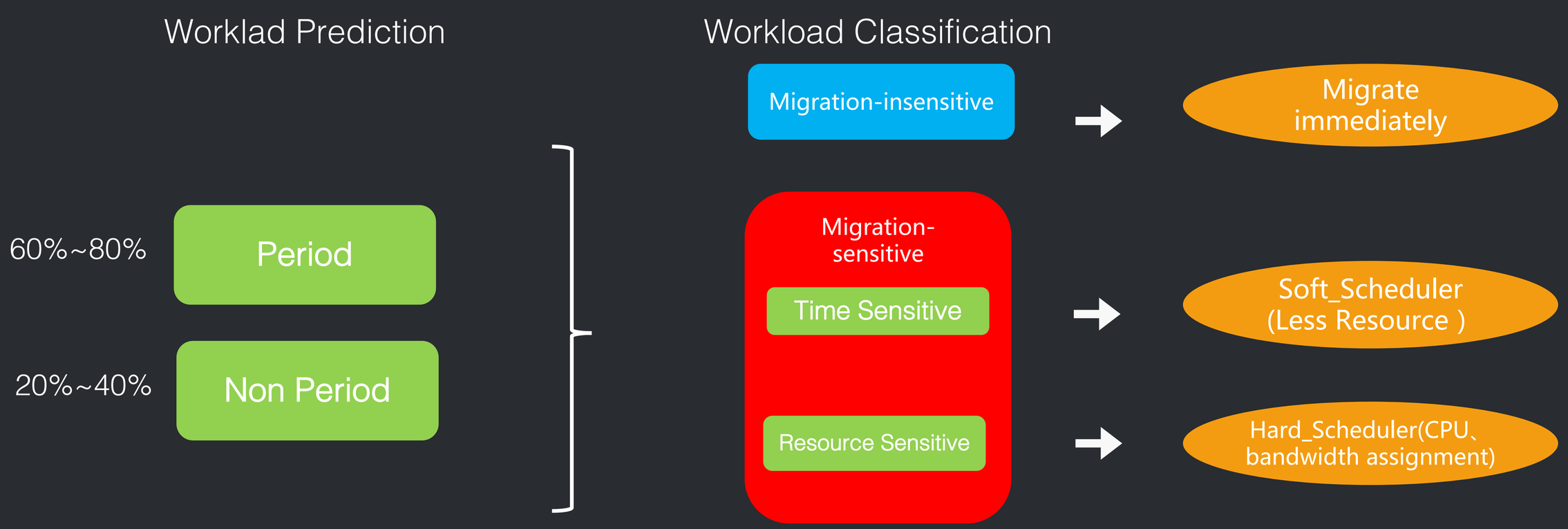
- WHY should a VM migration be performed ?
- WHICH VM is required to migrate ?
- WHEN to migrate it?
- HOW many resources are required ?



