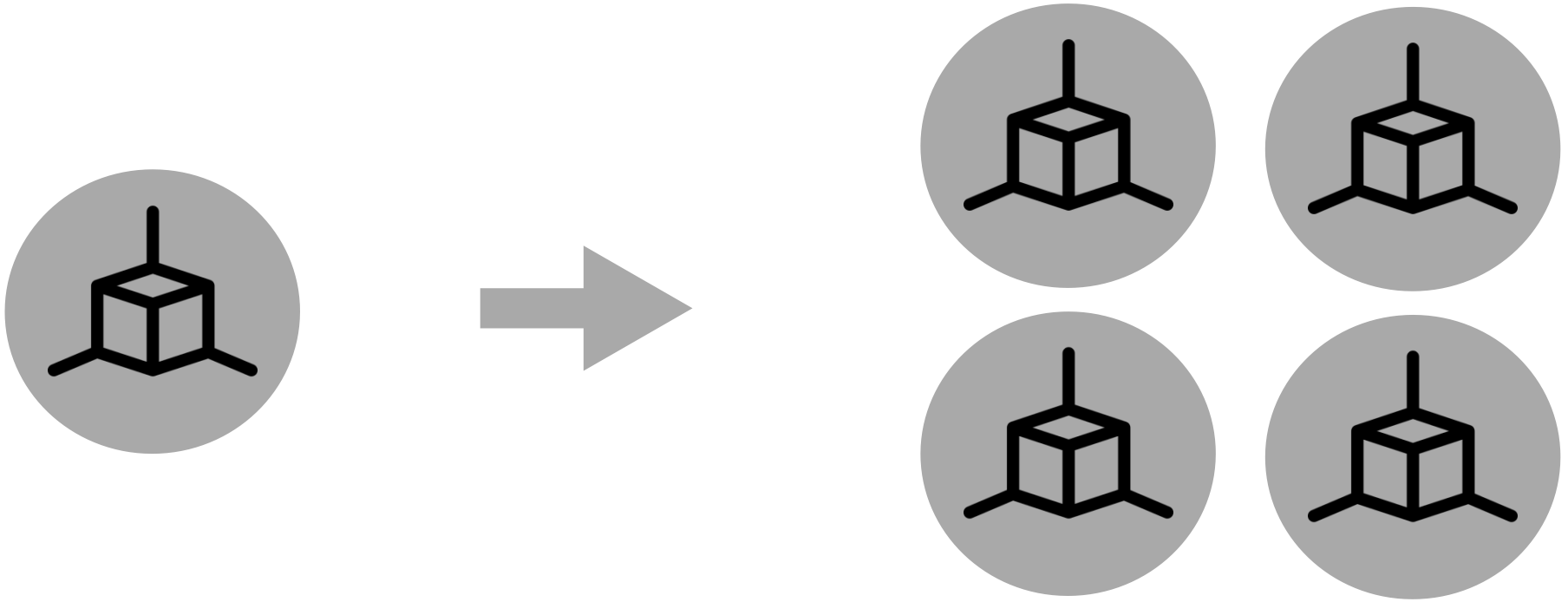
Open Infrastructure & Cloud Native Days Korea 2019
핸즈온 워크샵

How to scale your ML job with Kubernetes

LG전자 유홍근

오늘의 Workshop 내용

- 손쉽게 머신러닝 학습 확장하기



안녕하세요, 저는요

커피고래 (coffeewhale.com)

- ML, Container

술 좋아하면 술고래,
커피 좋아하면 커피고래

학사 - 컴퓨터 공학

석사 - 텍스트 분석

커피고래

LG전자 스마트데이터실

오늘 다루지 않을 내용

- 쿠버네티스에 대한 상세한 내용

API server? ✕

kubernetes

Kubelet? ✕

오늘 다루지 않을 내용

- 모델링에 대한 이야기

새로운 모델 소개? ✗

Model

모델 적용 사례? ✗

발표내용

누구나

손쉽게 기계학습 훈련

확장시키는 방법

feat. Kubernetes

기계학습 엔지니어링의 중요성

- 쿠버네티스를 이용하여 손쉽게 모델을 학습 시킵시다!

뛰어난 모델

탄탄한 머신러닝 엔지니어링 스킬

kubernetes

기계학습 엔지니어링의 중요성

- 왜 중요할까요?

> **AI 연구에서 엔지니어링 스킬은 생각보다 중요**
>
> 조직 이동전에는 연구에 엔지니어링 스킬이 어느정도 필요할지 감을 잡지 못했다. 지금은 엔지니어링 스킬이 연구를 위해 가장 필요한 체력적인 부분이라는 것에 100% 공감하고 있다. 축구 선수로 치면 체력이 좋아야 슛을 많이 시도할 수 있는 것과 같다.

“데이터 과학자에서 AI 연구자로 들어서며…”
SKT T-Brain 전희원
http://freesearch.pe.kr/archives/4905

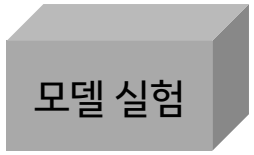
모델

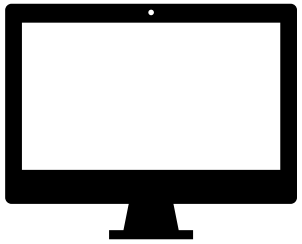
- 모델이란 무엇일까?

Model

모델

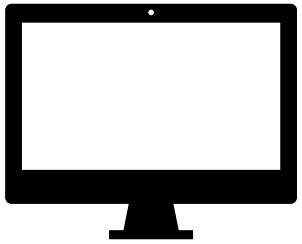
- 기계학습 시대





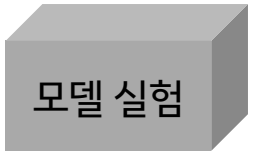
모델

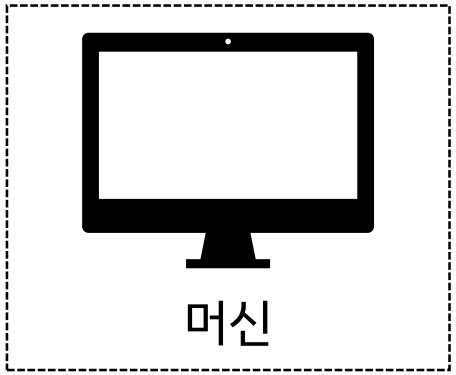
- 기계학습 시대



모델

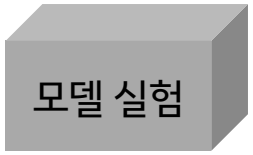
- 기계학습 시대

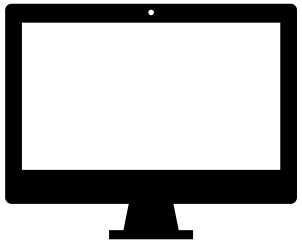




모델

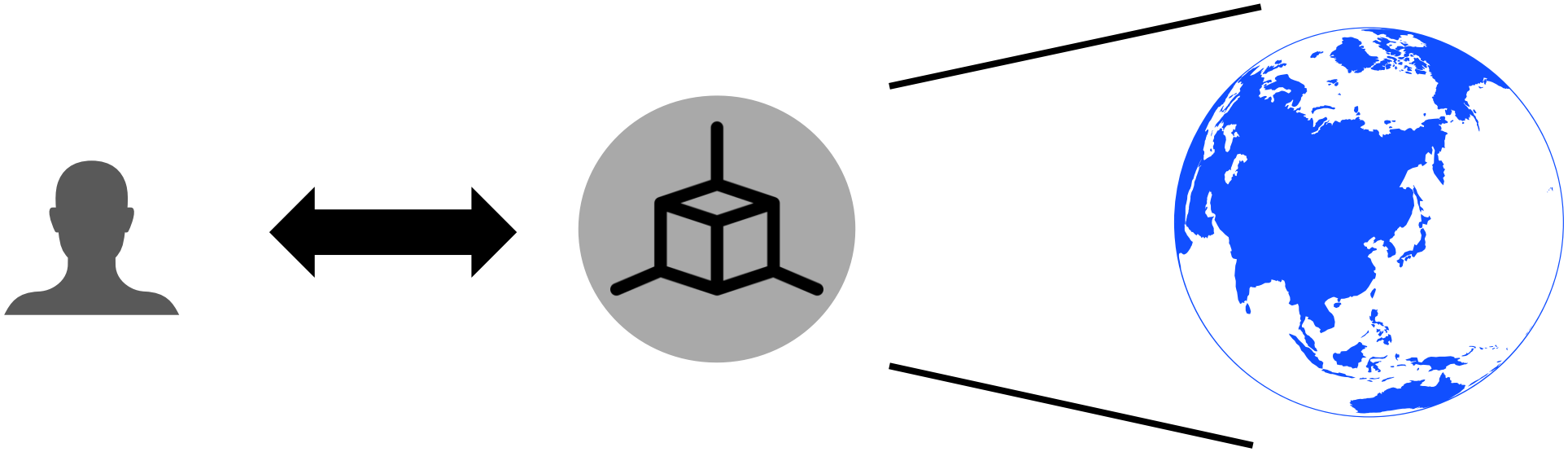
- 기계학습 시대





모델

- 조금 더 근본적인 생각
  - 현실 세계의 모습을 반영하는 매개체



Rule Based 모델

- 나의 주말 계획 모델

```
def my_weekend_plan(status):

    if status == boring:
        return play()
    elif status == hungry:
        return eat()
    else:
        return sleep()
```

Numeric 모델

- 거리 계산 모델

```
def distance_cal(velocity, time):
    return velocity * time
```

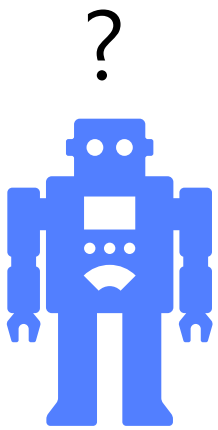
확률적 모델

- 동전 앞면이 나올 확률

```
p(H) = 0.5
p(T) = 0.5
```

기계가 학습한 모델

- 사람 손으로 풀기 어려운 복잡한 문제

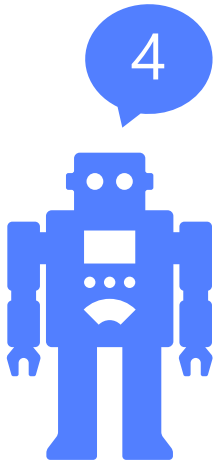


$$y = Ax + Bx^2 + C$$

풀기 어려운 문제

기계가 학습한 모델

- 기계한테 맡겨 보자!

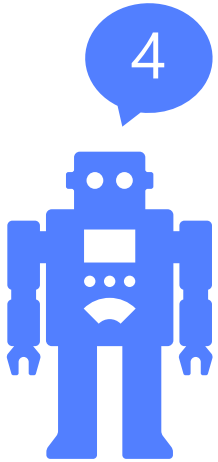


$$y = Ax + Bx^2 + C$$

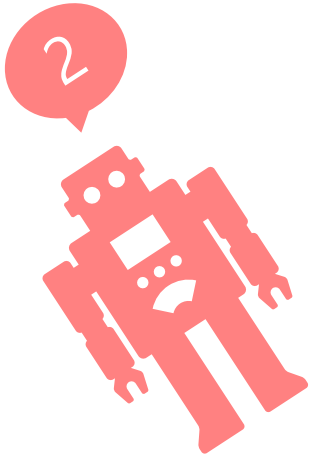
풀기 어려운 문제

기계가 학습한 모델

- 여러가지 경우의 수를 계산

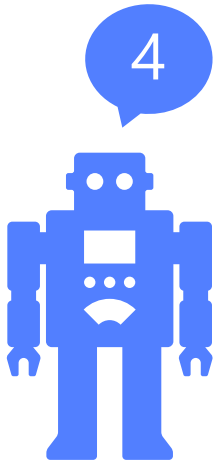


$$y = Ax + Bx^2 + C$$

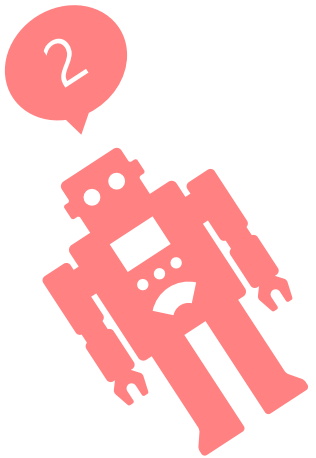


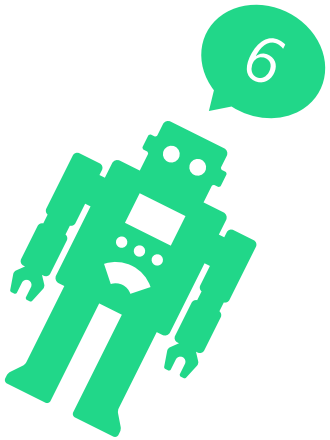
기계가 학습한 모델

- 필연적으로 많은 기계가 필요



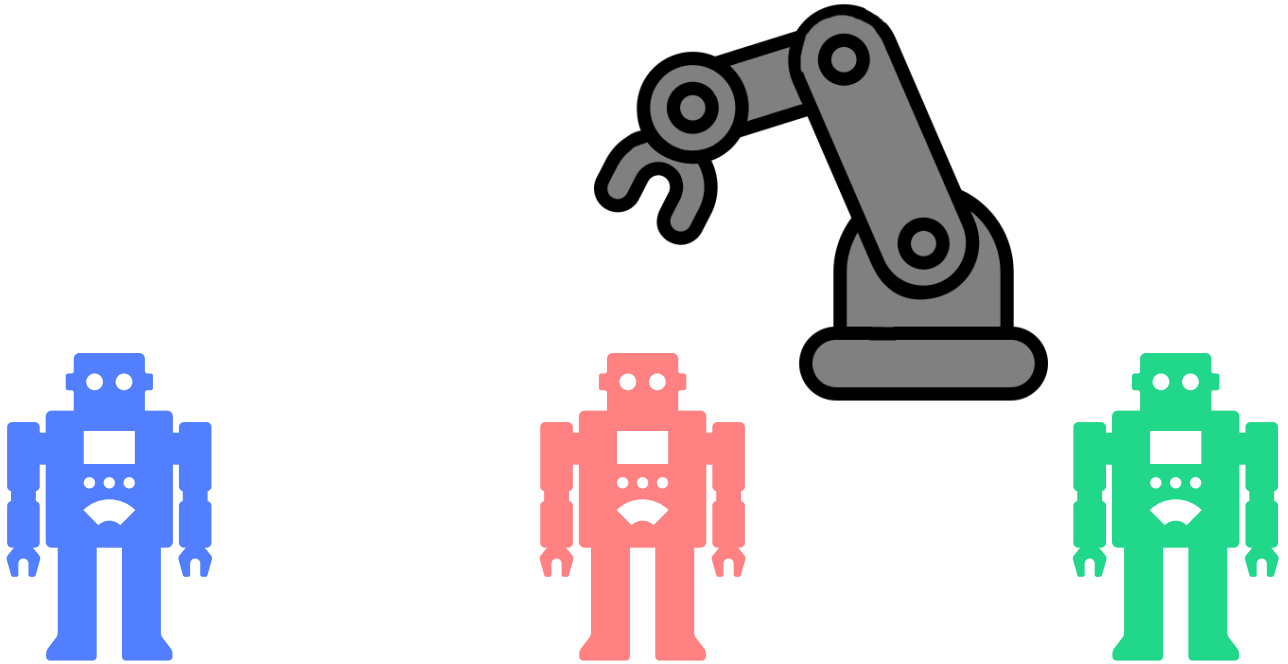
$$y = Ax + Bx^2 + C$$





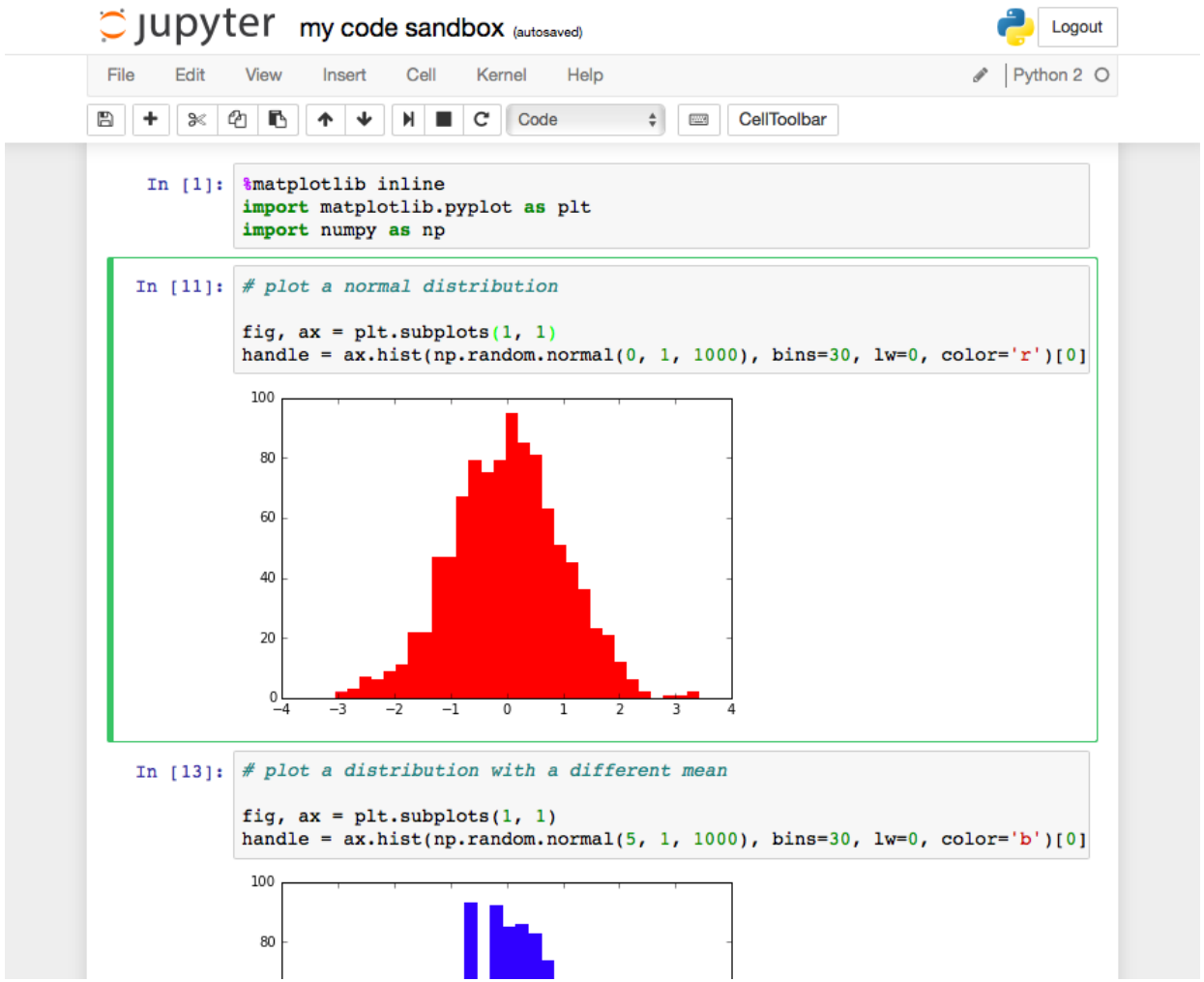
시작하게 된 고민

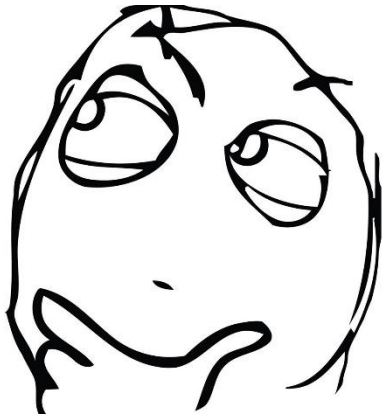
- 어떻게 하면 많은 기계들을 효율적으로 관리할 수 있을까?



