Spock: Exploiting Serverless Functions for SLO and Cost Aware Resource Procurement in Public Cloud

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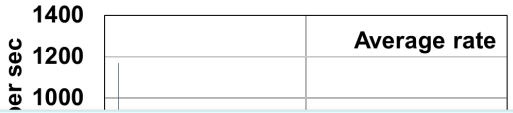
Outline

- Elastic Web Services.
- VM-based Resource Procurement.
- Serverless Functions.
- Cost of VMs vs Cloud Functions.
- Spock Hybrid Elastic Scaling.
- Implementation and Evaluation.
- Results.

Elastic Web Services

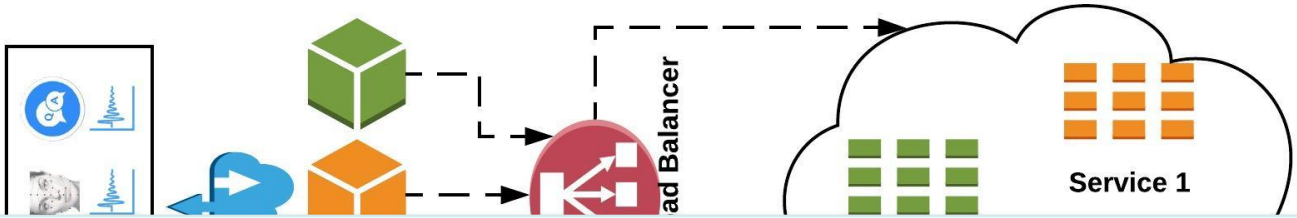
- Short lived queries
  - Strict SLO.



Typical example.?
ML based web services

- Resources Required
  - acquired/released on demand.
  - Average to Peak ratio is high.

ML Inference Engine



How to provision resources.?

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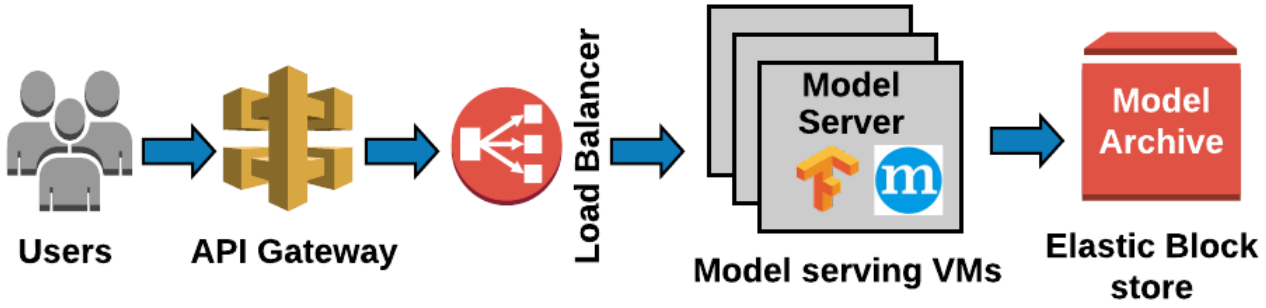
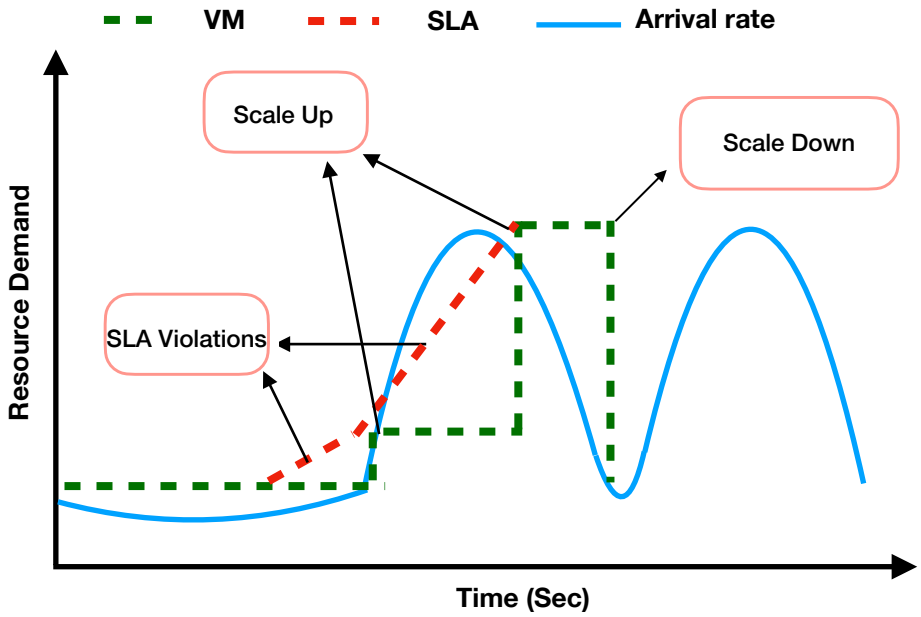
VM-based Procurement