DATA Boosted Migration Architecture

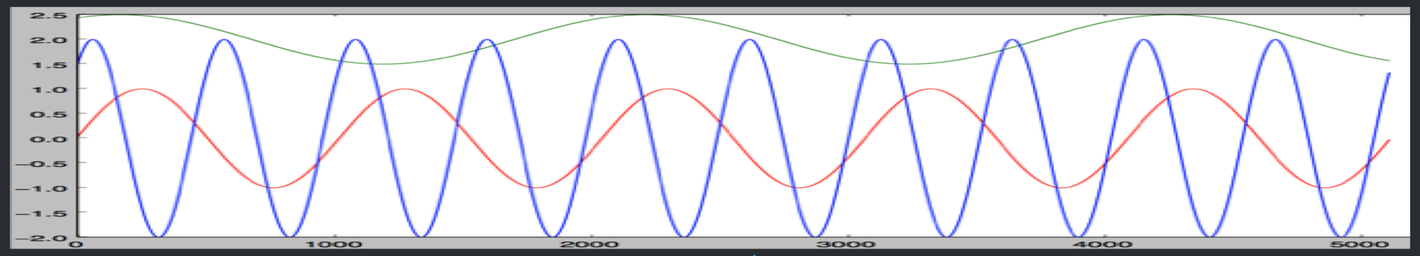


Work Flow of the Migration Analyzer

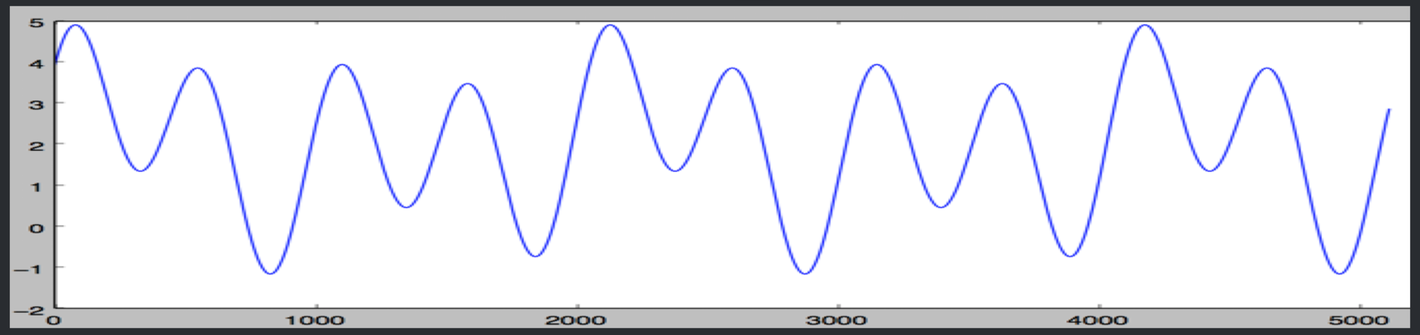


Basics of Signal Processing

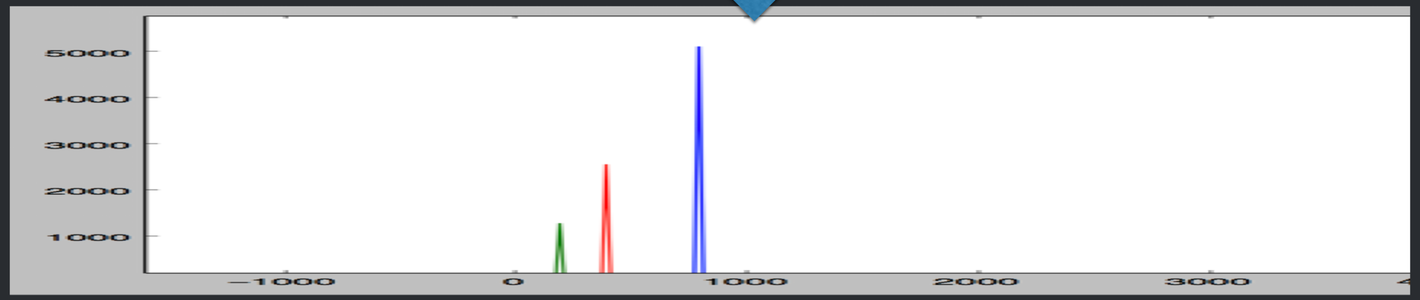
Input time series



Original series

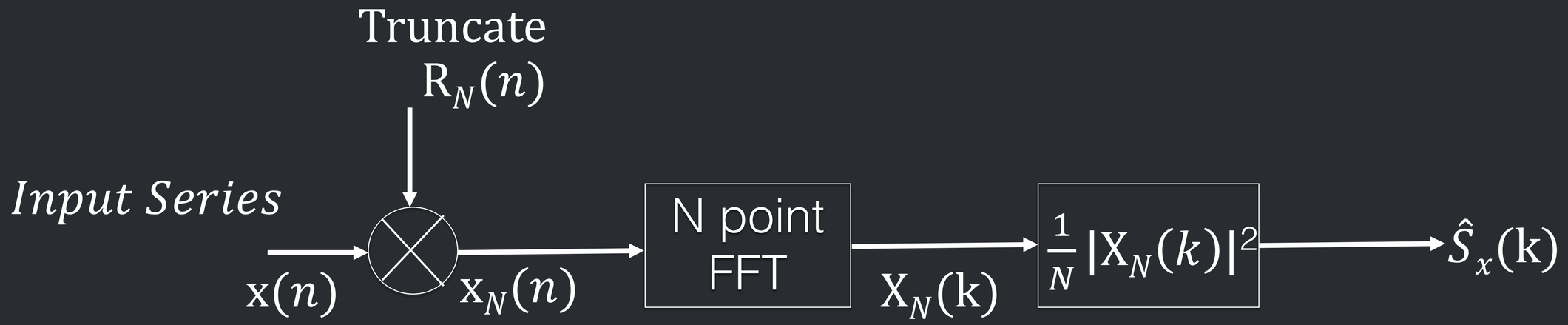


Frequency Domain



Transforming the original time series into the frequency domain can help us to detect the intrinsic pattern of the series.