나의 첫 모델 개발기

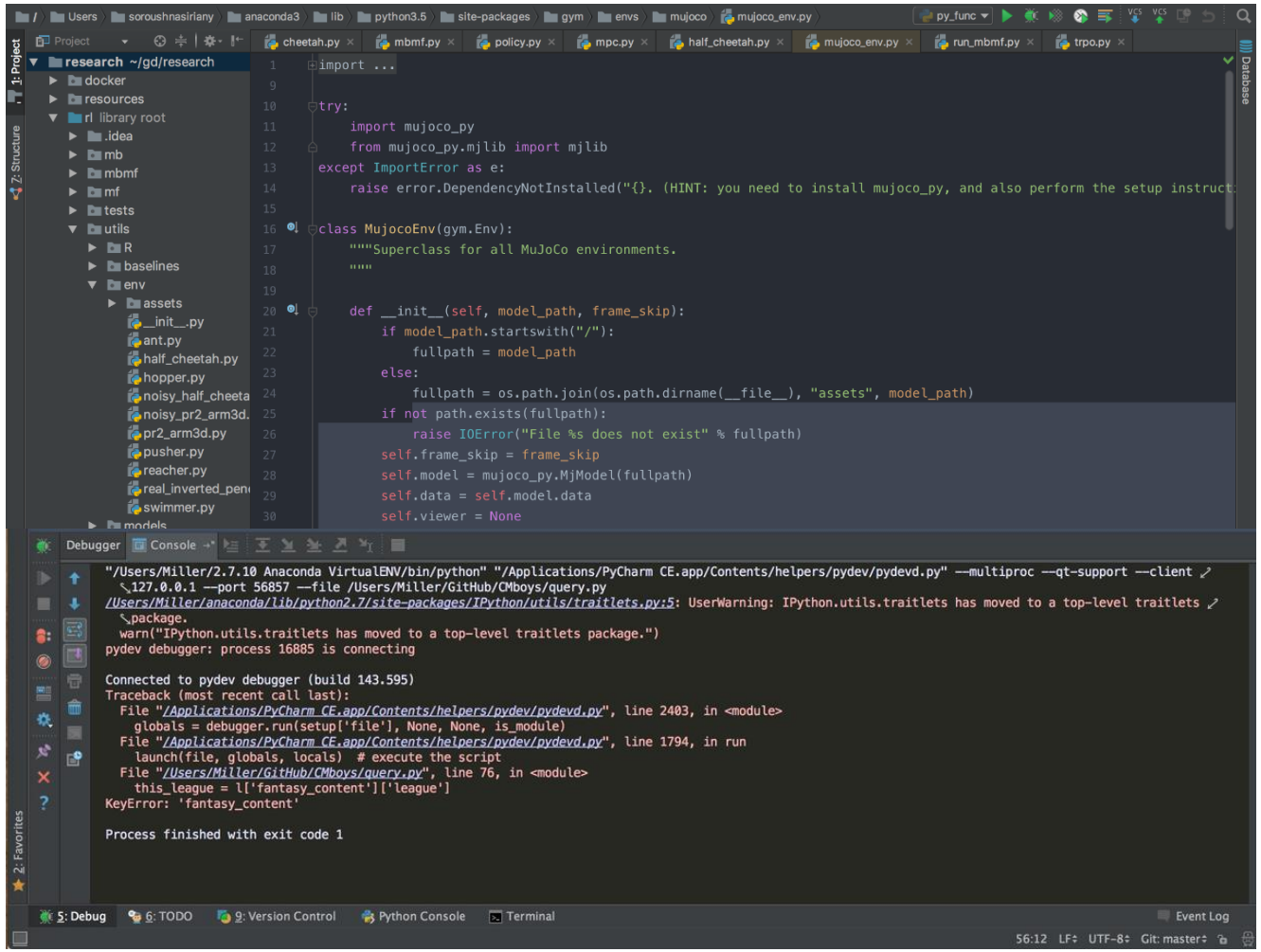
- 주피터 노트북으로 EDA & Vanilla 모델 개발





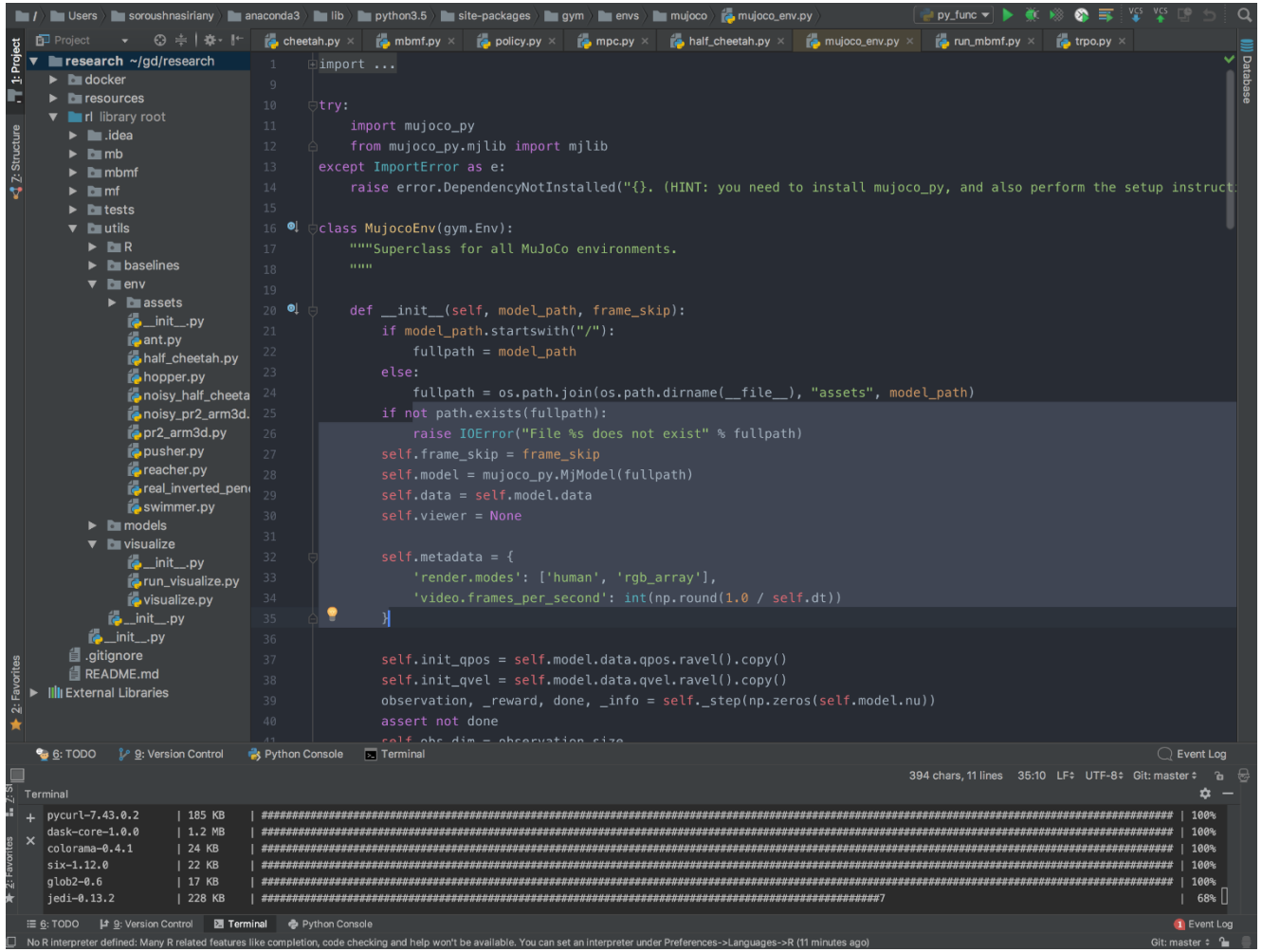
나의 첫 모델 개발기

- Run python



나의 첫 모델 개발기

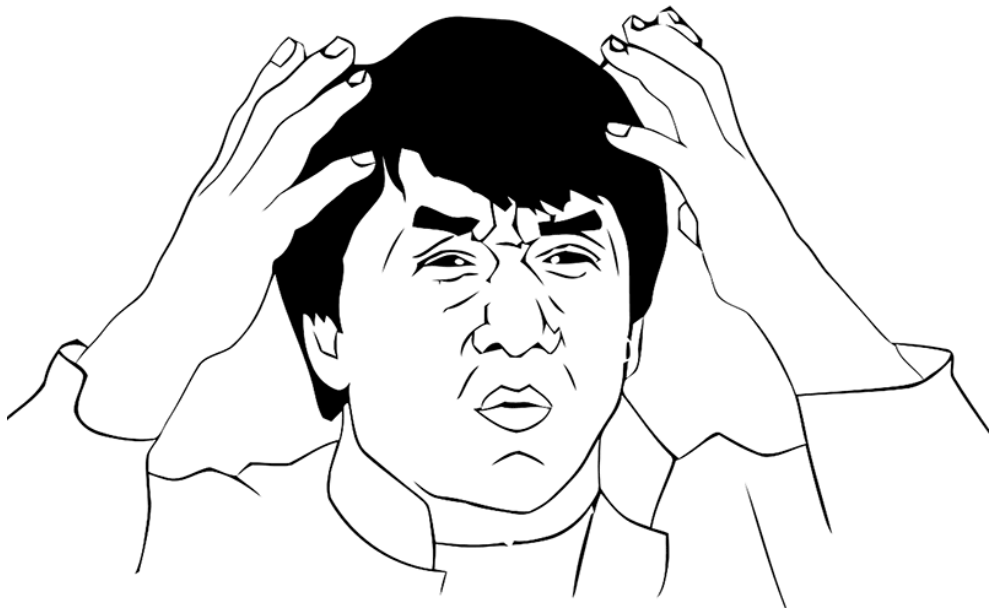
- Success!



나의 첫 모델 개발기

- 2시간 뒤….

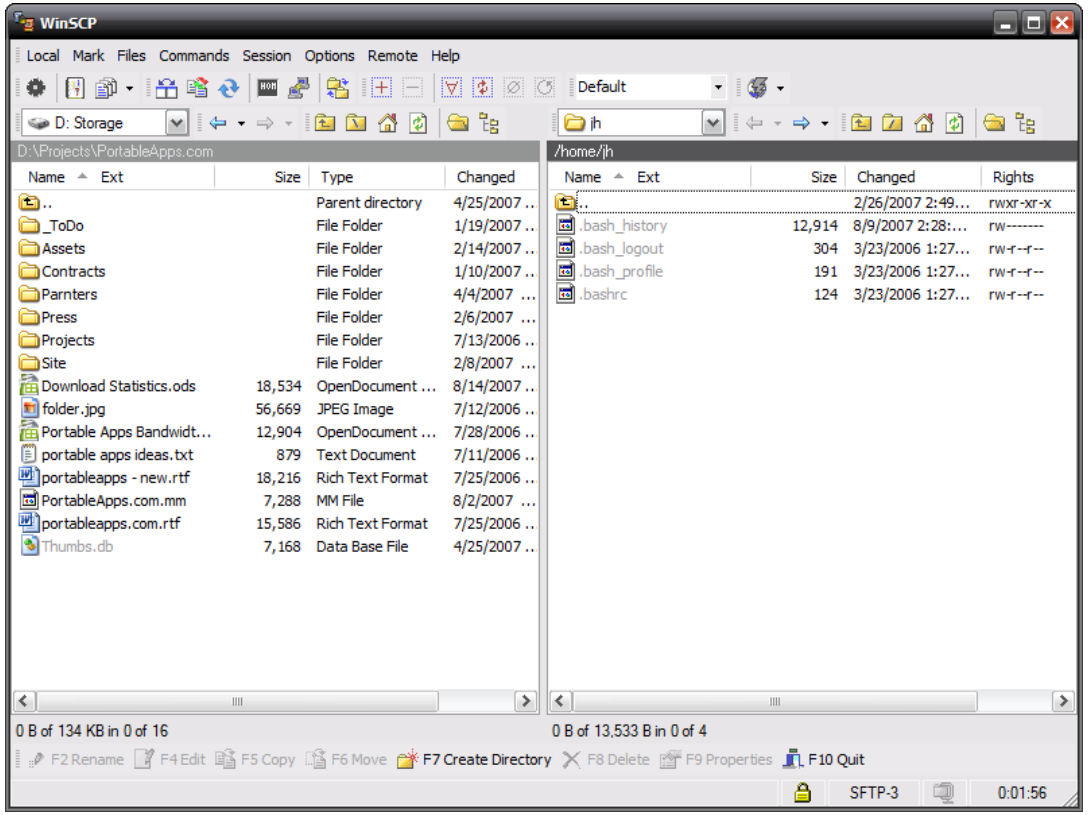
It’s too slow!!

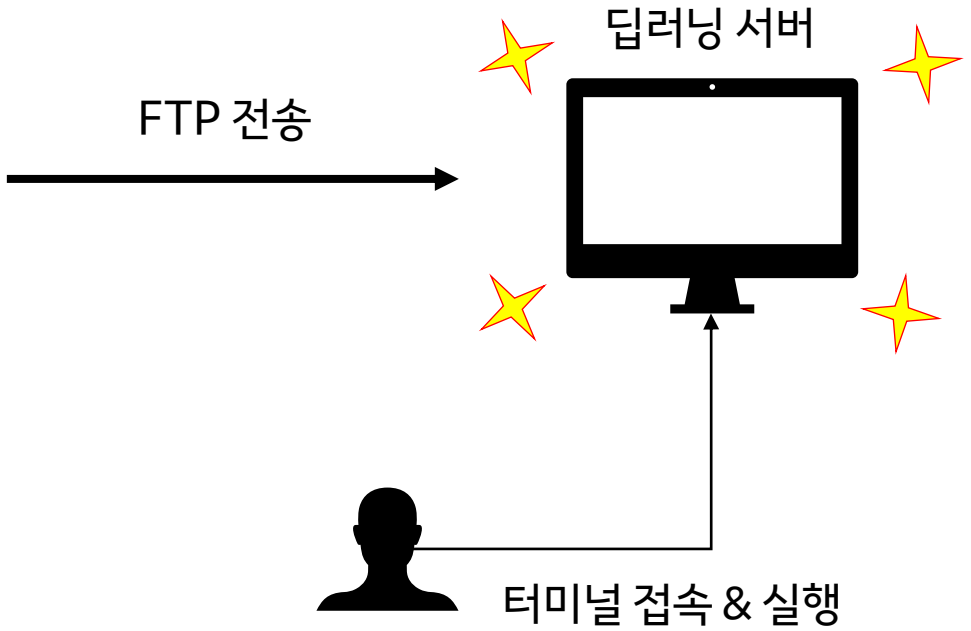


```
3%|▌         | 3/100 [00:03<01:37,  1.00s/it]
```