VM-based Procurement

- Initial warm pool of active VMs.
- Procure more VMs on demand.
- Autoscaling during request surge.



Disadvantages

- Very long VM setup times.

Possible alternative.?

- Under-provisioned during sudden surge.

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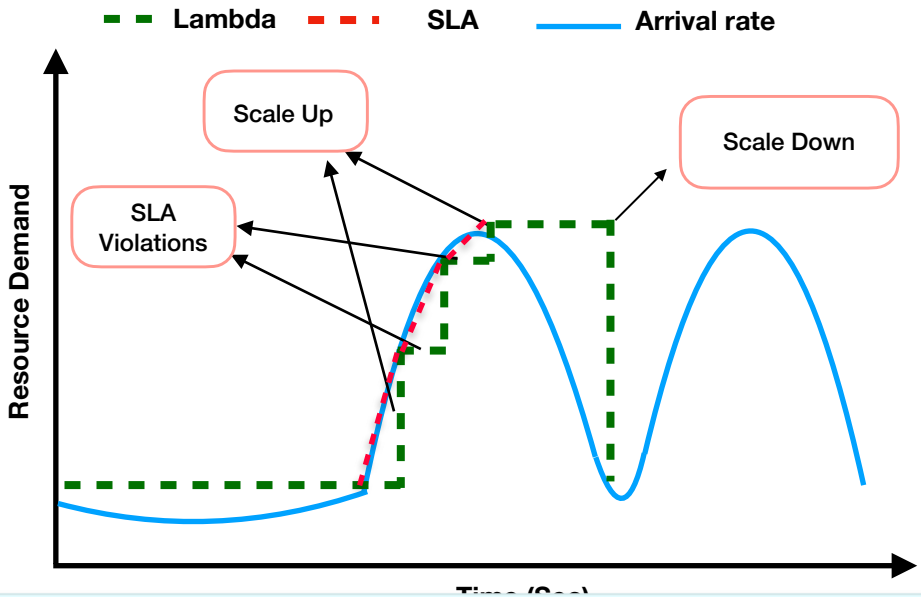
Serverless Functions

Serverless Functions

- Pay per second.
- Cost efficient.
- Scale instantaneously.

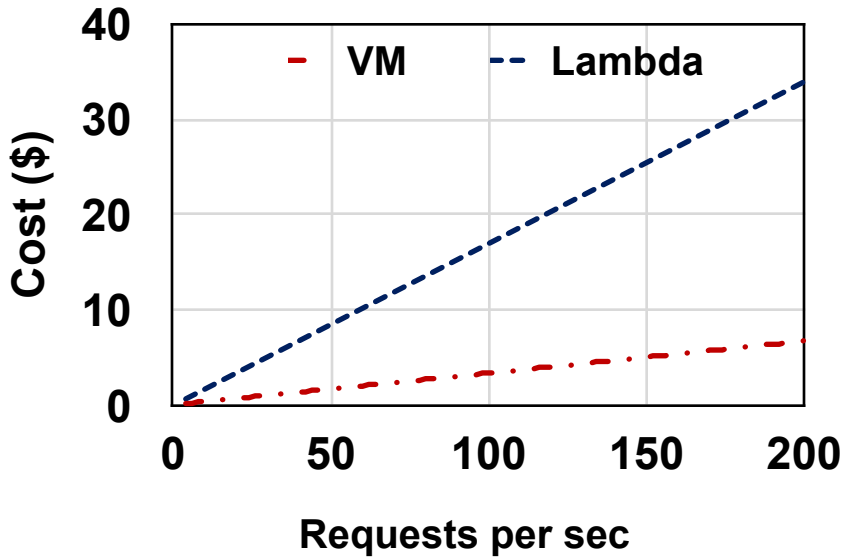


But, is serverless a replacement for VMs.?
Lets see an example.