Power Spectrum Density Estimation



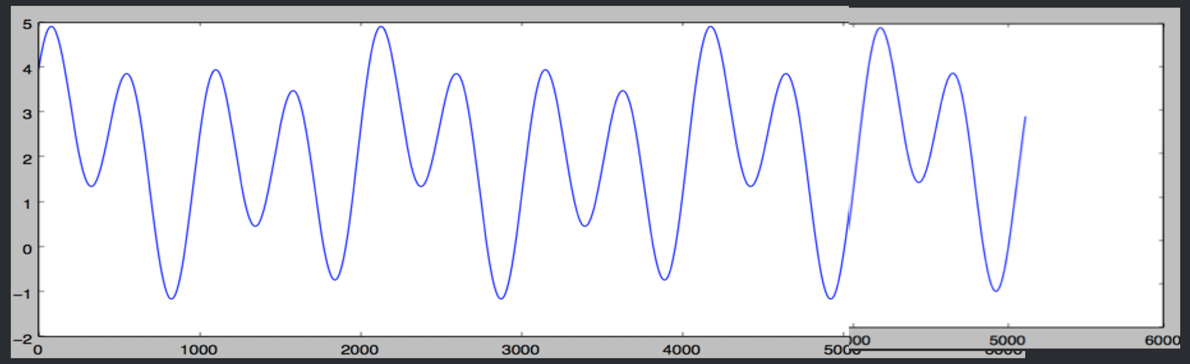
$\hat{S}_x(k)$ f_1 f_2 ⋮ f_5

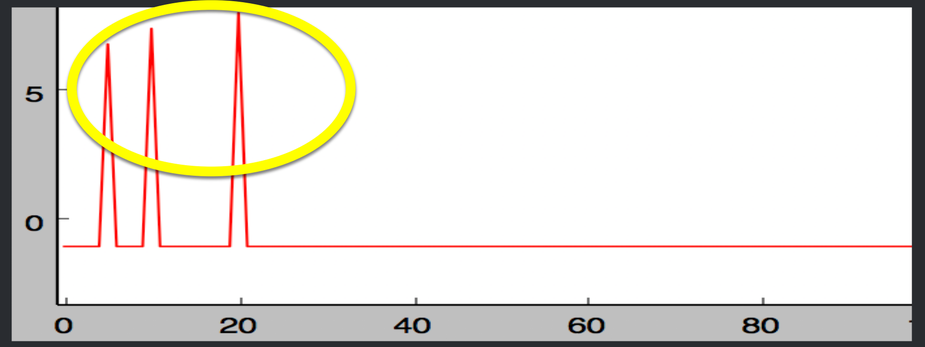
Criteria :

- Top frequencies are selected.
- Lowest frequency is used as the base frequency.
- Original series are repeated in base frequencies as a prediction.