나의 첫 모델 개발기

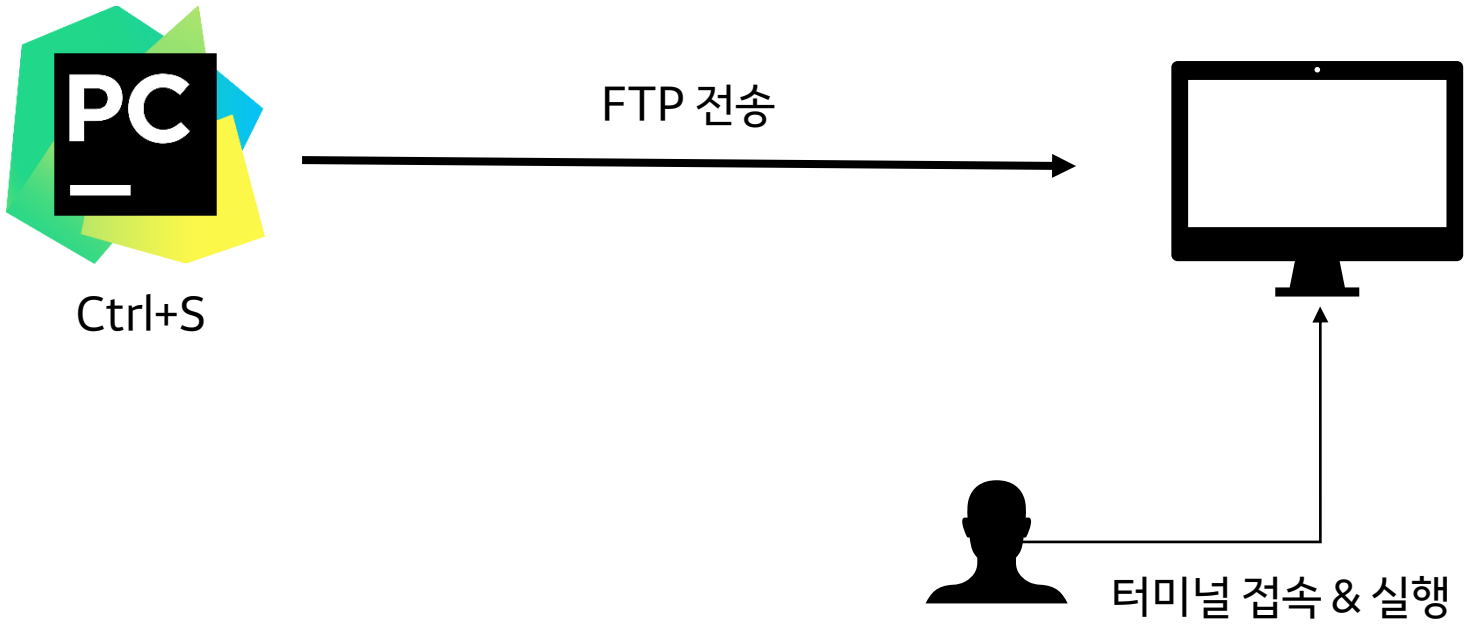
- FTP로 서버로 파일 전송 후 학습 실행





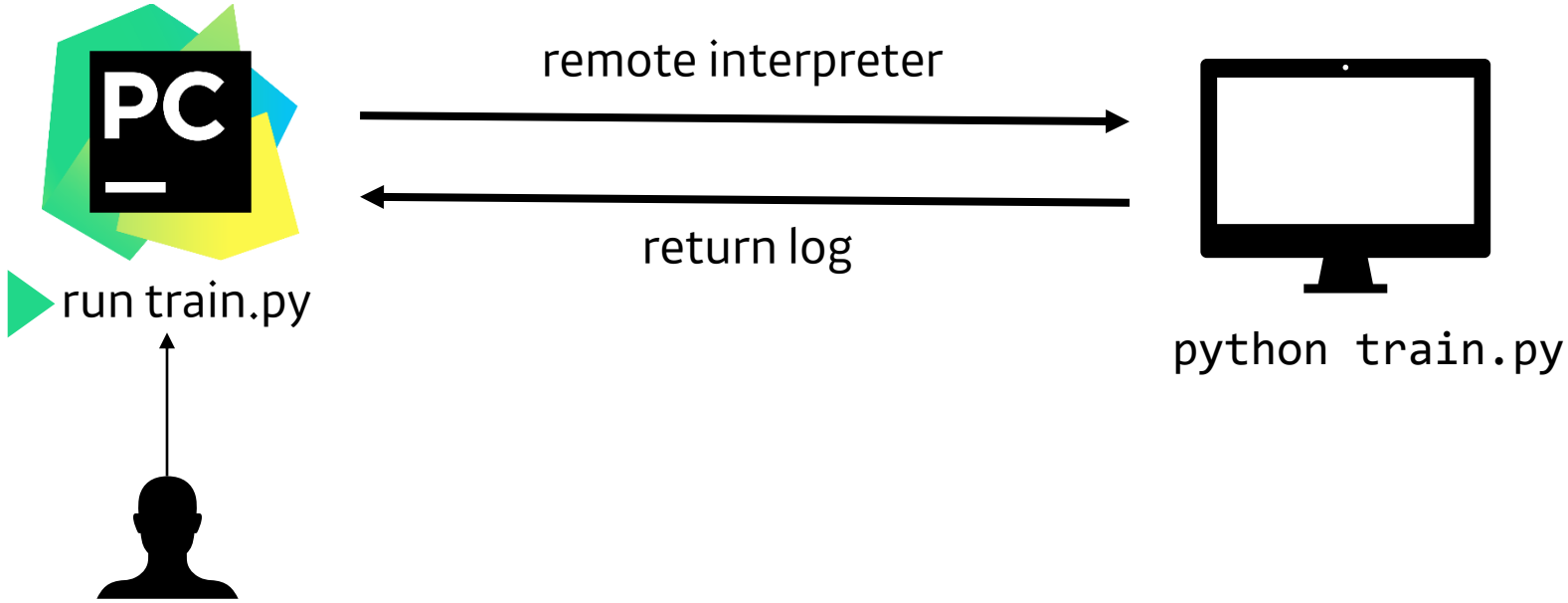
나의 첫 모델 개발기

- 파일 저장 → 자동 FTP 전송



나의 첫 모델 개발기

- Remote execution (professional)

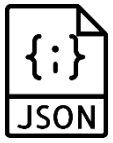


나의 첫 모델 개발기

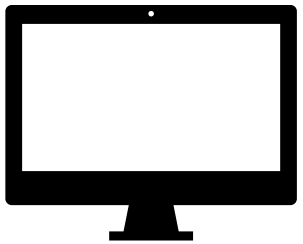
- 좋아, 이제 모델 실험의 개수를 늘려보자!

나의 첫 모델 개발기

- 모델 실험 리스트 생성



params.json



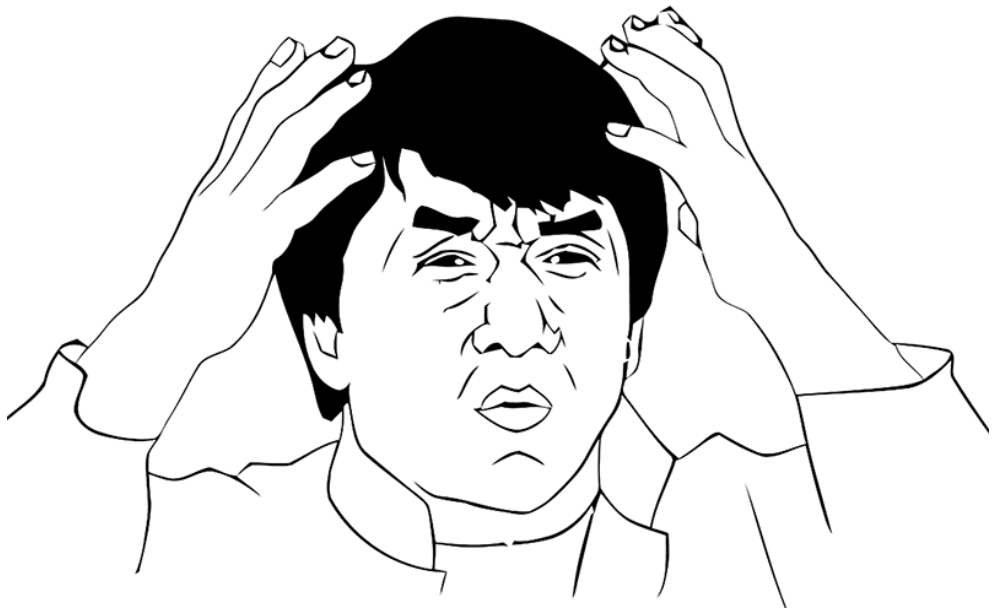
python train.py params.json

```
[
  {
    “model”: “CNN-01”,
    “preproc”: “algo-01”,
    “params”: [
       “weight=0.5 depth=2”,
       “weight=0.3 depth=3”
    ]
  },
  {
    “model”: “RNN-01”,
    “preproc”: “algo-02”,
    “params”: [
       “dropout=0.5 act=softmax”,
       “dropout=0.7 act=tanh”
    ]
  },
  ……
]
```

나의 첫 모델 개발기

- 실험 모델이 많이지다 보니….

It’s too slow!!



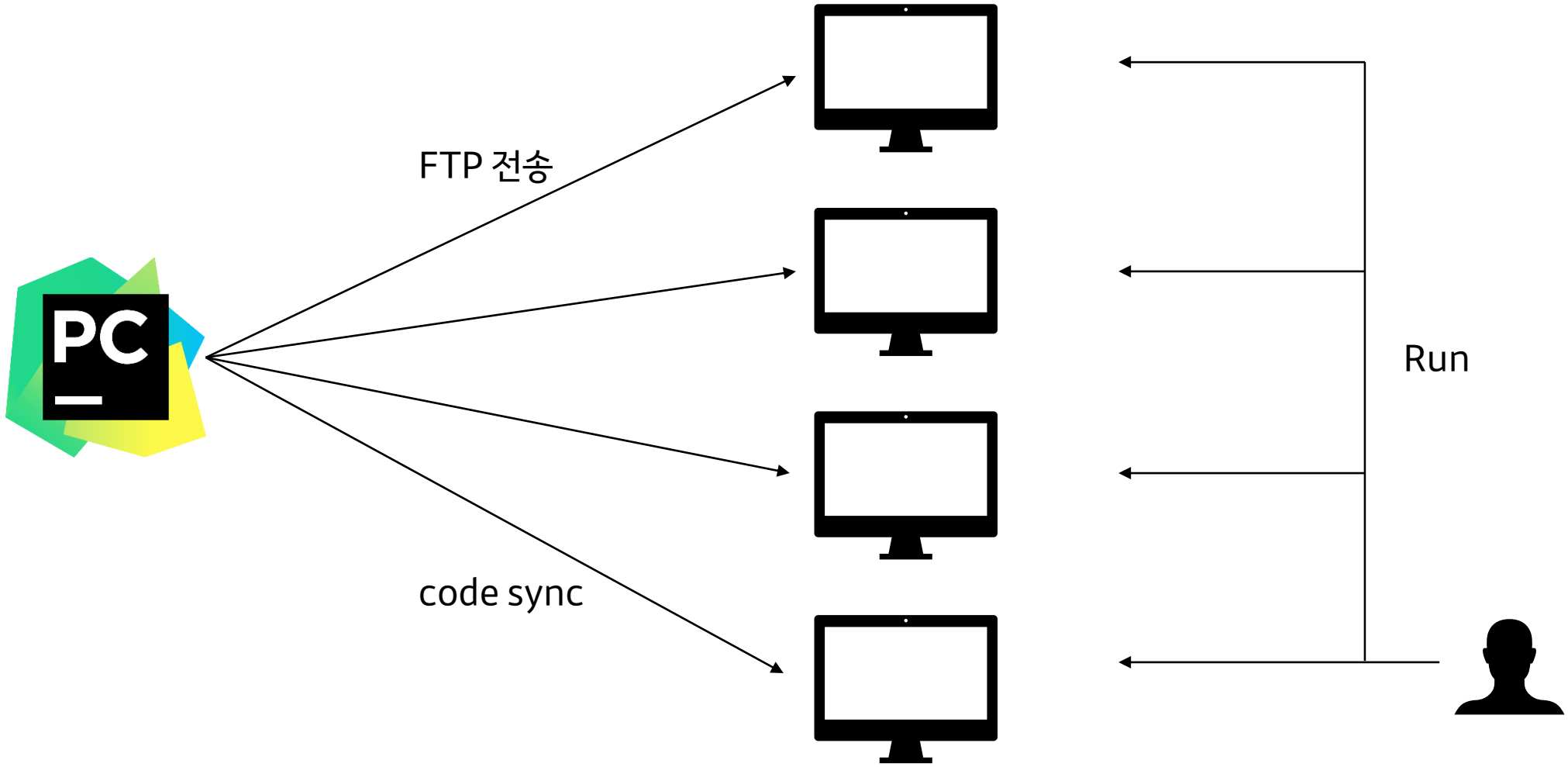
```
3%|▌         | 3/100 [00:03<01:37,  1.00s/it]
```

나의 첫 모델 개발기

- 좋아, 이제 서버의 개수를 늘려보자!