violations

Constant arrival rate

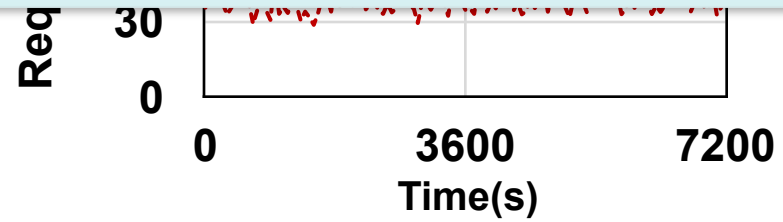
- Constant arrival rate.
- Cost compared under iso-performance.
- All requests have similar SLA compliance.
- VMs are 100% utilized.

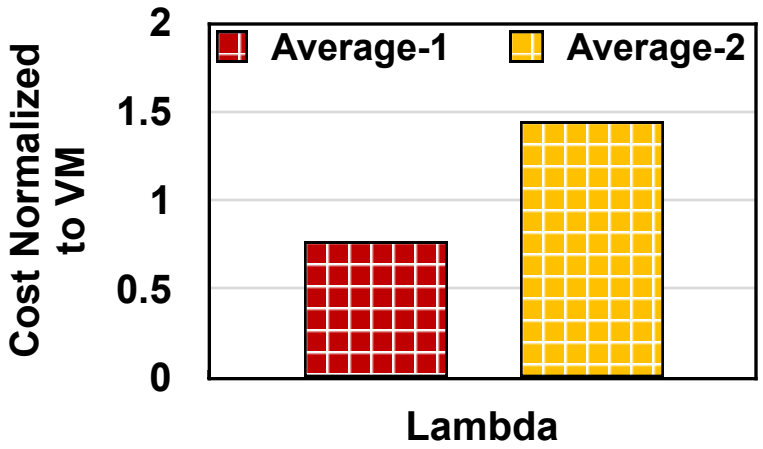


Varying arrival rate

Cost-effective Solution.?

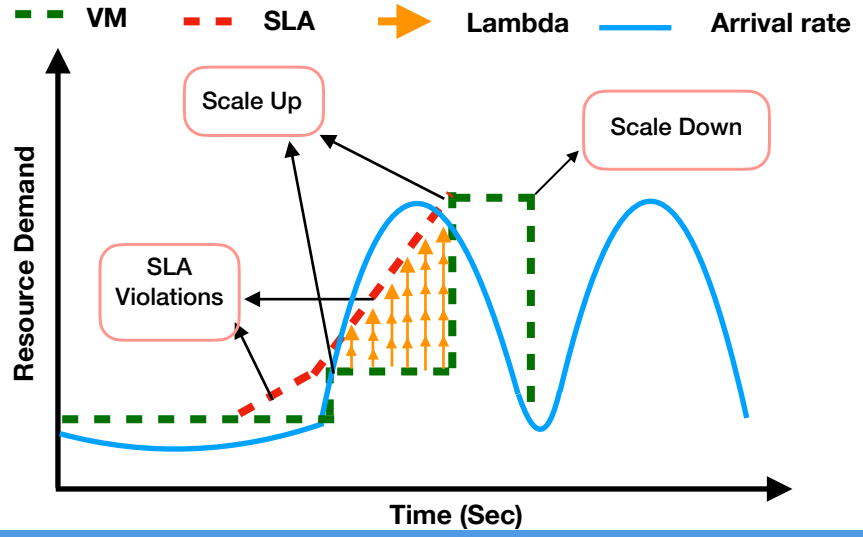
- Each request is an ML inference for caffenet-model
- Cost compared under iso-performance.
- All requests have similar SLA compliance.
- VMs are provisioned for the peak request rate.





Why SPOCK.?