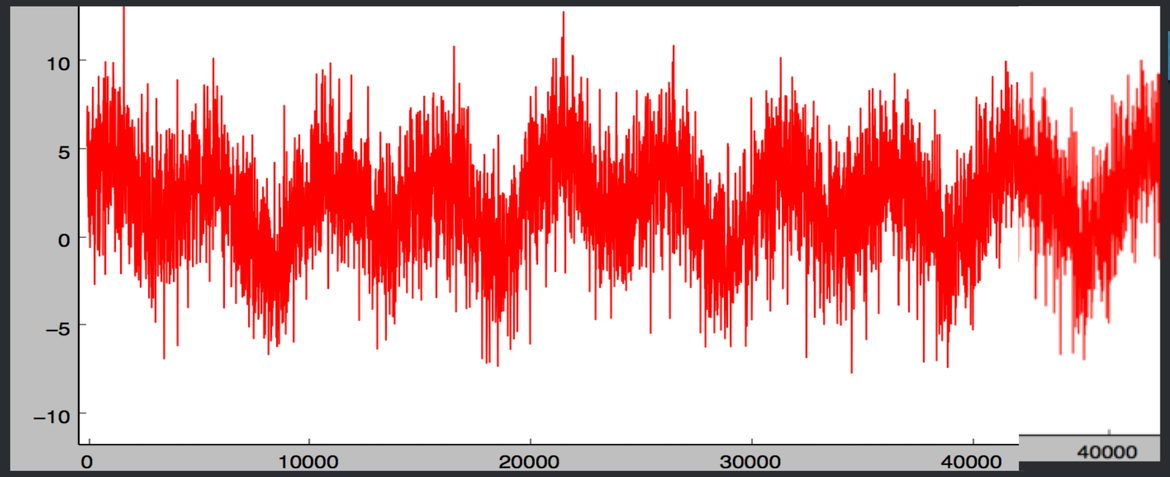
Time Series Period Estimation

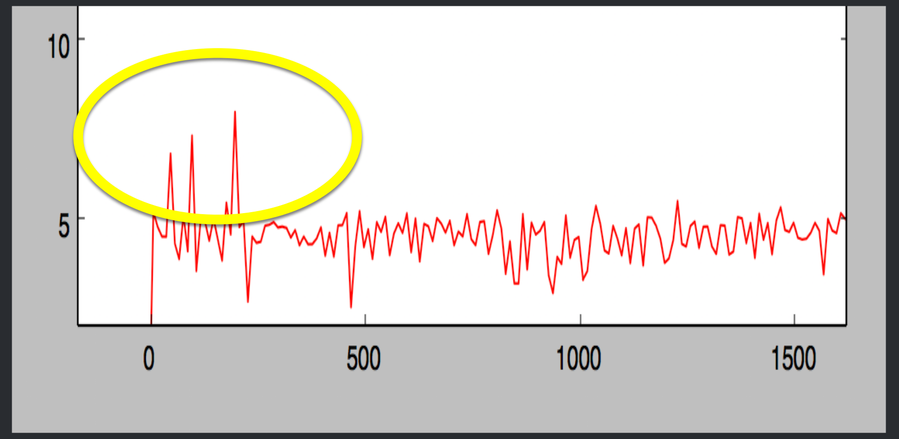
Input time series





Input time series with noises





Period Estimation

Estimation of Predict Accuracy

Assume:

noises has a distribution of $\mathrm{w}(n) \sim N(\mu, \delta)$

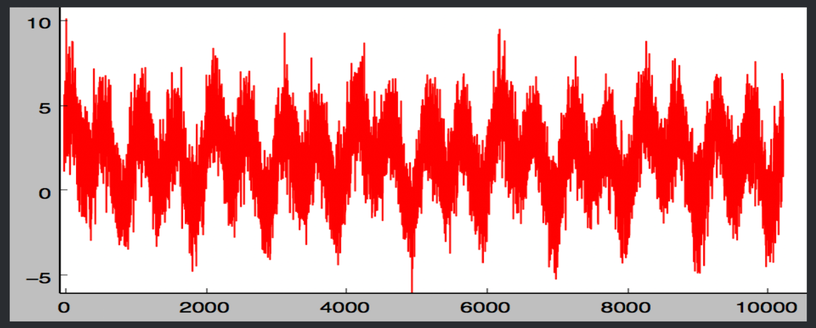
For simplicity :

$x[-T:] - x[-2T:-T]$ has a distribution of $N(0,2\delta)$

Thus:

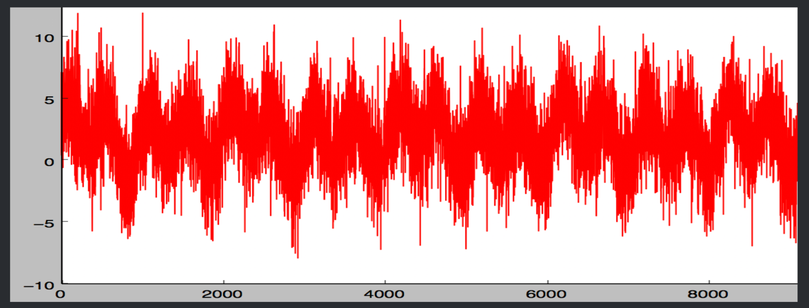
RMSE of $(x[-T:] - x[-2T:-T])$ can be used to indicate the predict accuracy of the future workload.