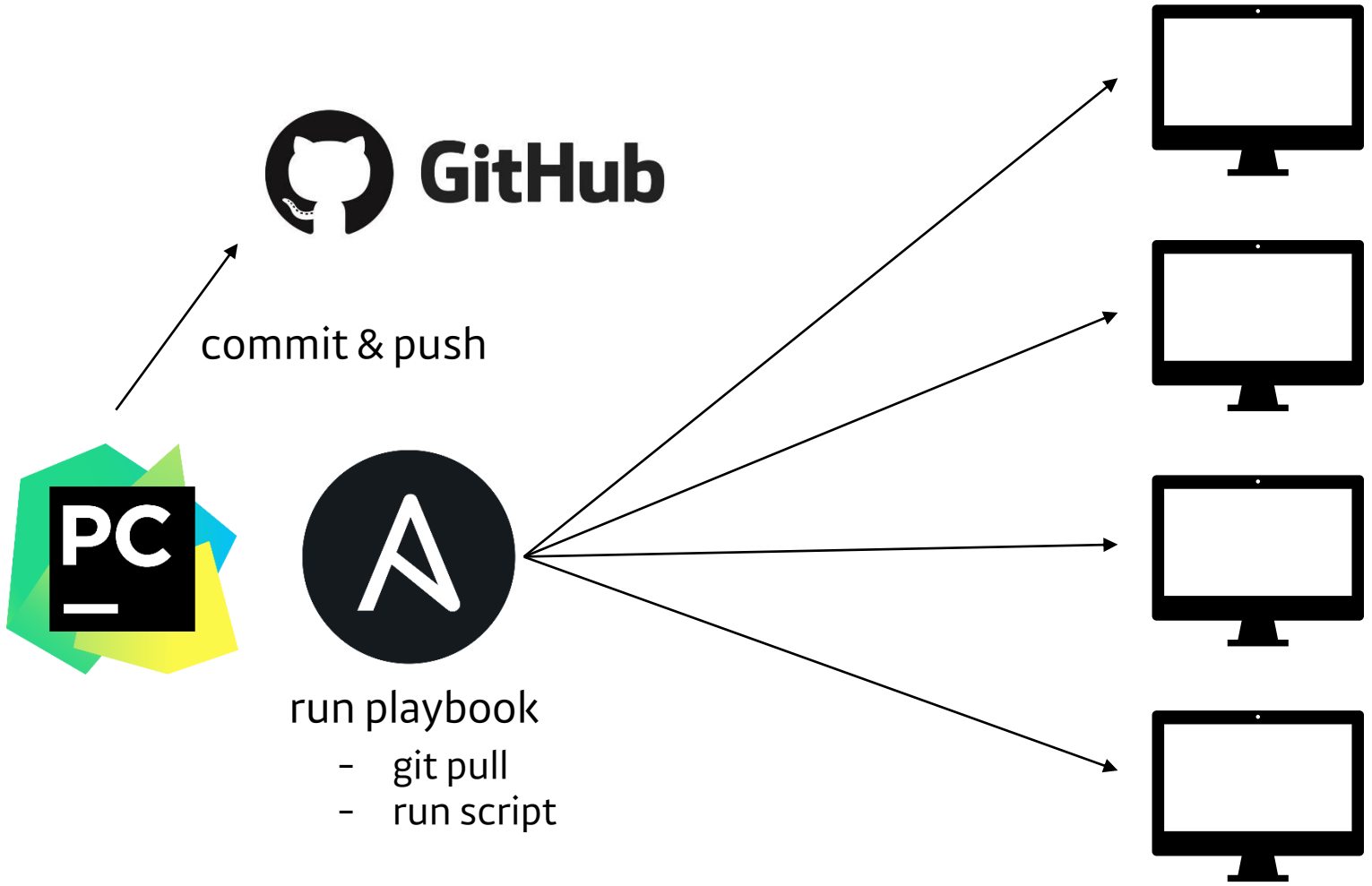
나의 첫 모델 개발기

- 각 서버에 FTP 전송 & Run



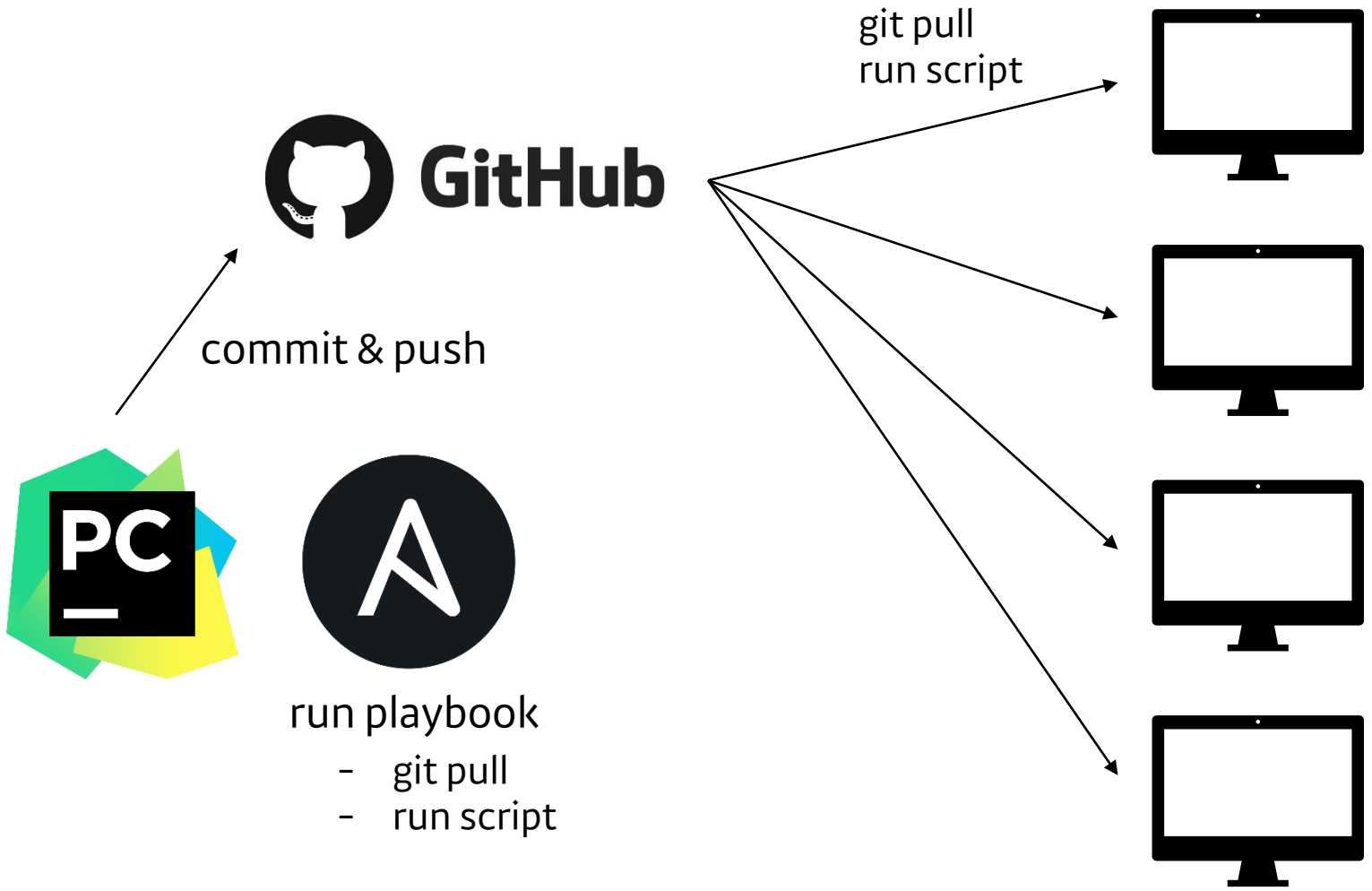
나의 첫 모델 개발기

- 깃&ansible 사용



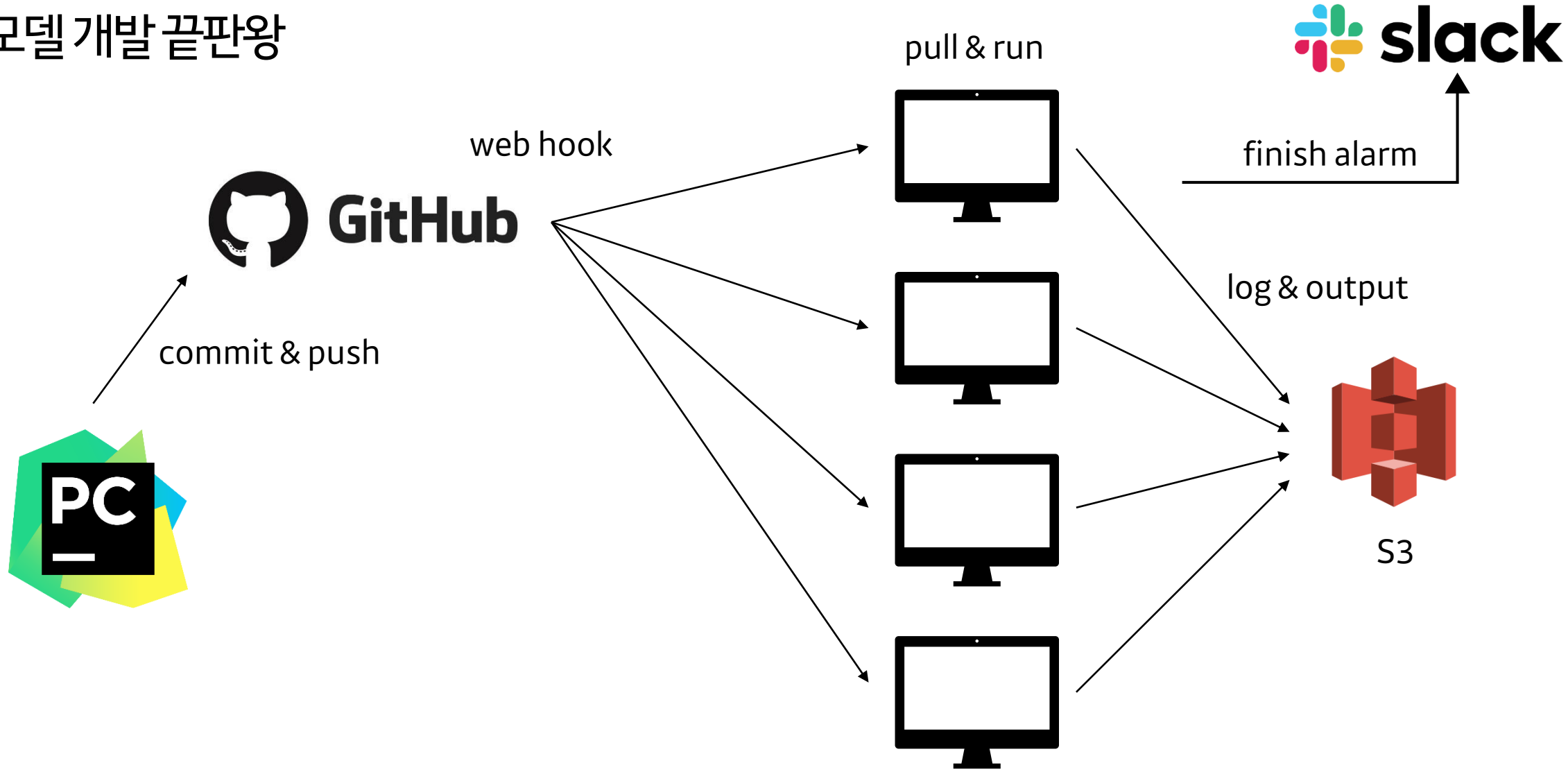
나의 첫 모델 개발기

- 깃&ansible 사용



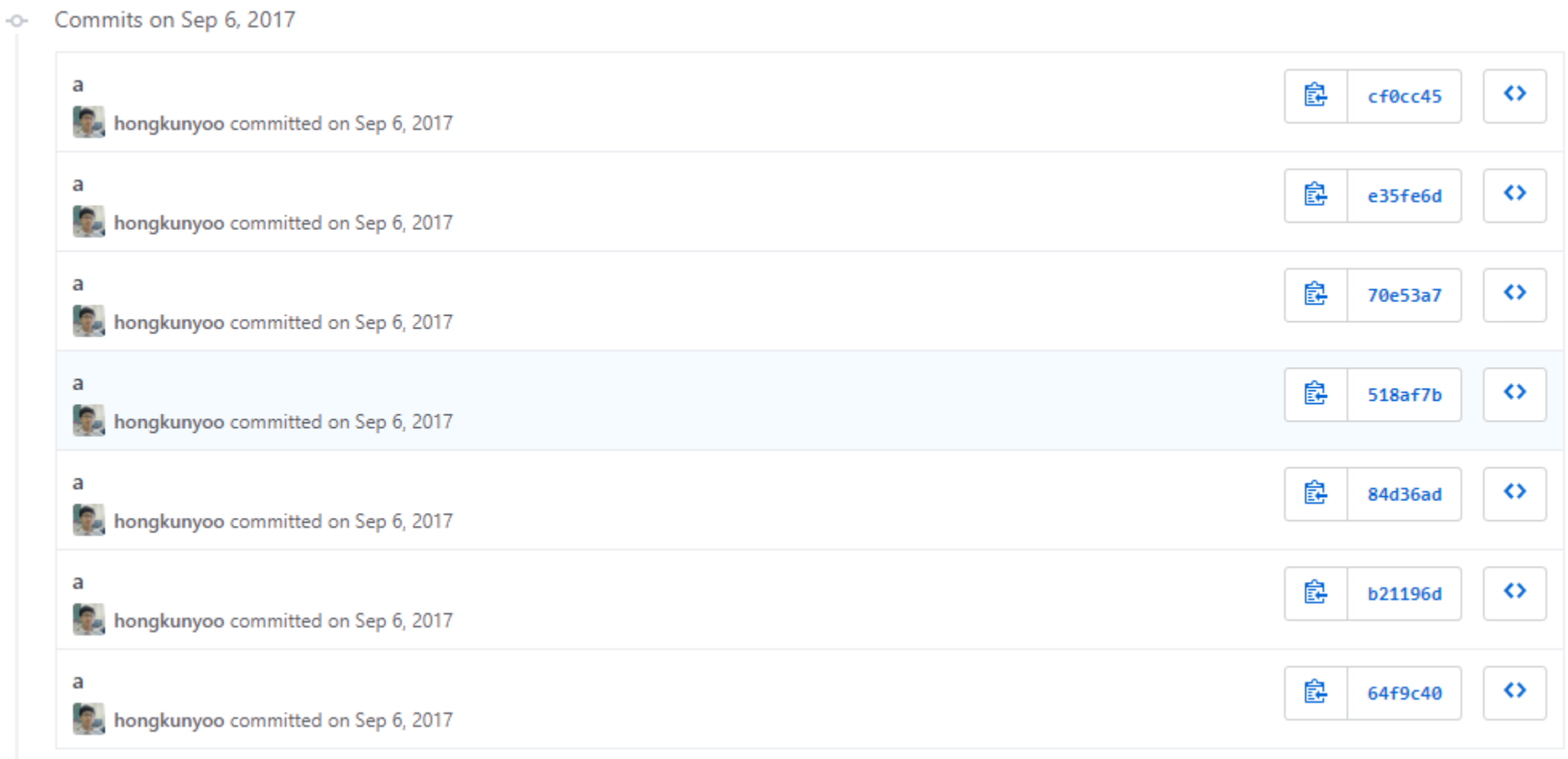
나의 첫 모델 개발기

- 모델 개발 끝판왕



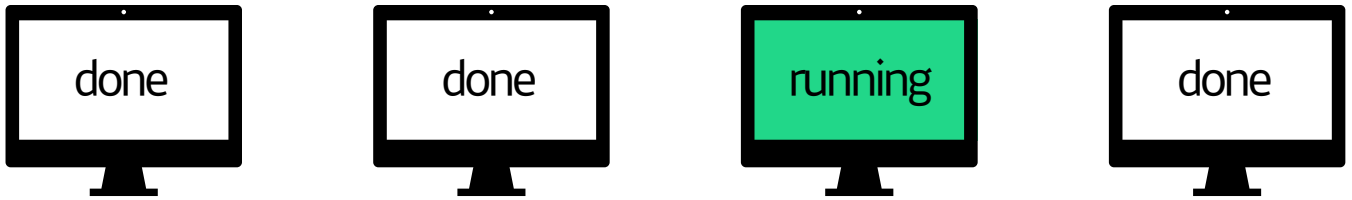
여전히 문제

- 어지럽혀지는 커밋 로그



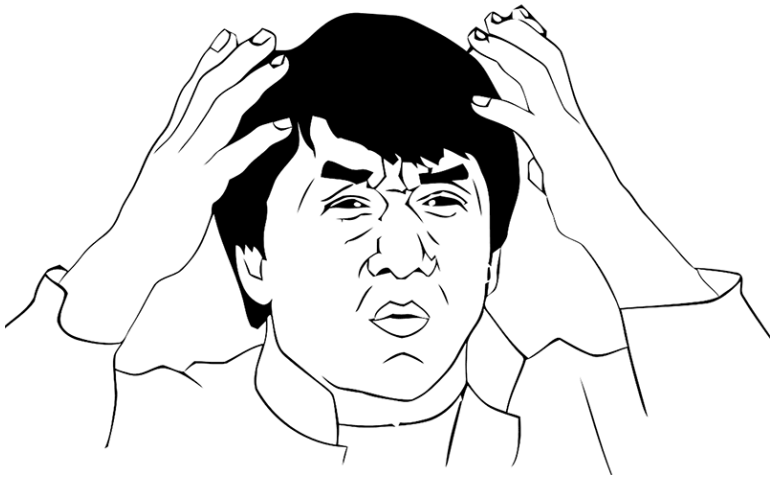
여전히 문제

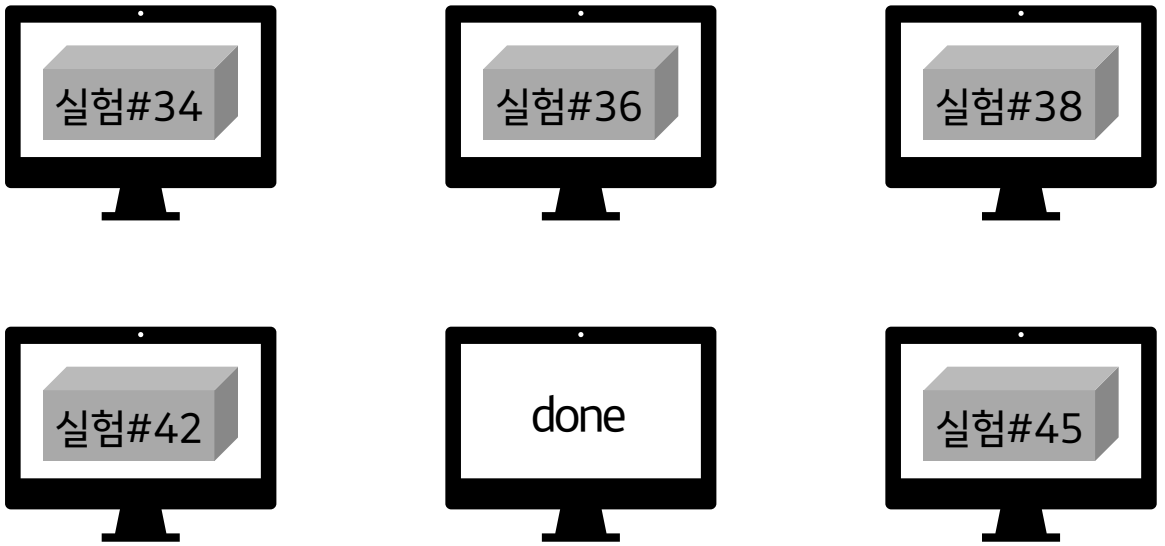
- 학습 끝나는 시간이 달라서 개별적으로 재실행



여전히 문제

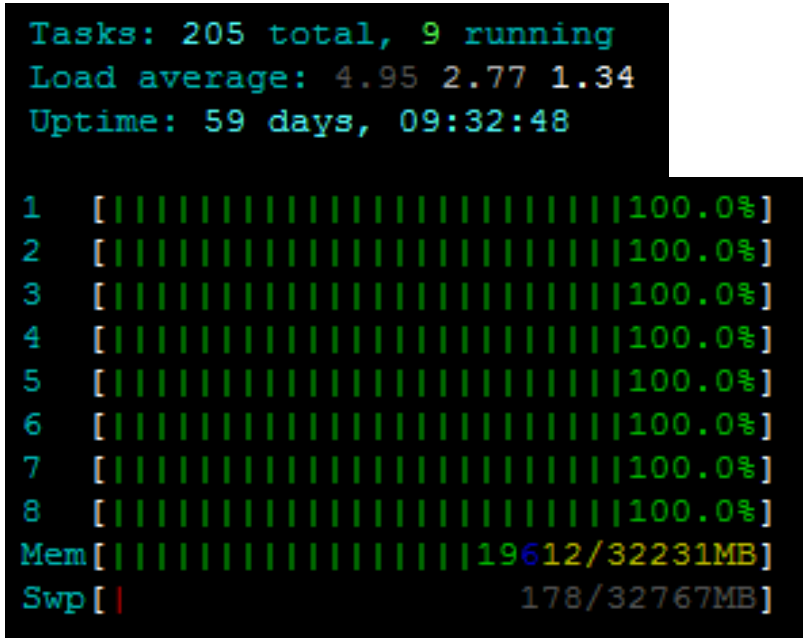
- 어느 서버에서 어떤 모델 실험이 돌아가는지 일일이 찾기가 힘듬





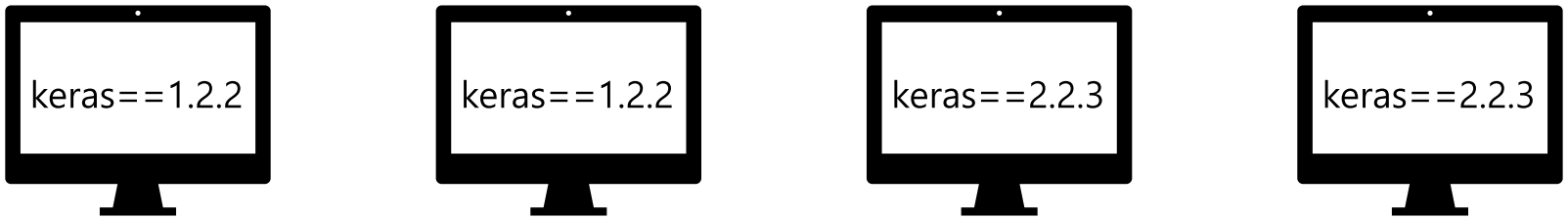
여전히 문제

- 자원 모니터링 & 에러 파악 확인



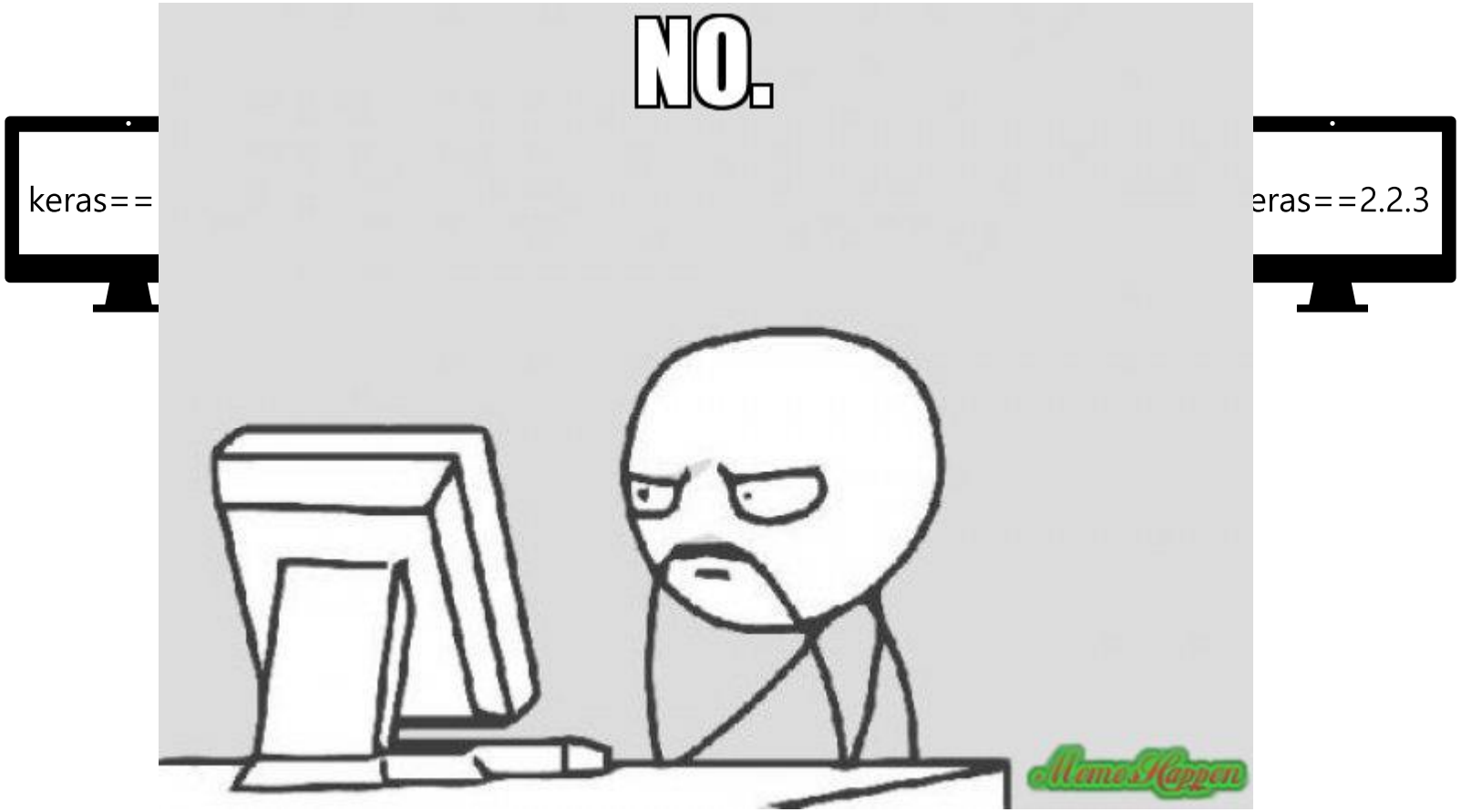
여전히 문제