- Use serverless functions along with VMS
  - Reduce SLO violations during request surge
  - Reduce intermittent over-provisioning VMs



Key Motivation

- It is non-trivial to predict the peak request rate at any given time period.
- Provisioning VMs for the peak demands would always lead to higher cost of deployment. While, under provisioning VMs leads to severe SLO violations for queries.
- Using serverless functions would overcome the SLO violation problem. However, it is not cost effective.

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Spock Scheme

- Schedule queries on VM's if available.
- If VM's are fully utilized, redirect queries to lambda functions.
- Spawn a new VM in the meantime.
- After spin-up incoming requests are sent to new VMs.
- Scale down VMs after three minutes of inactivity.

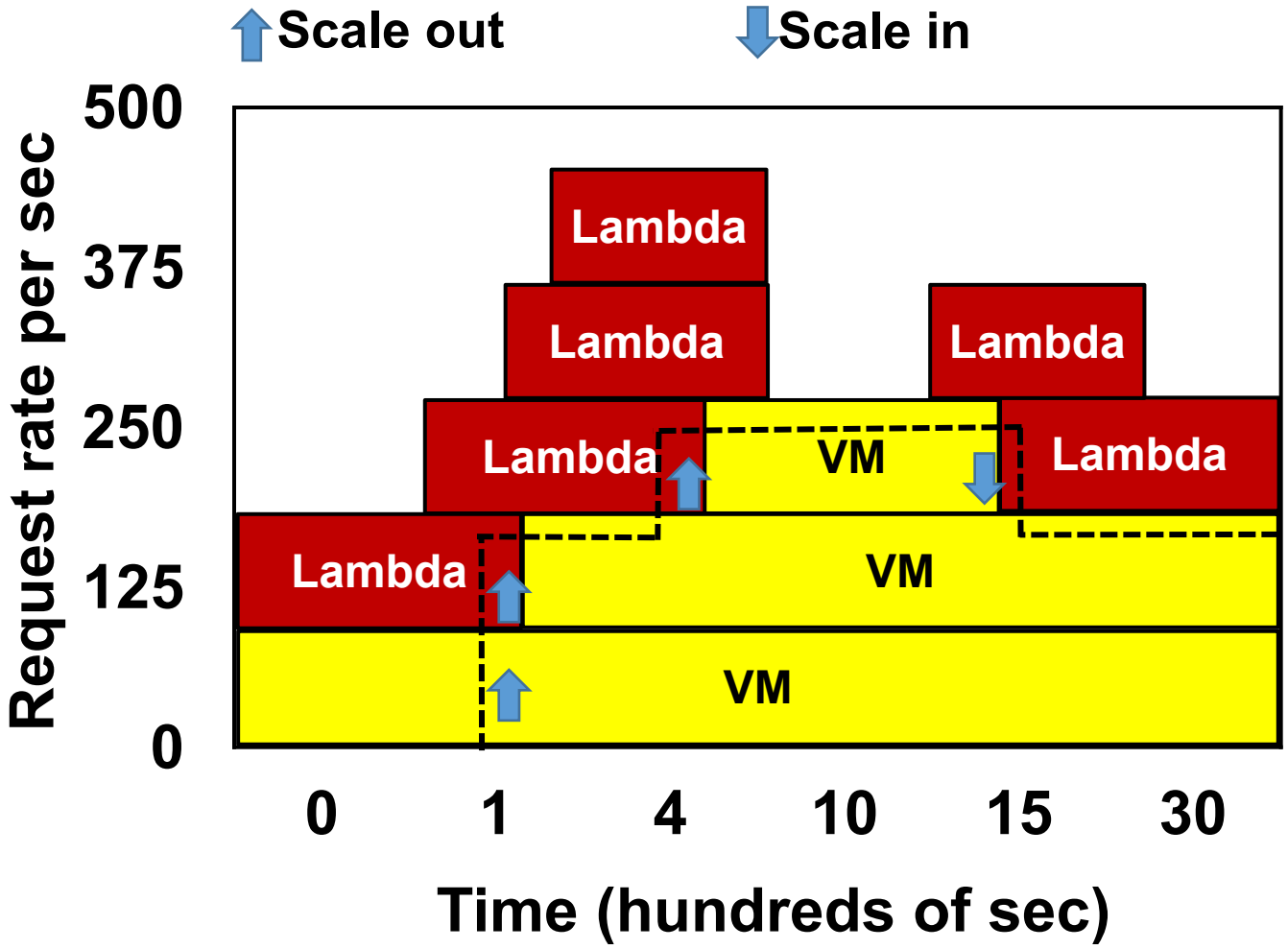
Two Scaling Policies

- **Reactive**
  - Spin-up new VMs as when request surge

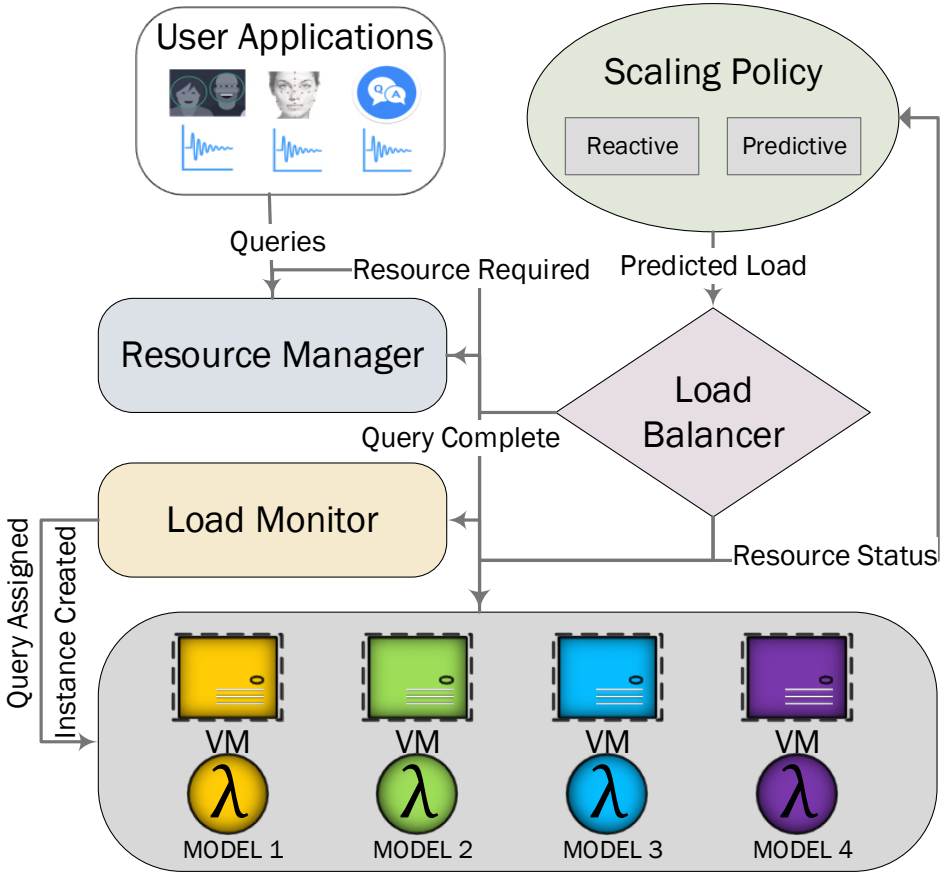
Lets see an example.

- **Predictive**
  - Using moving window linear regression predict request every 1 minute.
  - Spin up new VMs based on prediction.