Input time series with Noises. SNR: 5db



In sample RMSE: 1.98

Input time series with noises. SNR: 1db

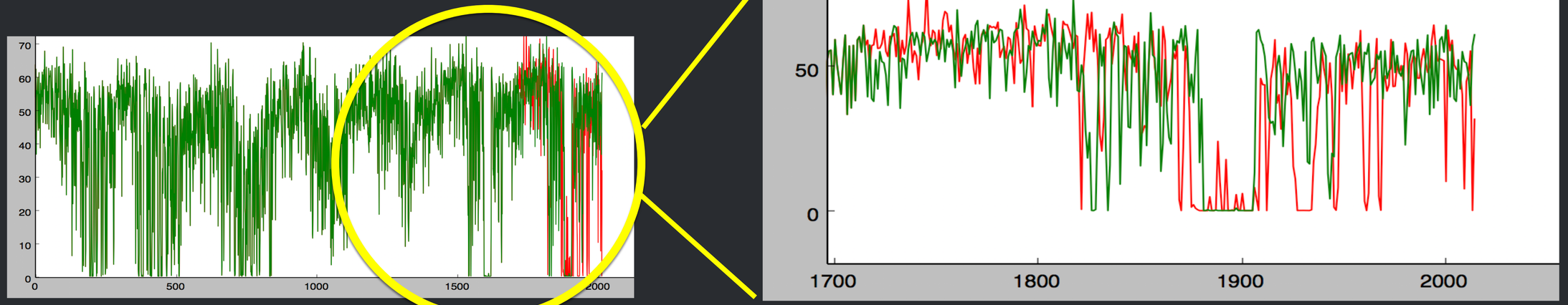


In sample RMSE: 3.21

Estimation of Real VM Usage data

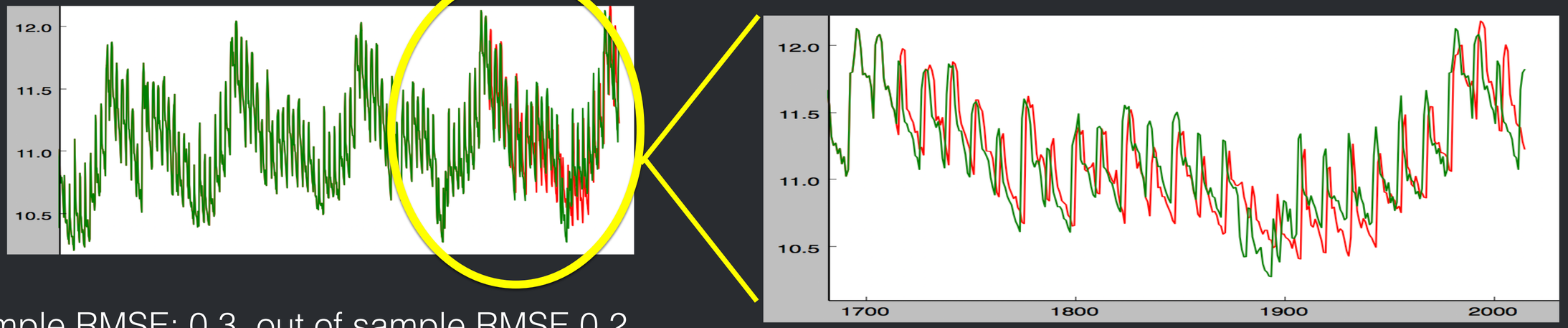
In sample RMSE: 21.8, out of sample RMSE 19.8

VM1



Time Cost to Estimate a Whole day workload: 10~20ms

VM2



In sample RMSE: 0.3, out of sample RMSE 0.2

Workload Time Series Model

Use Time Series Model to predict next 24 hours workload of VM

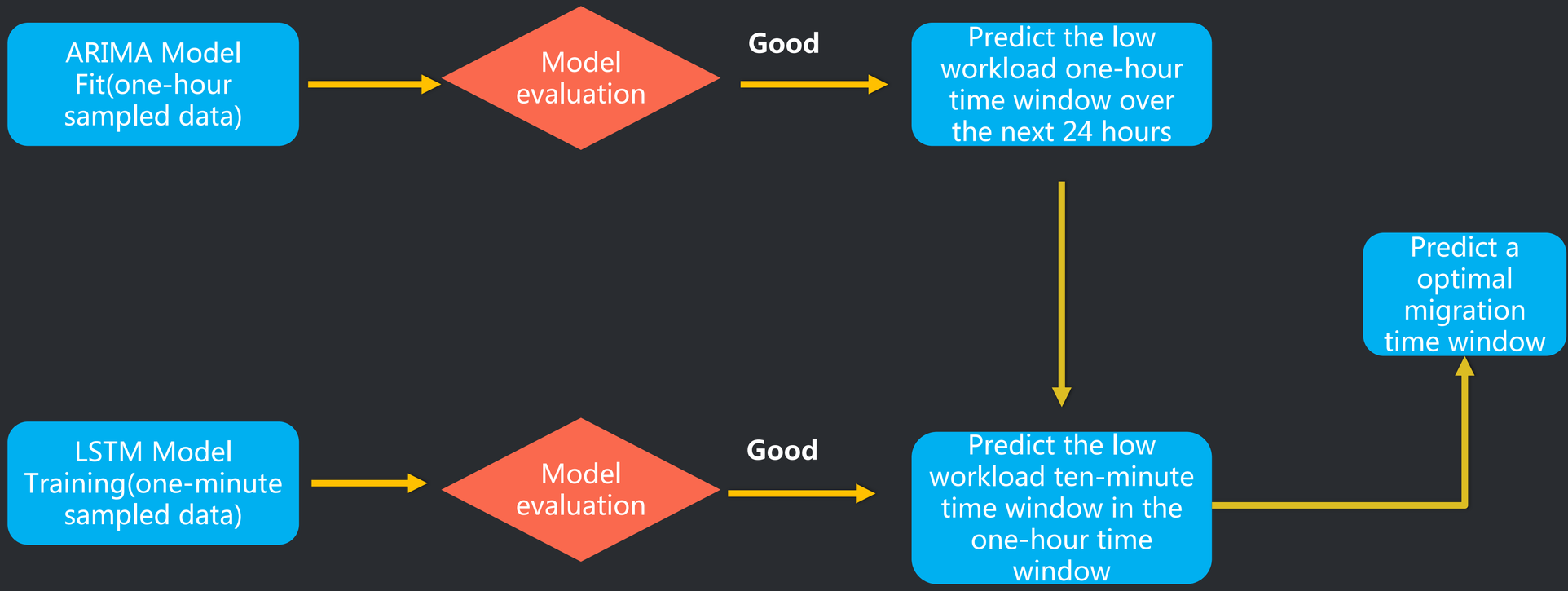
ARIMA Model: AutoRegressive Integrated Moving Average Model