- 패키지 & 라이브러리 버전 관리



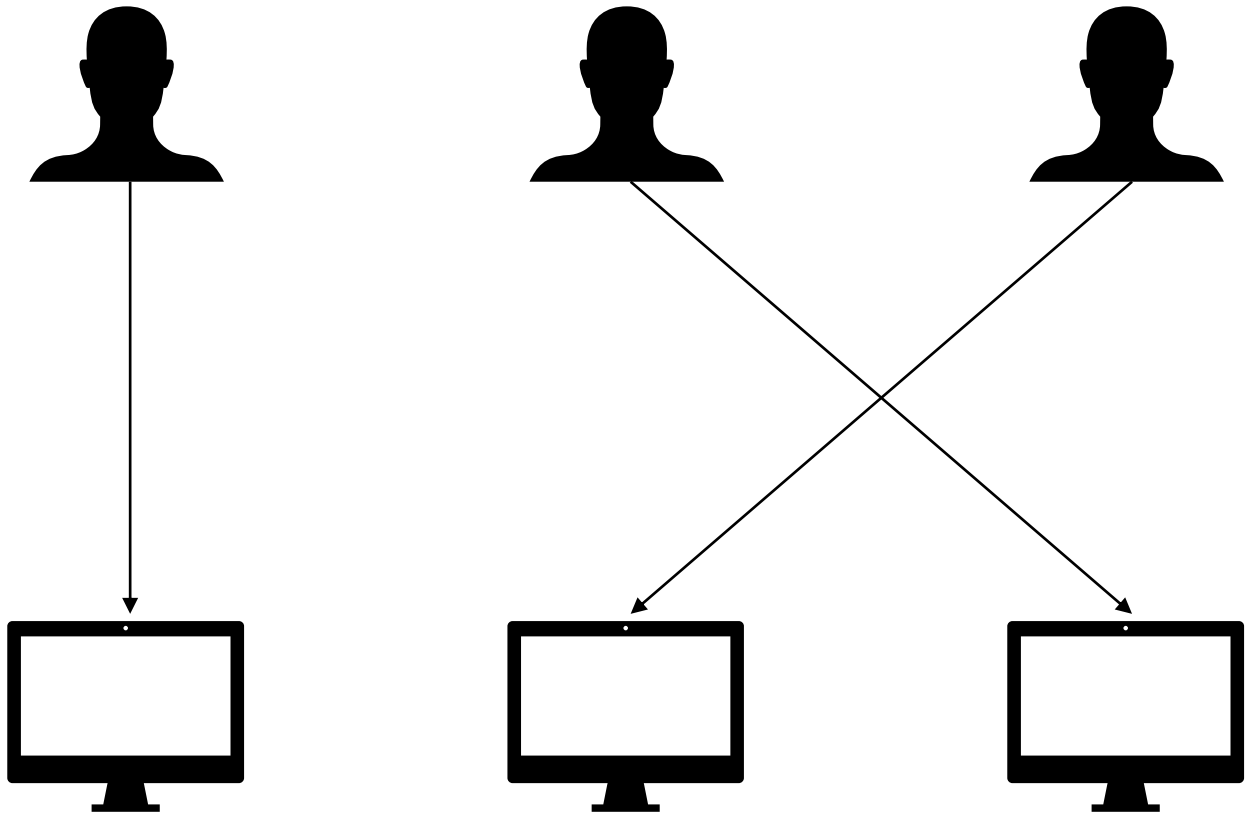
여전히 문제

- 패키지 업데이트 하는 날엔…



근본적인 문제

- 직접 관리



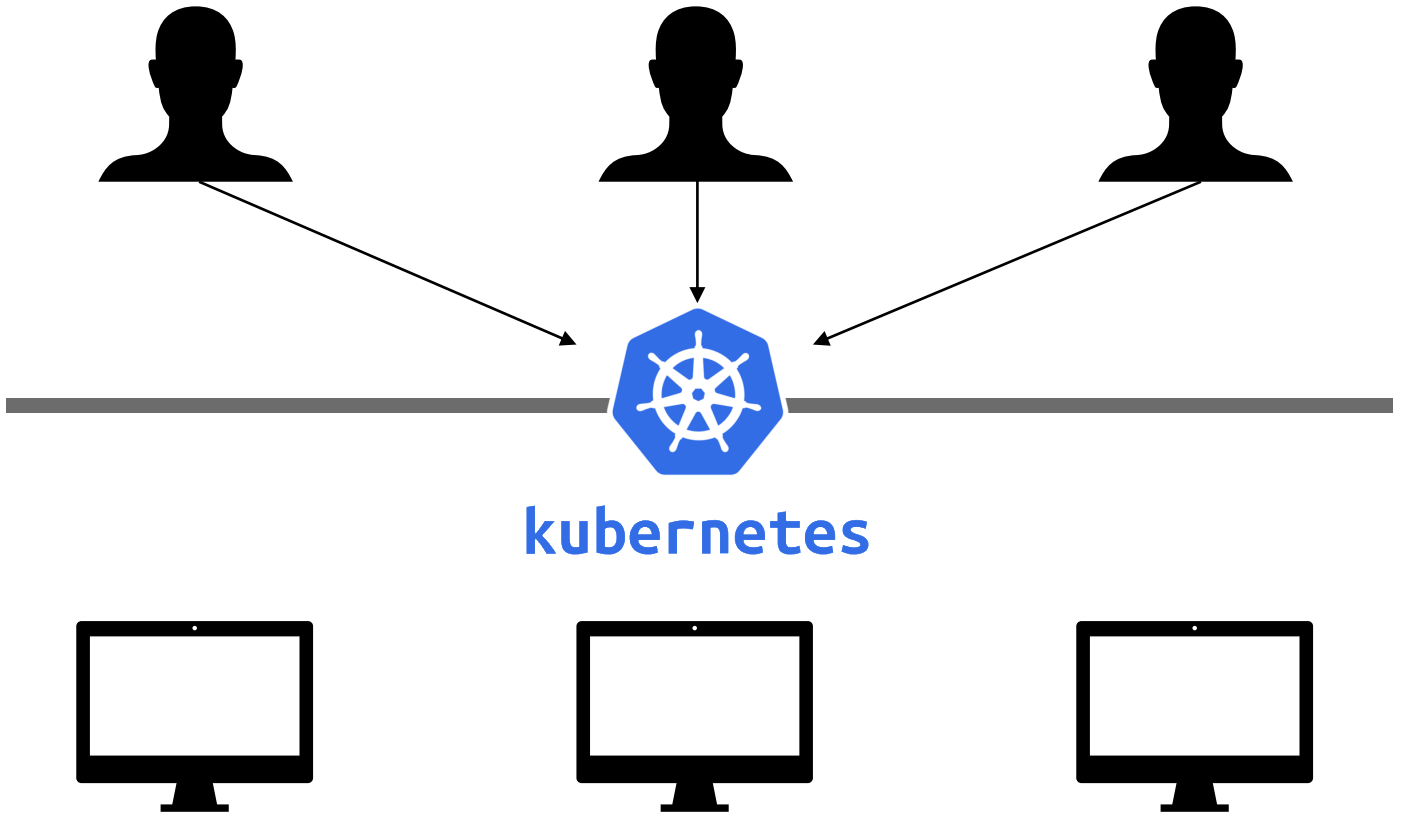
Scheduling

Resource Management

Job Management

제안 방법

- 위임 관리



Scheduling

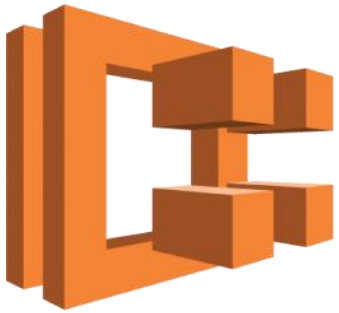
Resource Management

Job Management

Kubernetes란?

- 도커 Orchestration 툴 중에 하나?

kubernetes

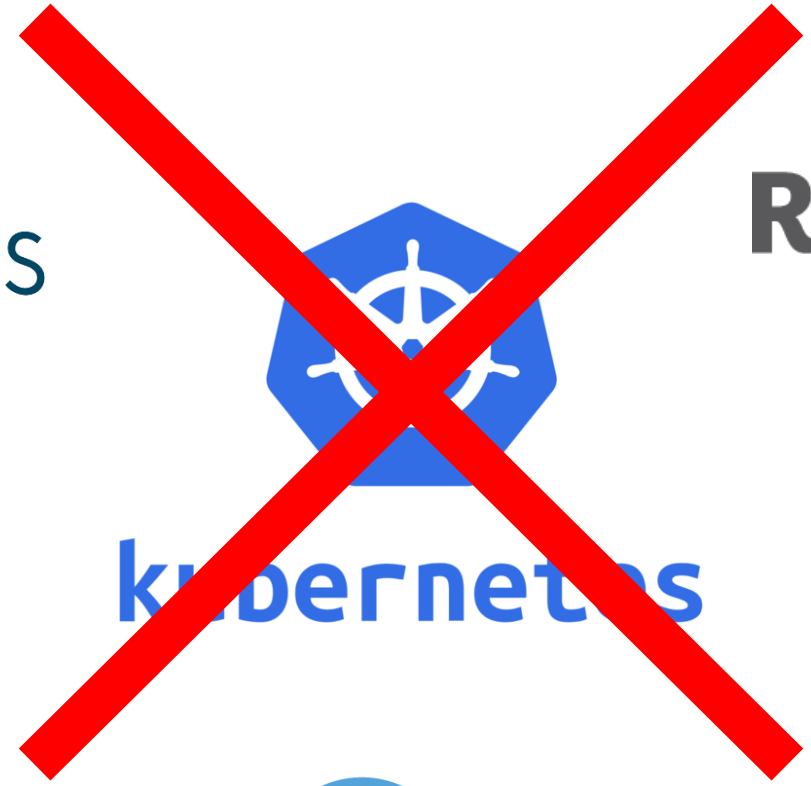


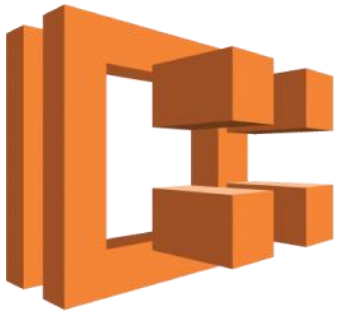
Amazon ECS

CoreOS

Kubernetes란?

- 도커 Orchestration 툴 중에 하나?

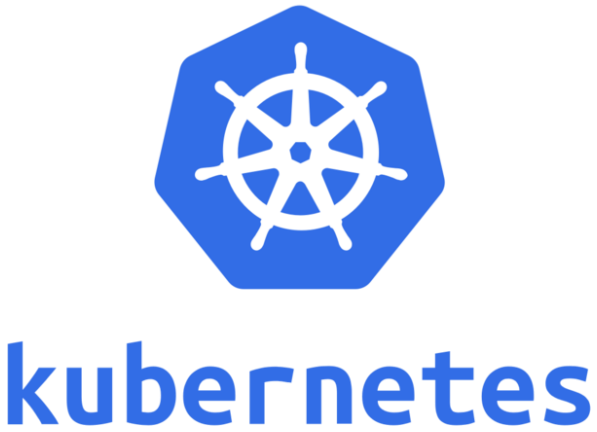




Kubernetes란?

- 조금 다르게 정의해 봅시다.

→ 쿠버네티스란 Cluster OS 입니다.



Kubernetes란?

- 응...?

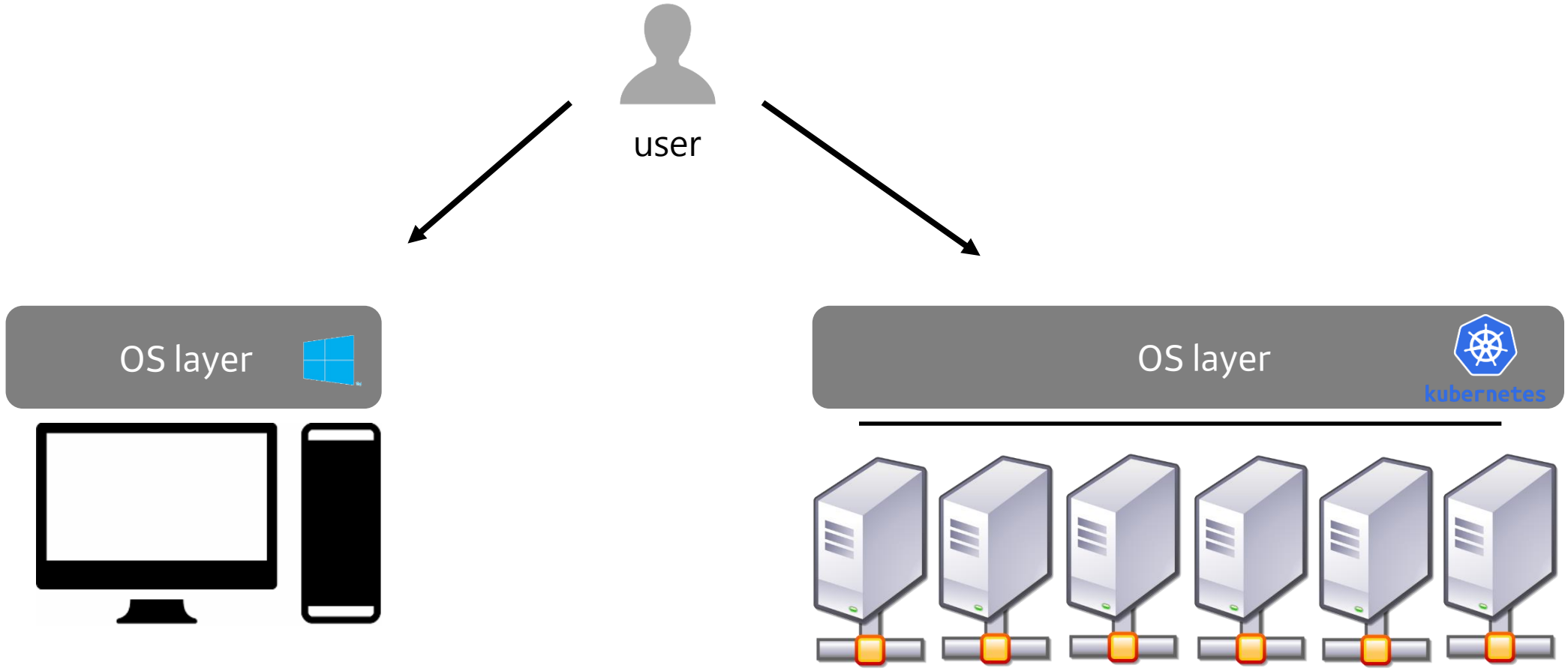
Kubernetes란?