Spock resource procurement



Overall Design of Spock



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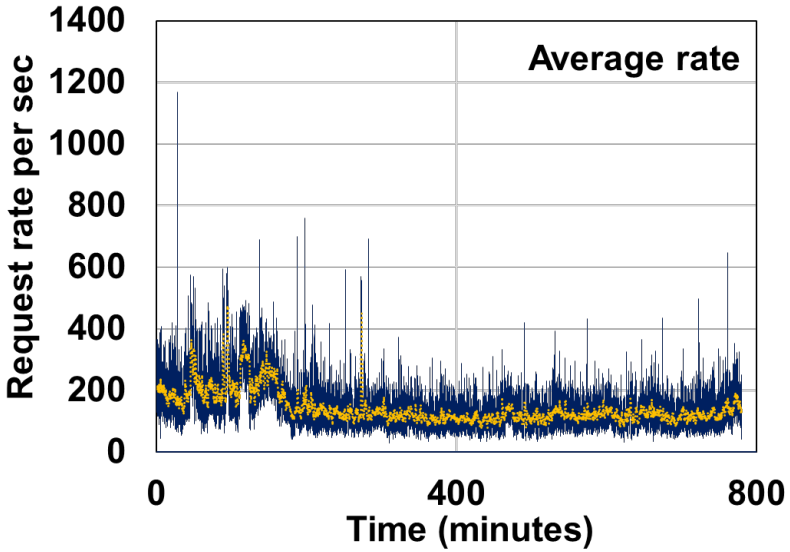
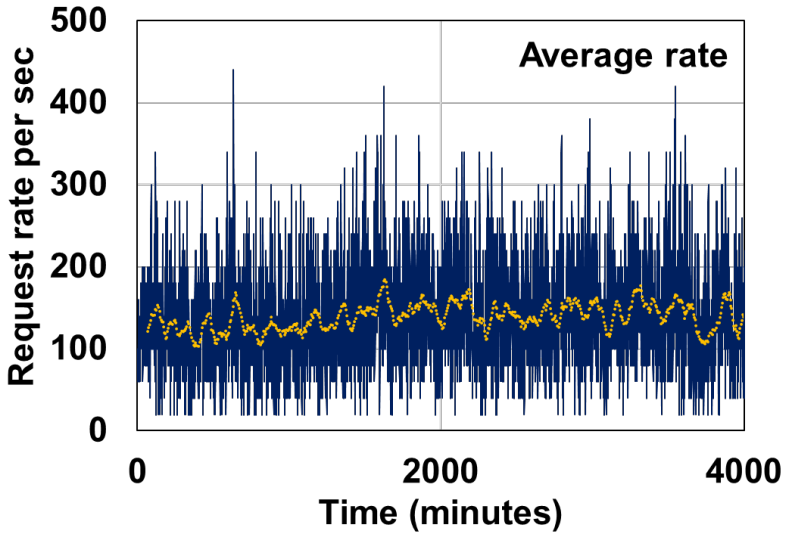
Evaluation

- Two traces used to generate ML inference workload.



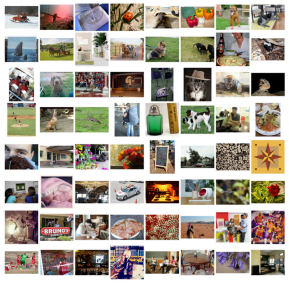
WITS



Berkeley

Evaluation

- Mxnet Framework.
- AWS resources.
- Pretrained ML models on imagenet dataset.



Query Type	Memory Required (GB)	Memory Allocated (GB)	Average Execution (ms)	Requests per vCPU for VMs
Caffenet	1.024	3.072	300	4
Googlenet	0.456	2.048	450	3
Squeezenet	0.154	2.048	130	6
Resnet-18	0.304	3.072	320	3
Resnet-200	1.024	3.072	956	1
Resnext-50	0.645	3.072	560	2

Evaluation

- Two scaling policies
  - **Predictive**
  - **Reactive**
- Three resource procurement schemes
  - **Autoscale**
  - **X-autoscale**
  - **Spock**