- A Traditional Machine Learning method
- Advantage:
  Low calculation cost
  Good performance on Small Data Set
- Disadvantage:
  Lower accuracy than Deep Learning

LSTM:Long Short Term Memory networks(a special kind of RNN)

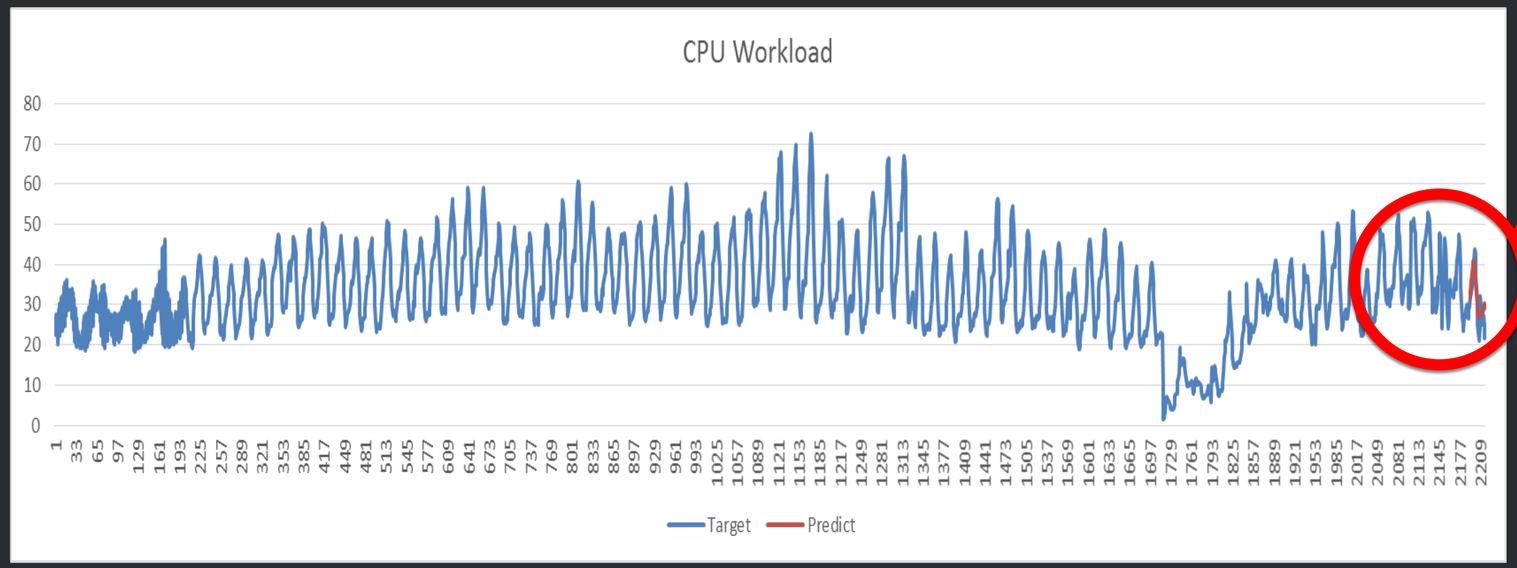
- A Deep Learning method
- Advantage:
  High accuracy
- Disadvantage:
  High calculation cost
  Need a Large Data Set