- Cluster
  - Collection of computers to compute large job.

- OS
  - Hardware 추상화 layer (CPU, memory, HDD)
  - 자원 분배 (resource management)
  - 프로세스 스케줄링 (scheduling)
  - User Interface (GUI, CUI)

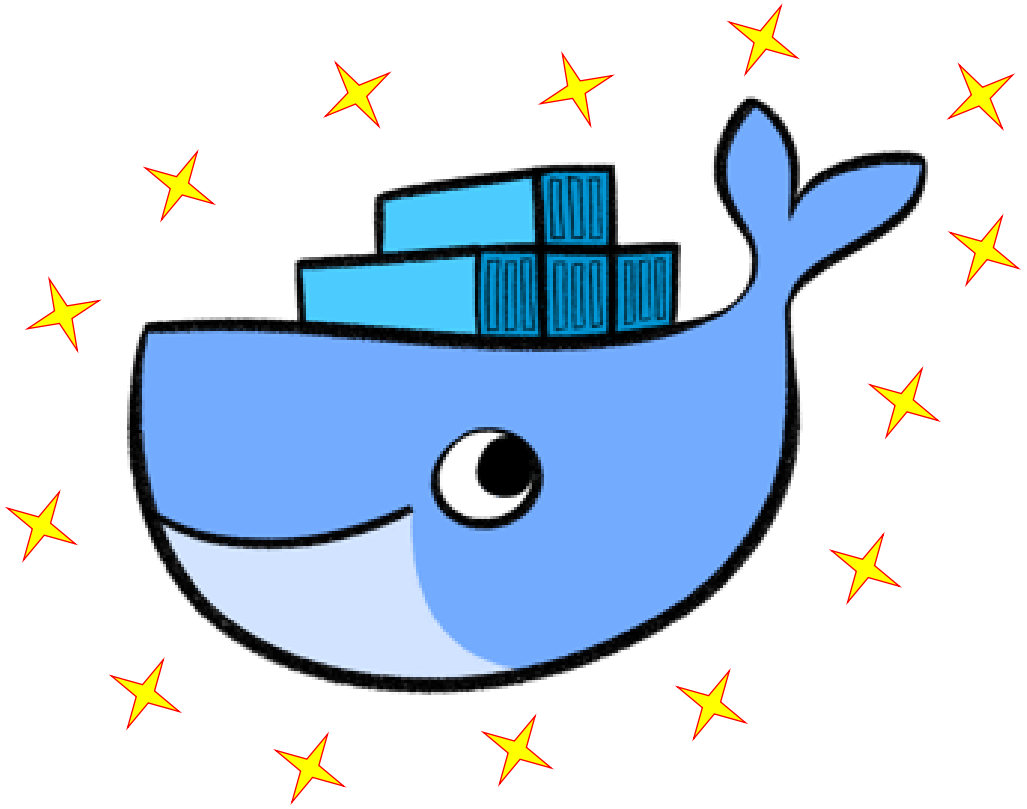
Kubernetes란?

- Kubernetes as Cluster OS



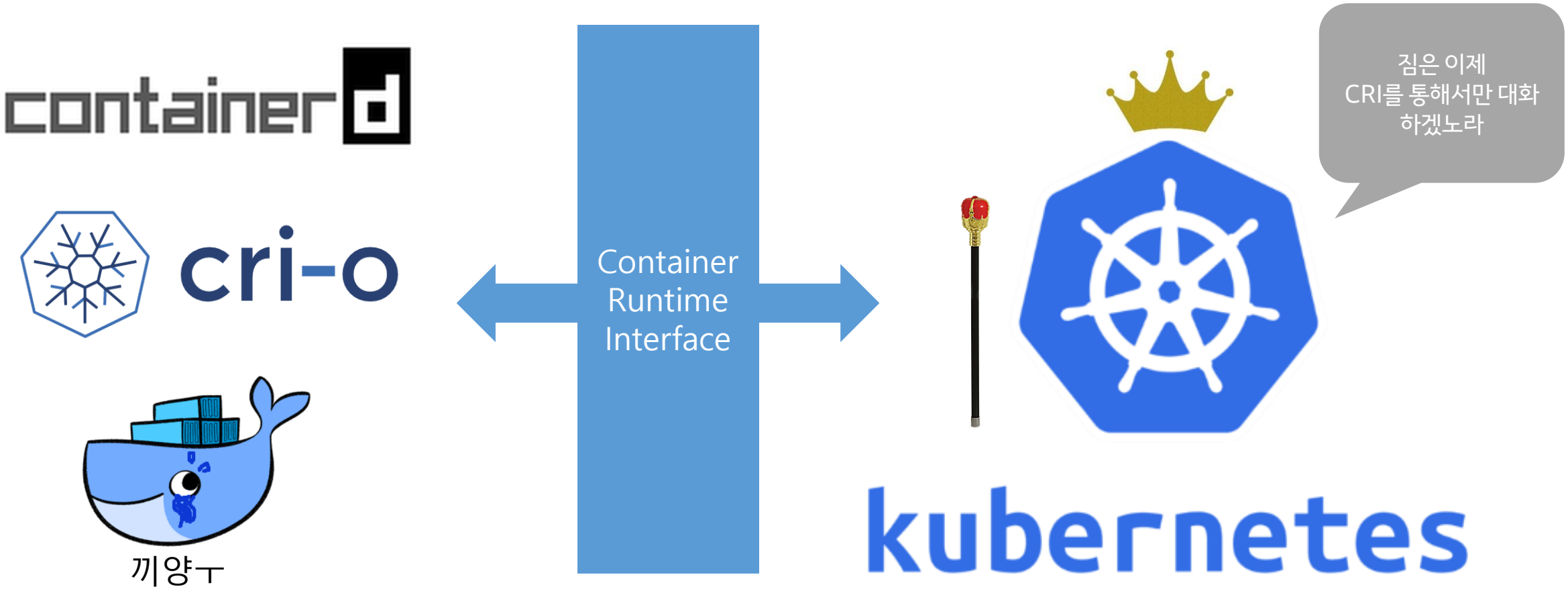
Kubernetes란?

- Docker orchestration tool이라 부르기 어려운 또 다른 이유



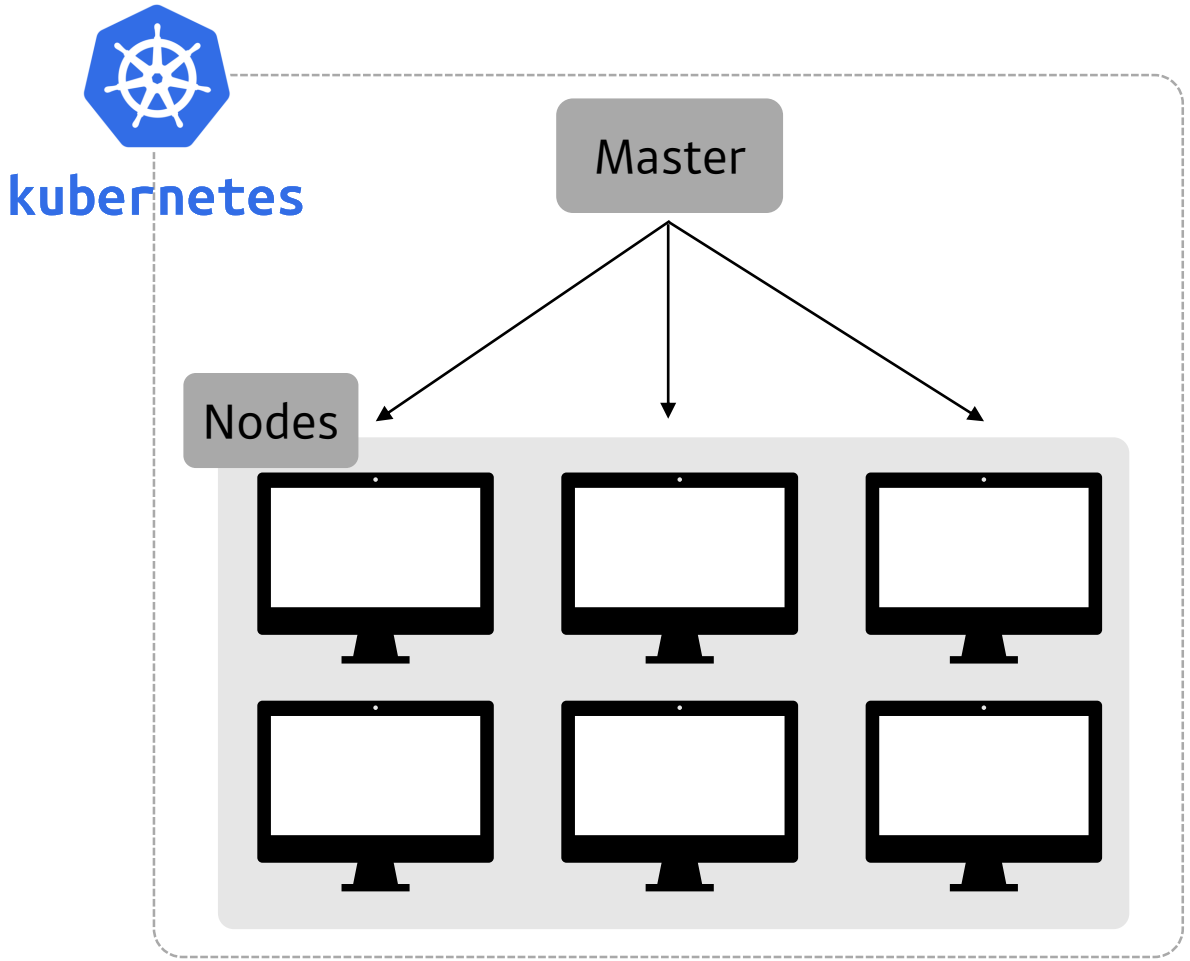
Kubernetes란?