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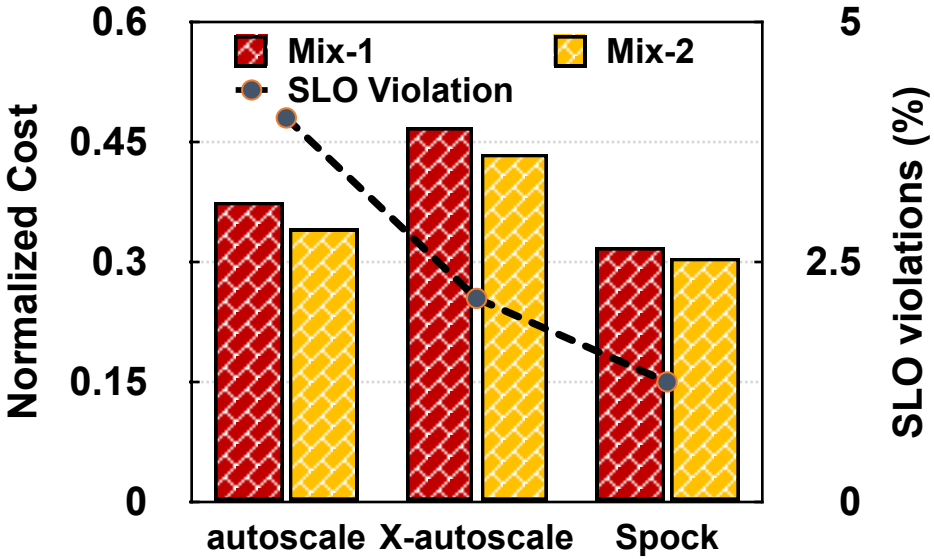
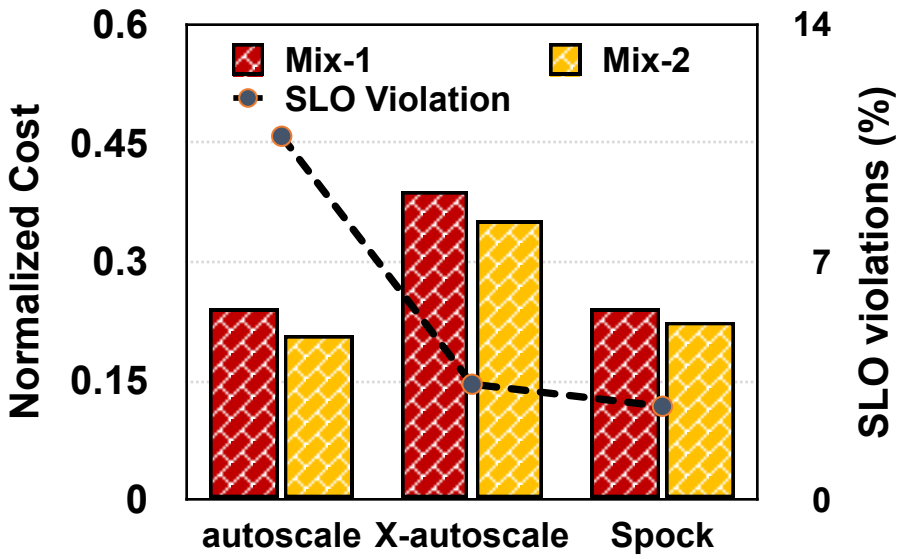
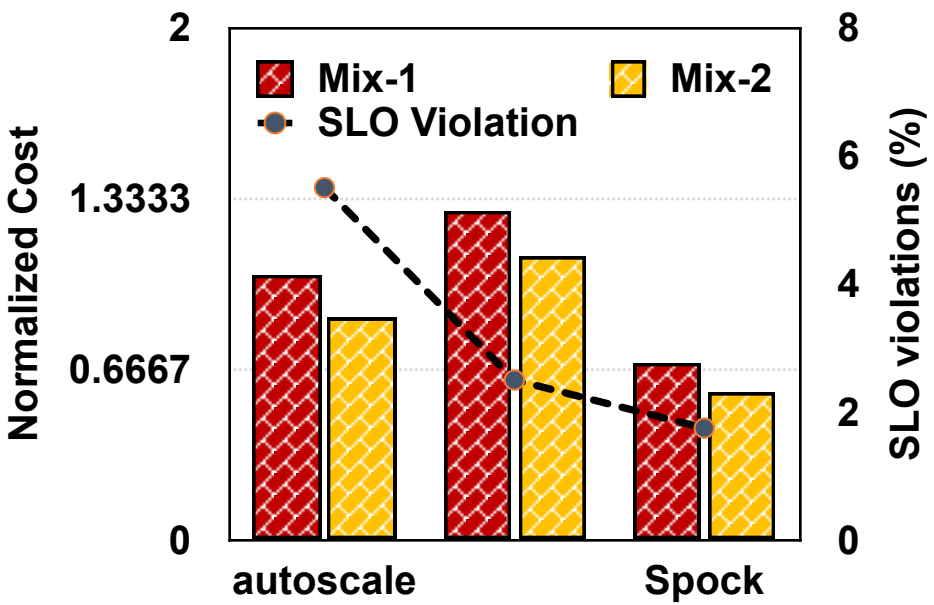
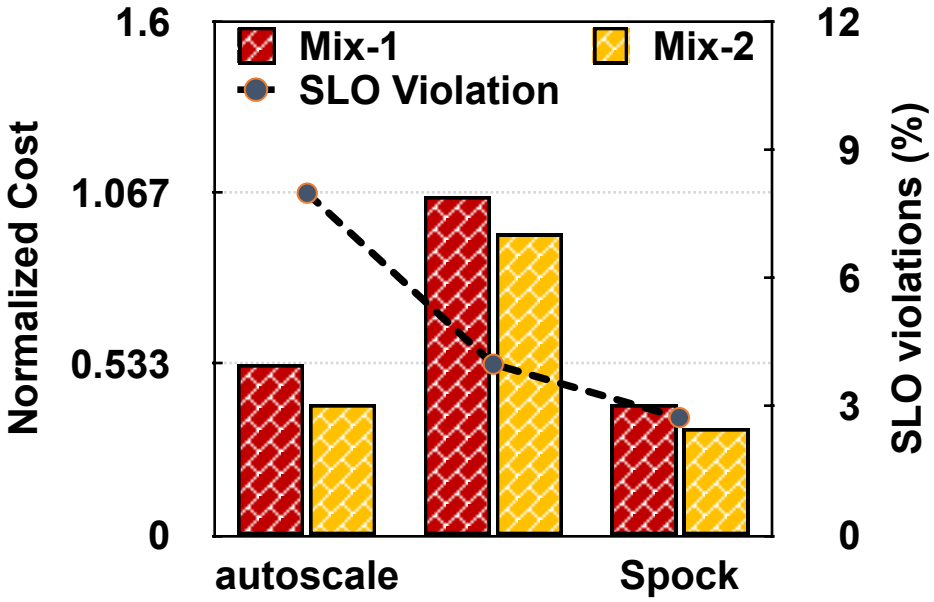
Berkely Trace Results