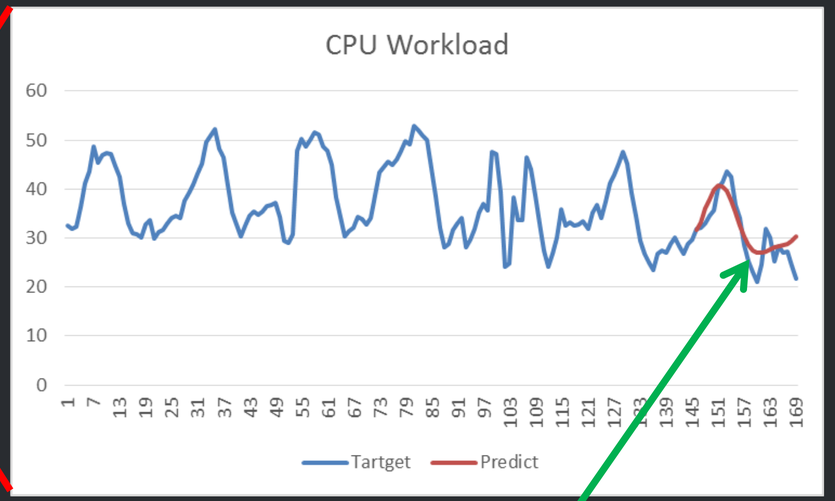
Regression algorithm Flow Chart



Regression algorithm Result:ARIMA

ARIMA Predict Next 24 Hours Result





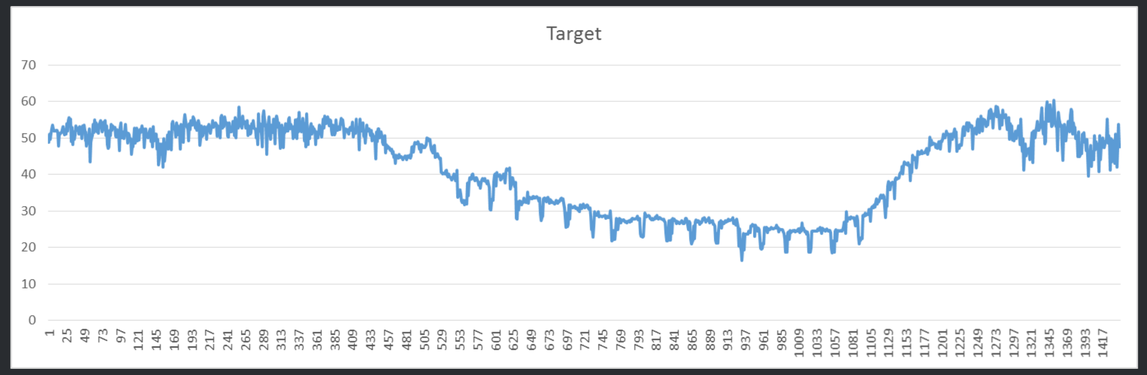
Low workload time window

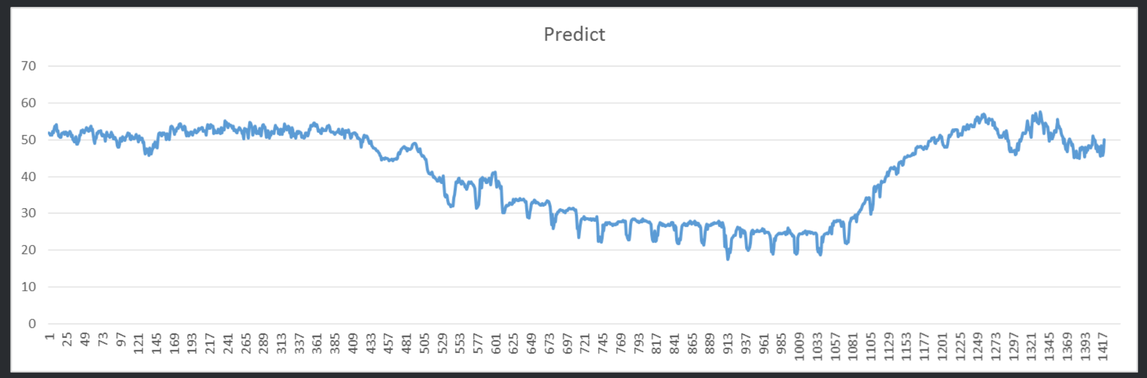
75% of non-periodic VM
RMSE < 10

93% of non-periodic VM
RMSE < 15

Regression algorithm Result:LSTM

LSTM Real Time Predict Result





80% of non-periodic VM
RMSE < 5

91% of non-periodic VM
RMSE < 10

Algorithm Performance

Workload Type	Algorithm	Time cost	Perc.	RMSE
Strong Period	FFT	10~30ms	60%~80%	<10
Weak Period	ARIMA	< 10min	10%~15%	<15
	LSTM	< 2hour		
Non Period	ARIMA	< 10min	9%~15%	<15
	LSTM	< 2hour		