- Docker orchestration tool이라 부르기 어려운 또 다른 이유



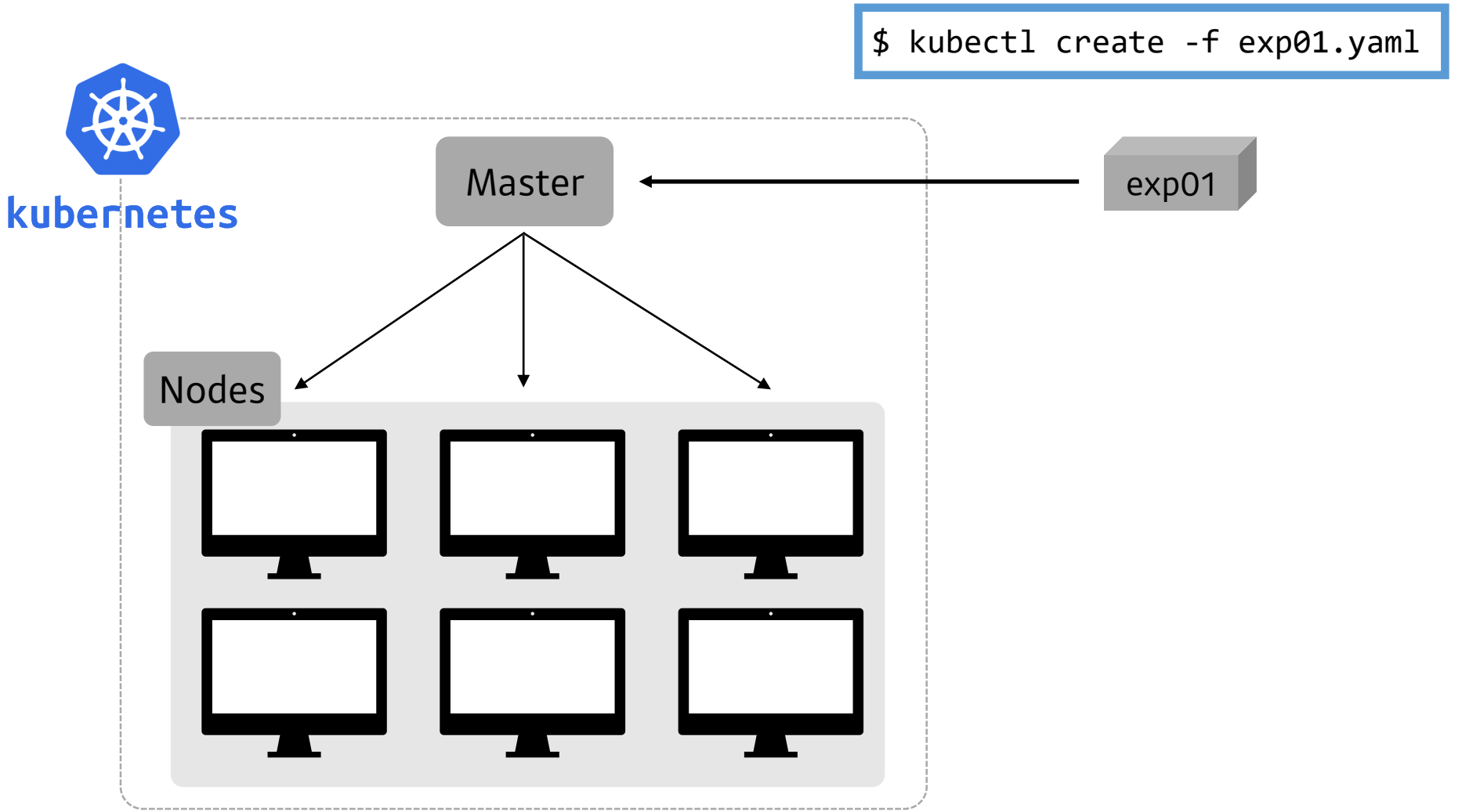
Kubernetes 소개

- Master / Node



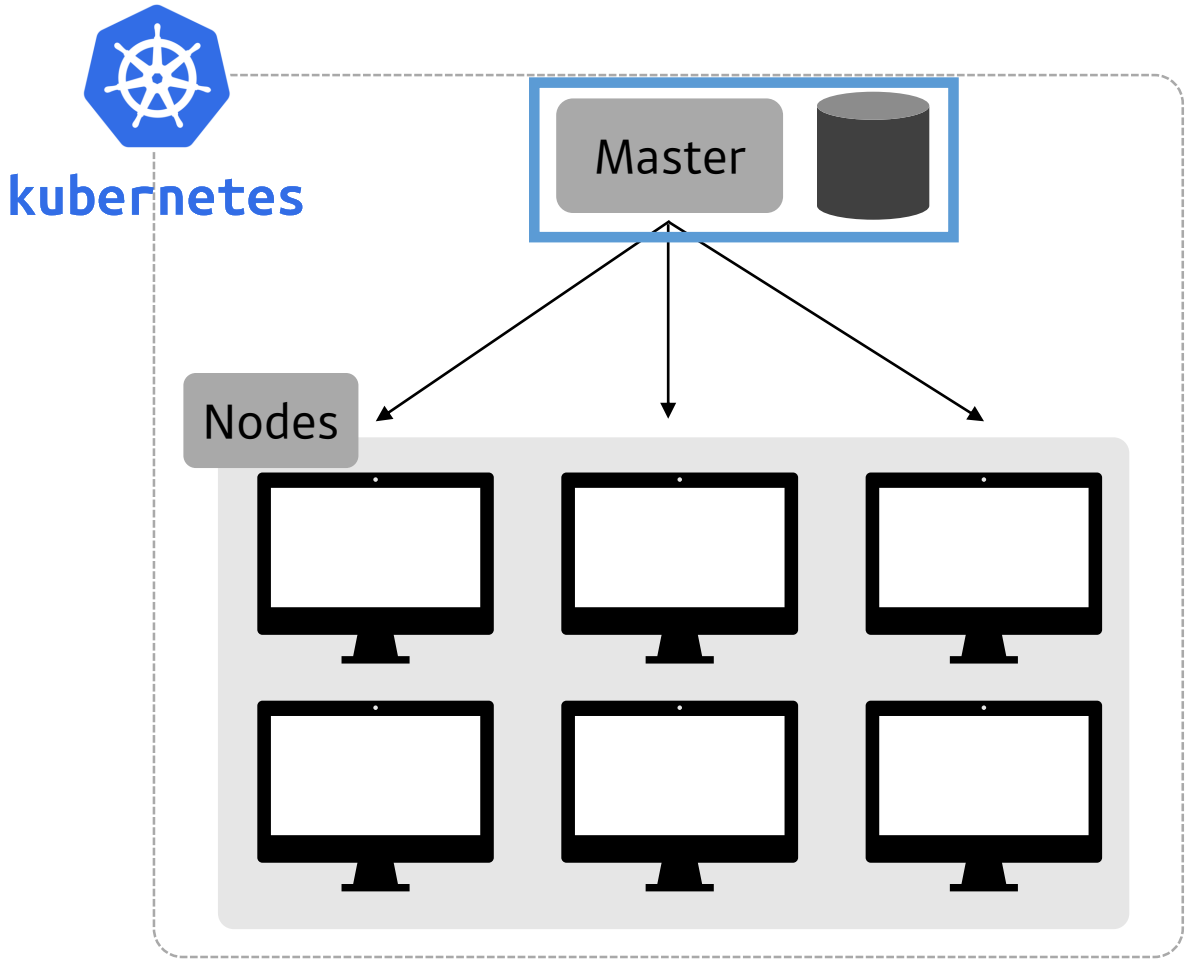
Kubernetes 소개

- kubectl 툴



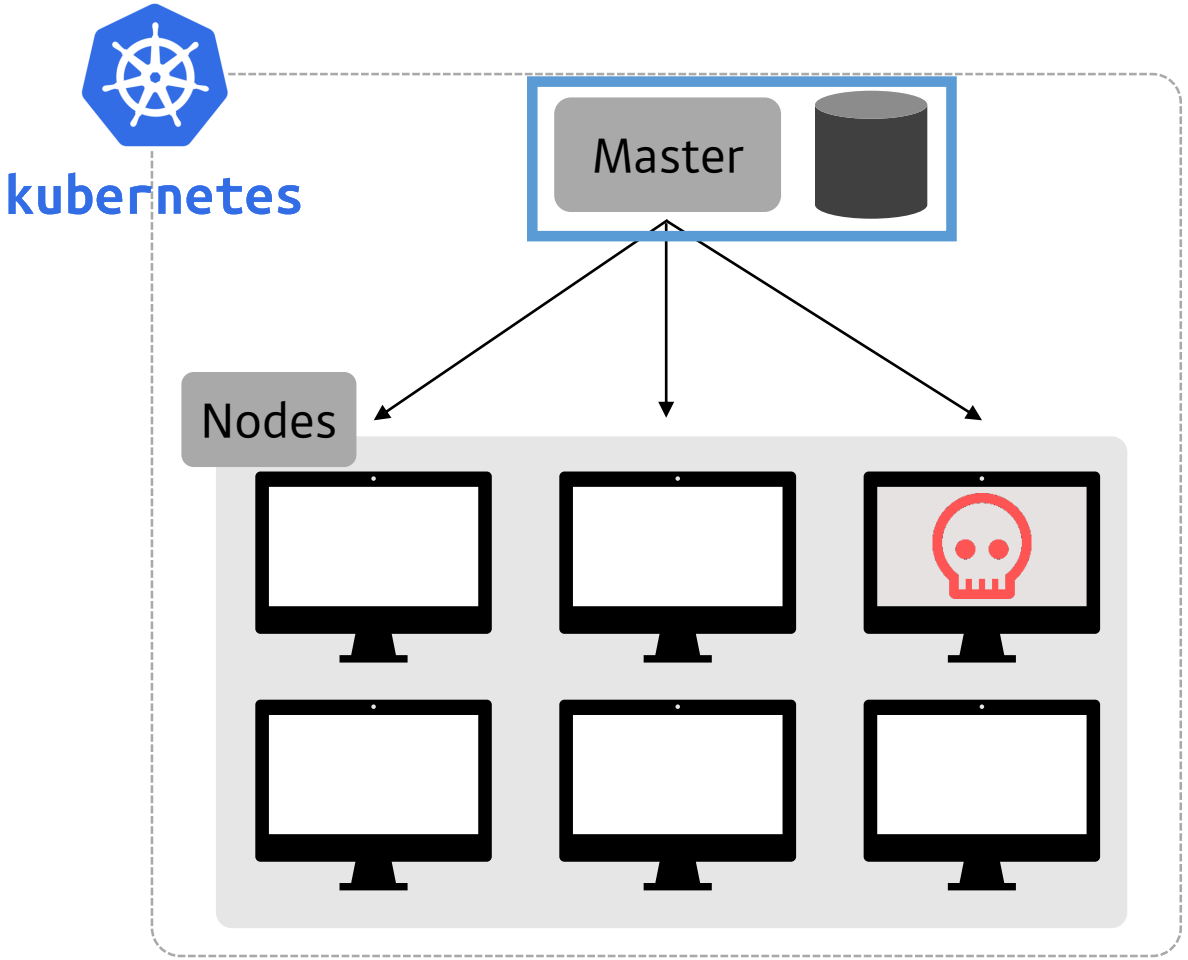
Kubernetes 소개

- 내부 DB



Kubernetes 소개

- 내부 DB



Kubernetes 소개

- 모든 것이 resource

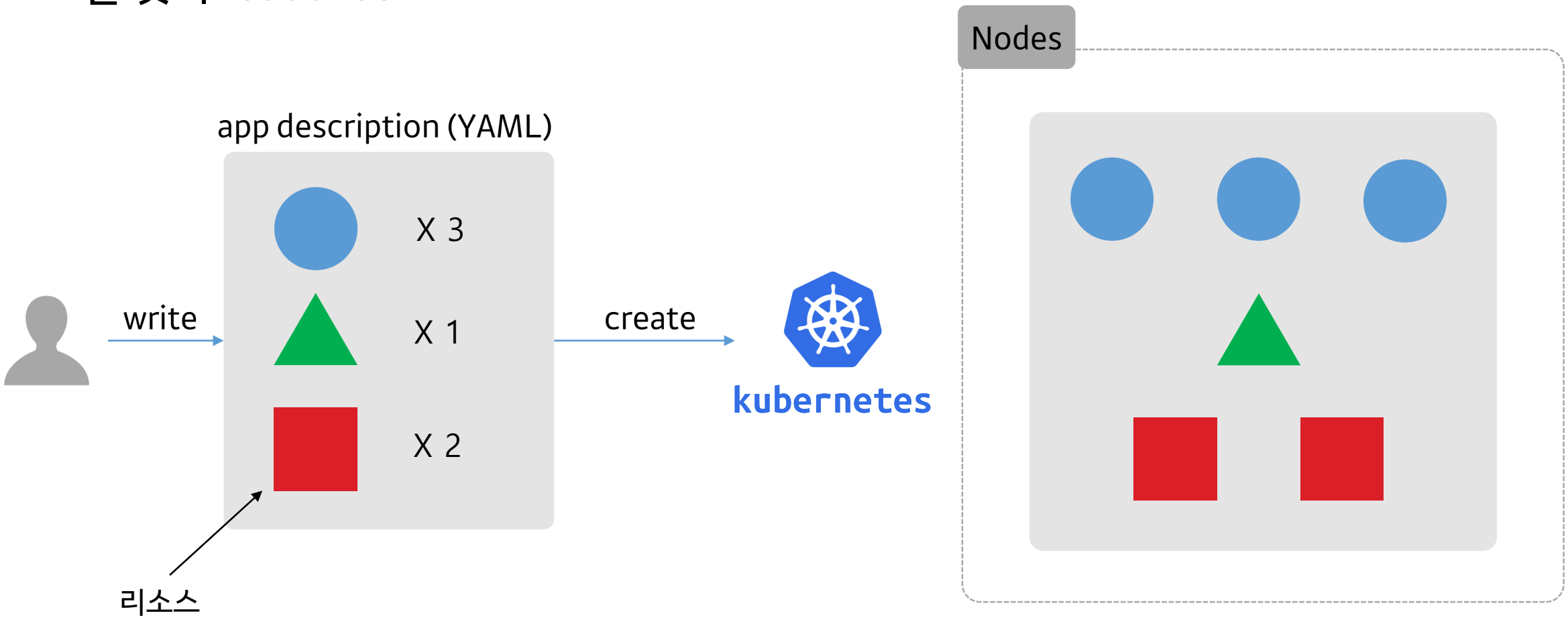
  Job

  Deployment

  Service

Kubernetes 소개

- 모든 것이 resource



Kubernetes 소개

- 모든 것이 resource

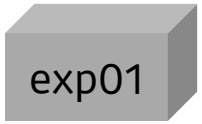
  Job: 1회성 배치 작업을 실행할 때 사용하는 리소스

  Deployment: 데몬처럼 계속 실행되는 리소스

  Service: 사용자 request를 받을 수 있는 Endpoint

Kubernetes 소개

```
apiVersion: batch/v1
kind: Job
metadata:
  name: exp01
spec:
  template:
    spec:
      containers:
      - name: ml
        image: $model_image
        command: ["python", "train.py"]
        args: [‘2’, ‘softmax’, ‘0.5’]
        resources:
          requests:
            cpu: "2"
            memory: "8Gi"
          limits:
            cpu: "4"
            memory: "16Gi"
      restartPolicy: OnFailure
```



exp01.yaml

Kubernetes 소개

```
apiVersion: batch/v1
kind: Job
metadata:
  name: exp01
spec:
  template:
    spec:
      containers:
      - name: ml
        image: $model_image
        command: ["python", "train.py"]
        args: [‘2’, ‘softmax’, ‘0.5’]
        resources:
          requests:
            cpu: "2"
            memory: "8Gi"
          limits:
            cpu: "4"
            memory: "16Gi"
      restartPolicy: OnFailure
```

exp01이라는 Job을

Kubernetes 소개

```
apiVersion: batch/v1
kind: Job
metadata:
  name: exp01
spec:
  template:
    spec:
      containers:
      - name: ml
        image: $model_image
        command: ["python", "train.py"]
        args: [‘2’, ‘softmax’, ‘0.5’]
        resources:
          requests:
            cpu: "2"
            memory: "8Gi"
          limits:
            cpu: "4"
            memory: "16Gi"
      restartPolicy: OnFailure
```

이렇게 실행하라

```
python train.py 2 softmax 0.5
```

Kubernetes 소개

```
apiVersion: batch/v1
kind: Job
metadata:
  name: exp01
spec:
  template:
    spec:
      containers:
      - name: ml
        image: $model_image
        command: ["python", "train.py"]
        args: [‘2’, ‘softmax’, ‘0.5’]
        resources:
          requests:
            cpu: "2"
            memory: "8Gi"
          limits:
            cpu: "4"
            memory: "16Gi"
      restartPolicy: OnFailure
```

이러한 자원을 가지고

Kubernetes 소개

```
apiVersion: batch/v1
kind: Job
metadata:
  name: exp01
spec:
  template:
    spec:
      containers:
      - name: ml
        image: $model_image
        command: ["python", "train.py"]
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        resources:
          requests:
            cpu: "2"
            memory: "8Gi"
          limits:
            cpu: "4"
            memory: "16Gi"
      restartPolicy: OnFailure
```

이름 정보

실행 정보

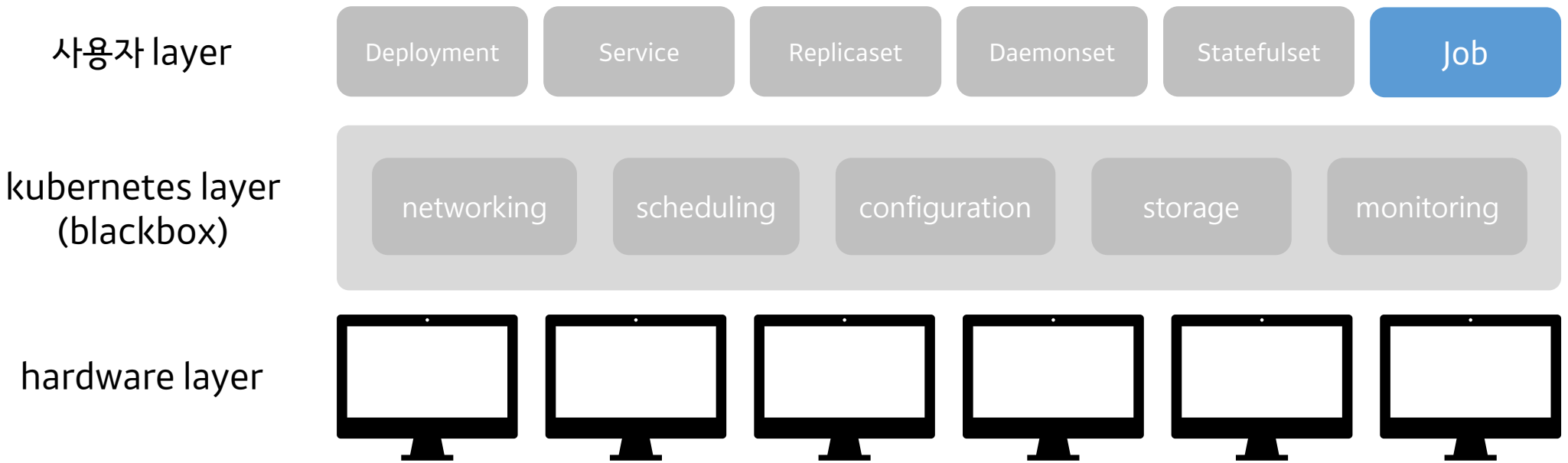
자원 정보

Kubernetes 소개

- `kubectl create -f exp01.yaml`

Kubernetes 소개

- 지금까지 알아본 것
  - Job 리소스 하나만 알아도

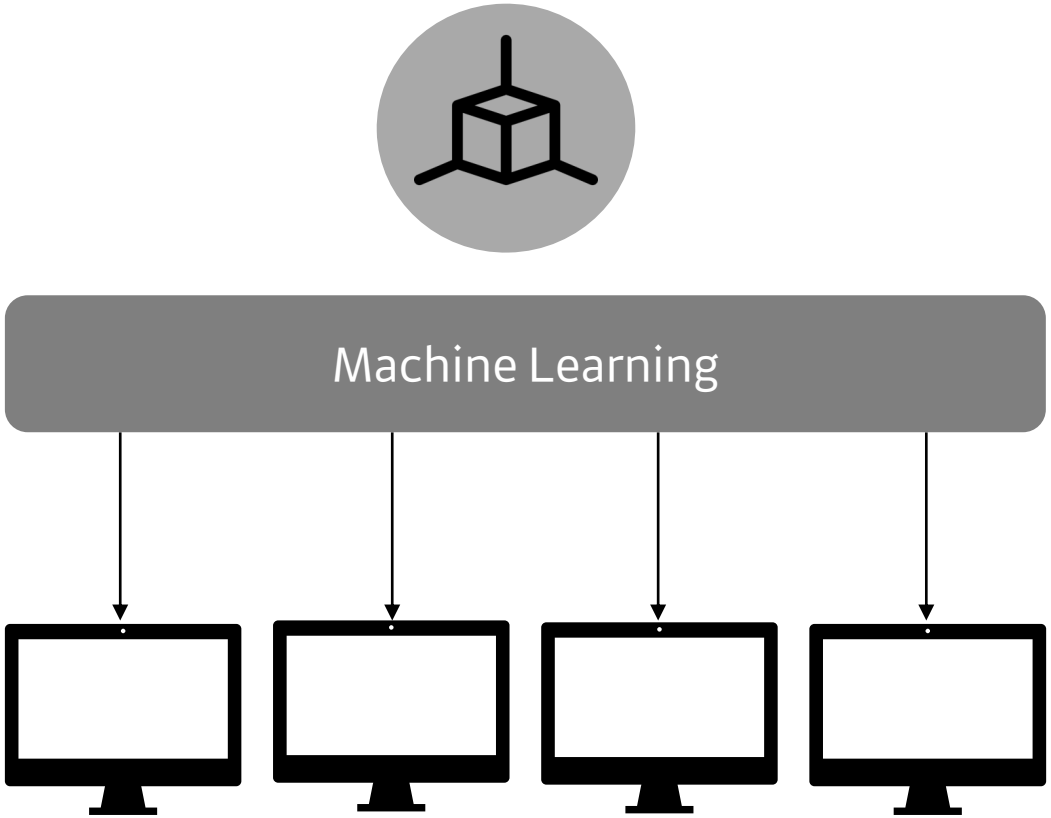


Kubernetes 소개

- 이제 여러분은 분산 기계학습 엔지니어

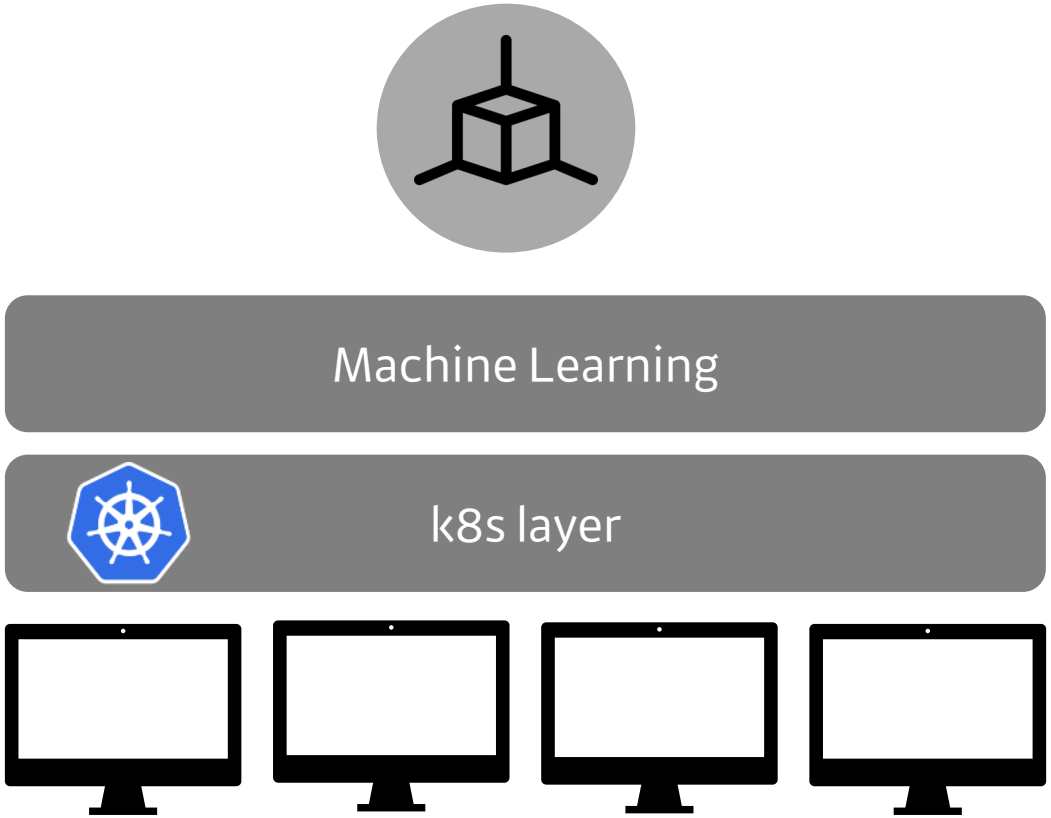
ML with k8s

- 어떤 장점들이 있을까요?