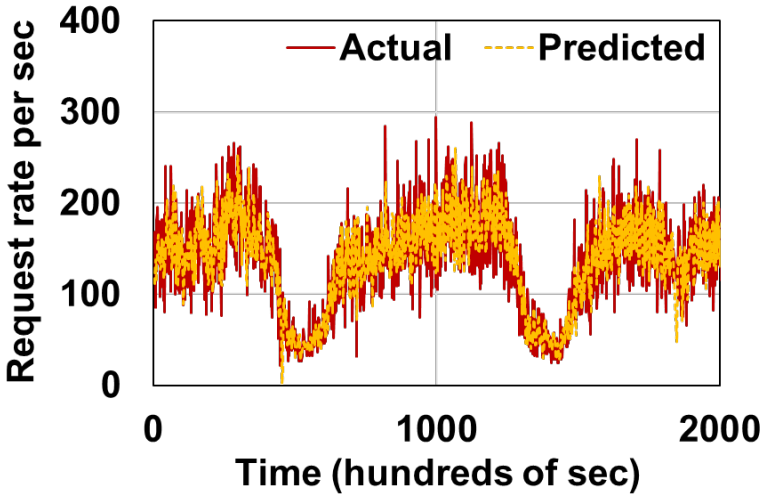


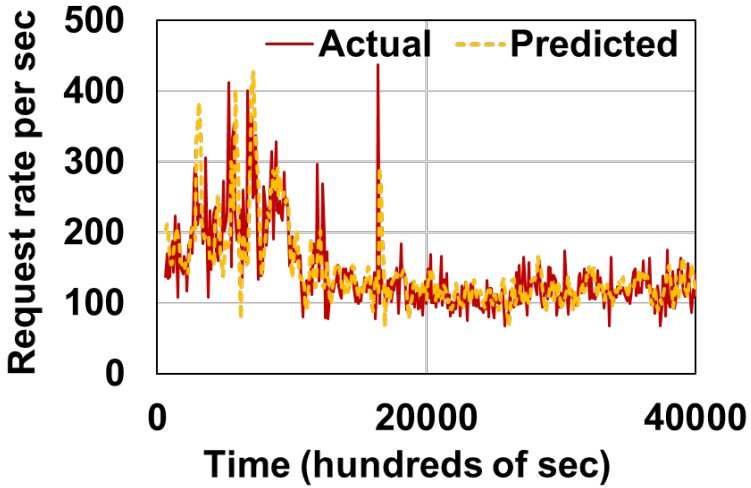
WITS Trace Results





Spock Prediction Accuracy





Spock Resource Procurement