Workload Classification algorithm(Work in process)

Use a Machine Learning binary classification algorithm to predict whether a VM is migration-sensitive

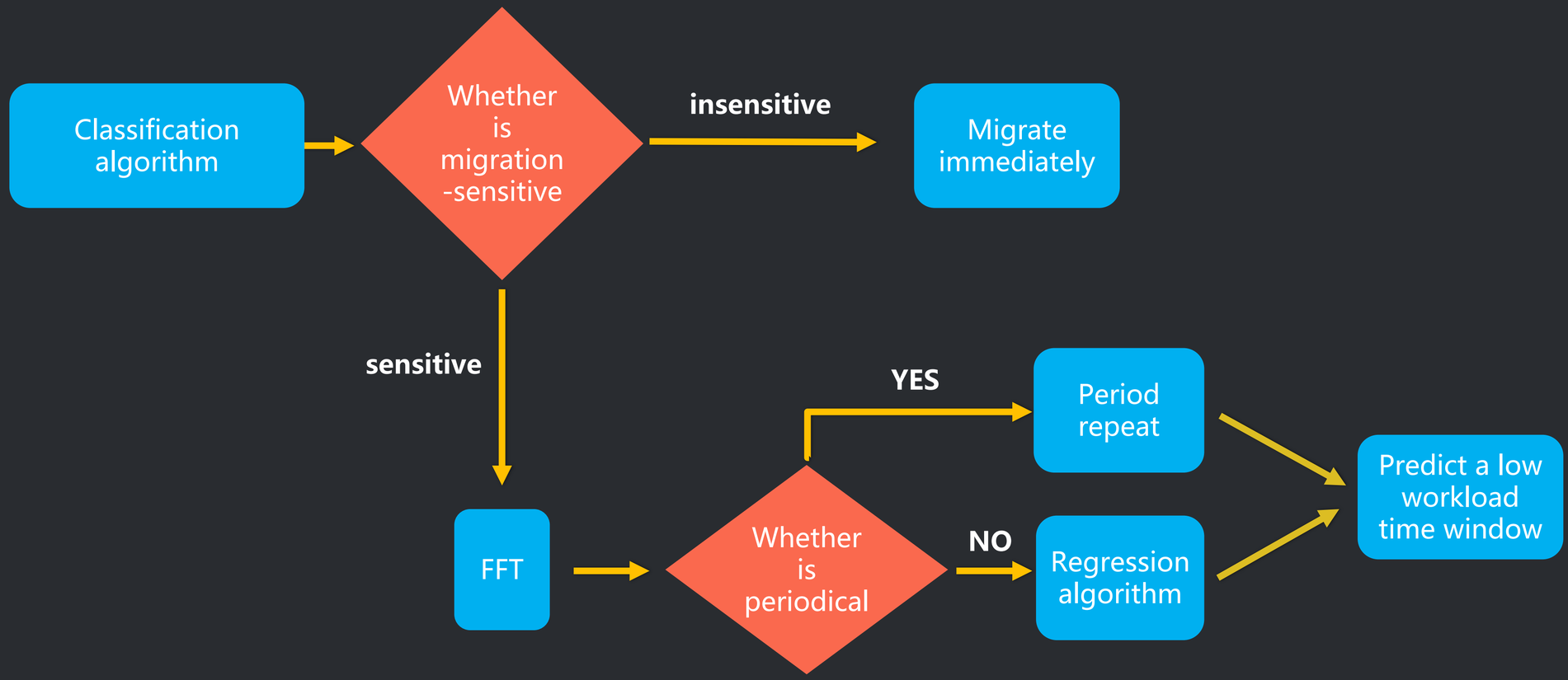
Feature

- Average vCPU utilization(1 hour before migration)
- Amplitude of fluctuation with vCPU utilization(one day before migration)
- VM Instance Type(How many vCPU/Memory?)

Result

- Migration-insensitive VM (downtime <= 100 ms)
- Migration-sensitive VM (downtime > 100 ms)

SUMMARY:Workload Prediction Flow Chart



Questions?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