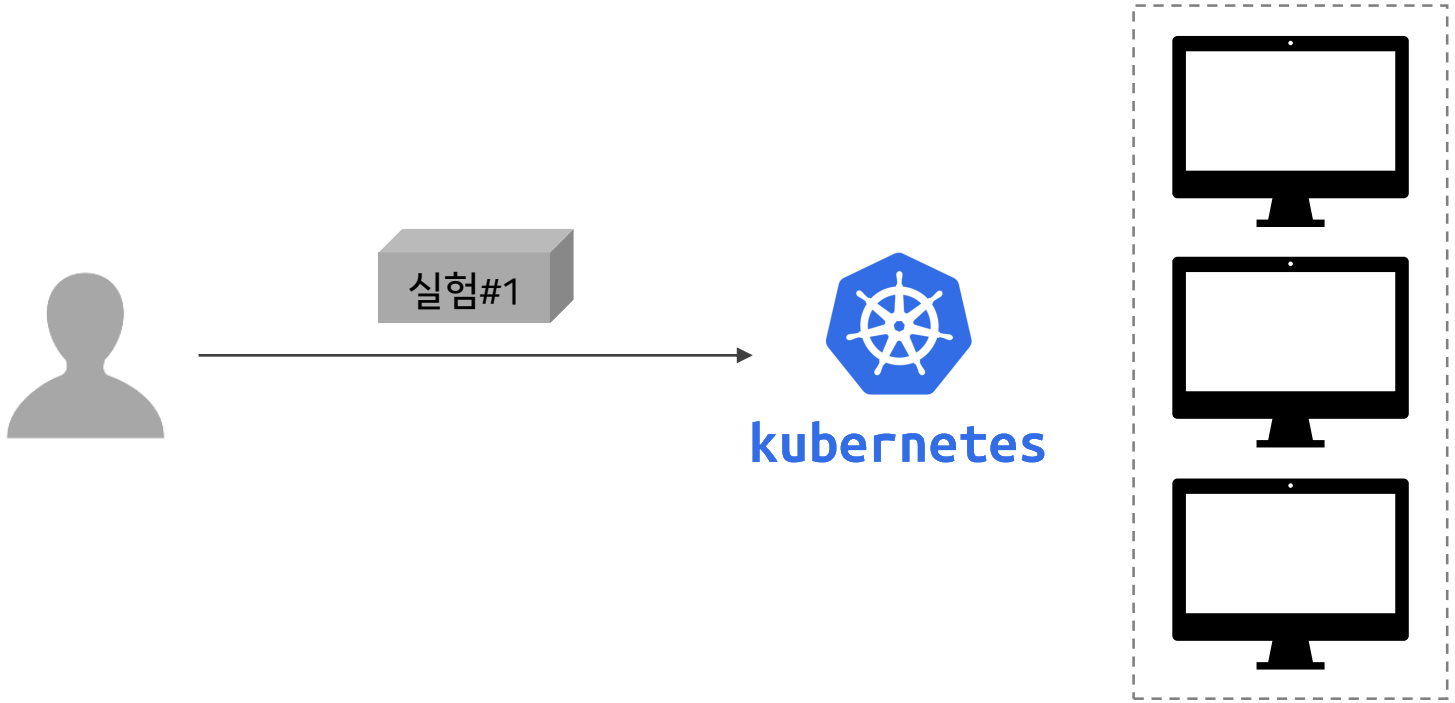
ML with k8s

- 어떤 장점들이 있을까요?



ML with k8s

- 스케줄링이 편리해 집니다.

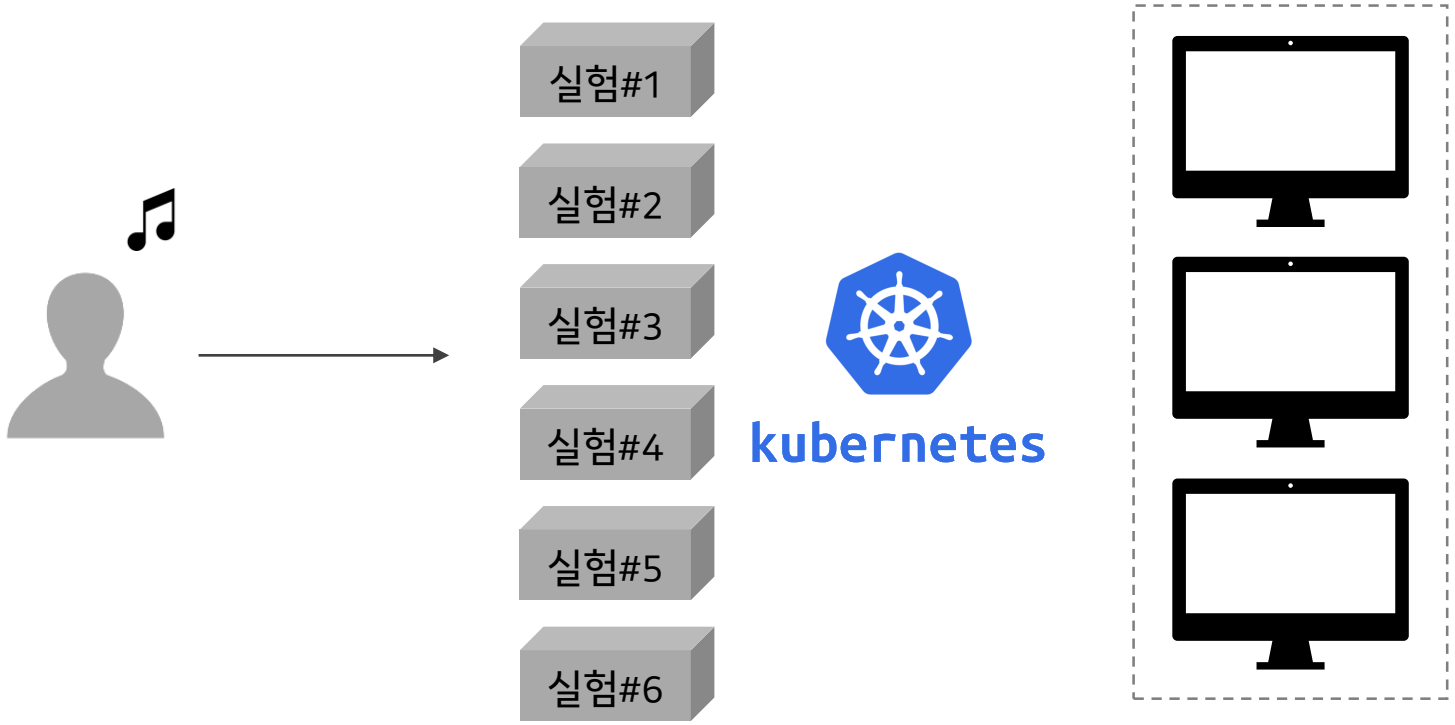


ML with k8s

- 스케줄링이 편리해 집니다.
  - 사람이 직접 스케줄링하던 기계학습 훈련을

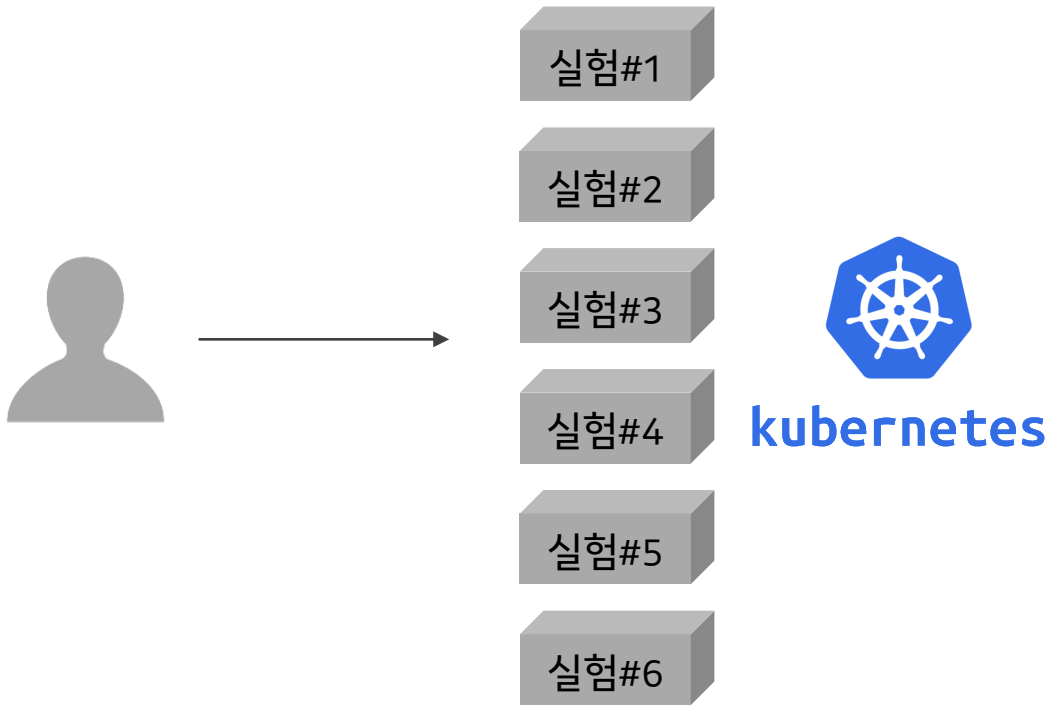
ML with k8s

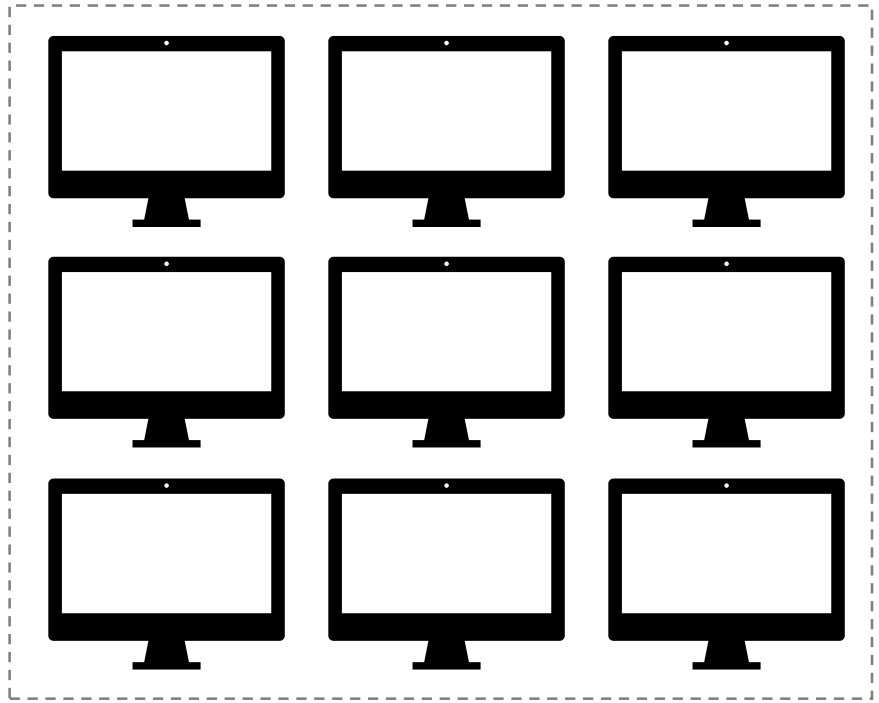
- 스케줄링이 편리해 집니다.
  - 쿠버네티스에게 맡깁니다.



ML with k8s

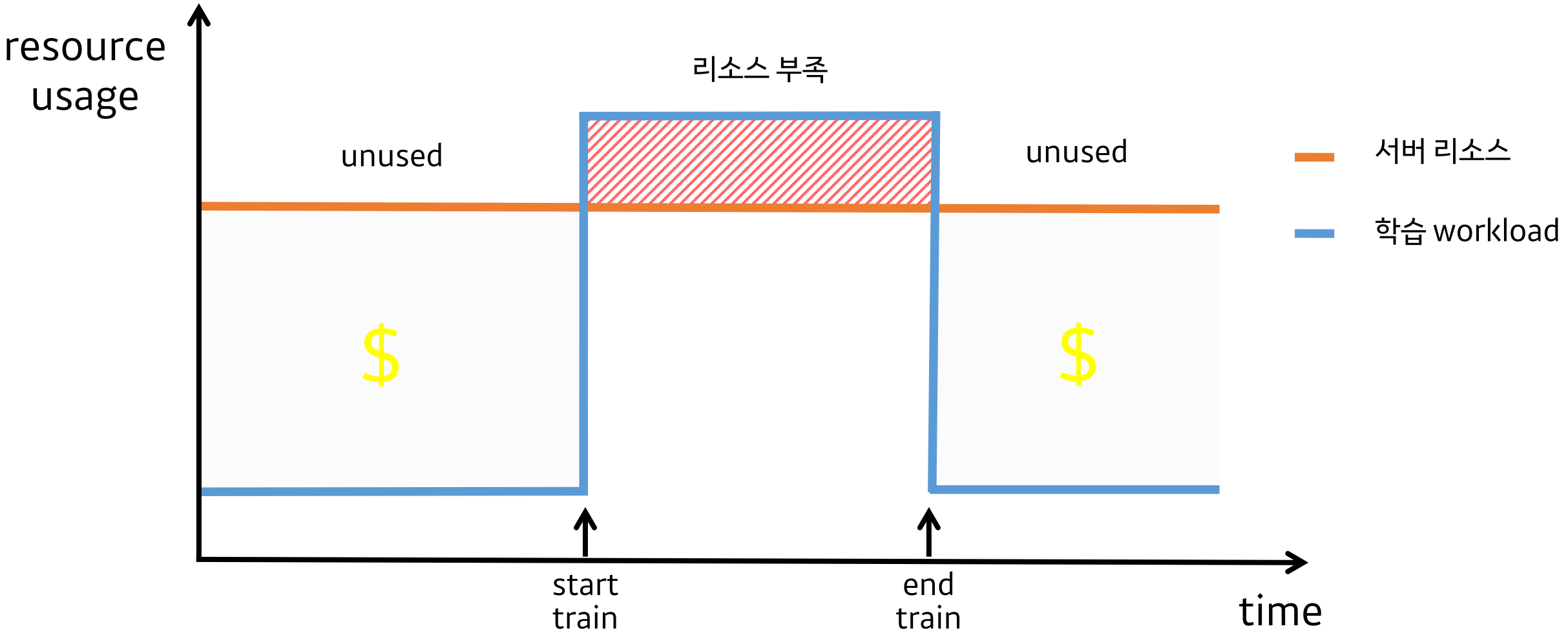
- 스케줄링이 편리해 집니다.
  - 학습 서버가 증가할수록 그 효과는 커집니다.





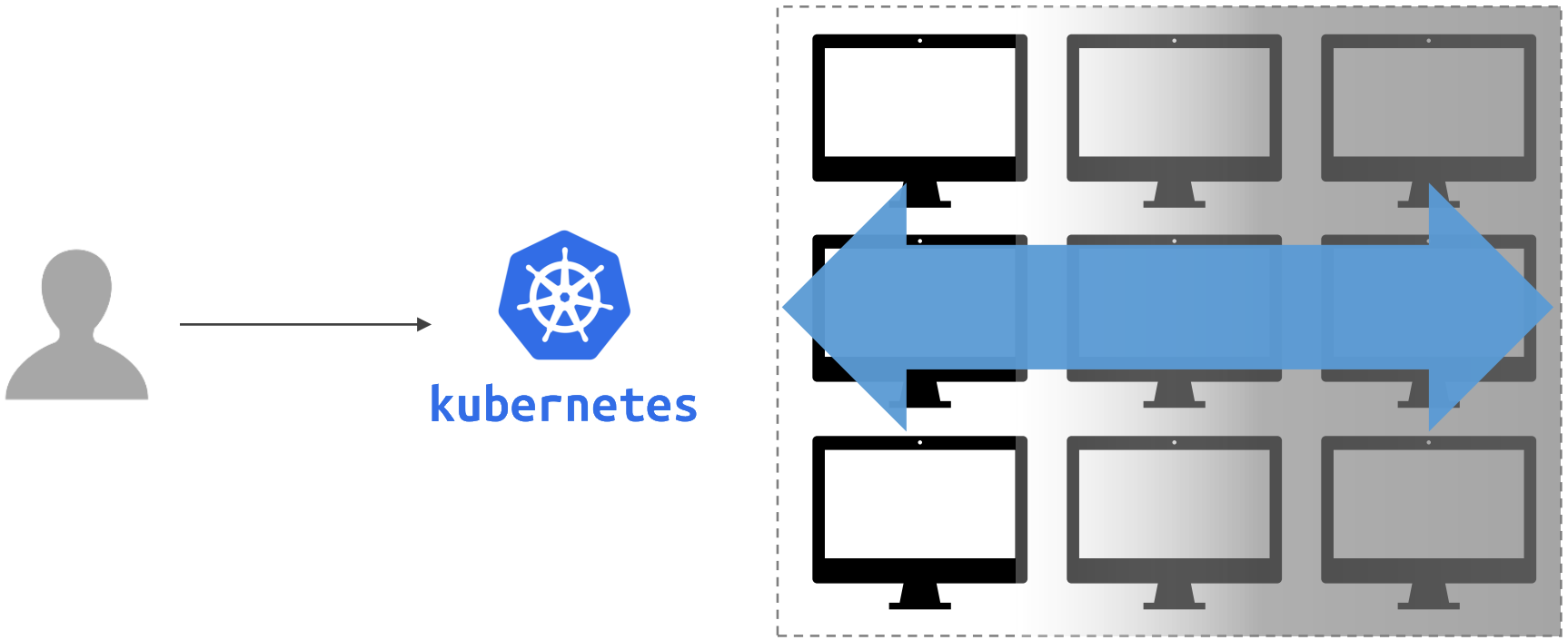
ML with k8s

- 확장이 용이해 집니다.



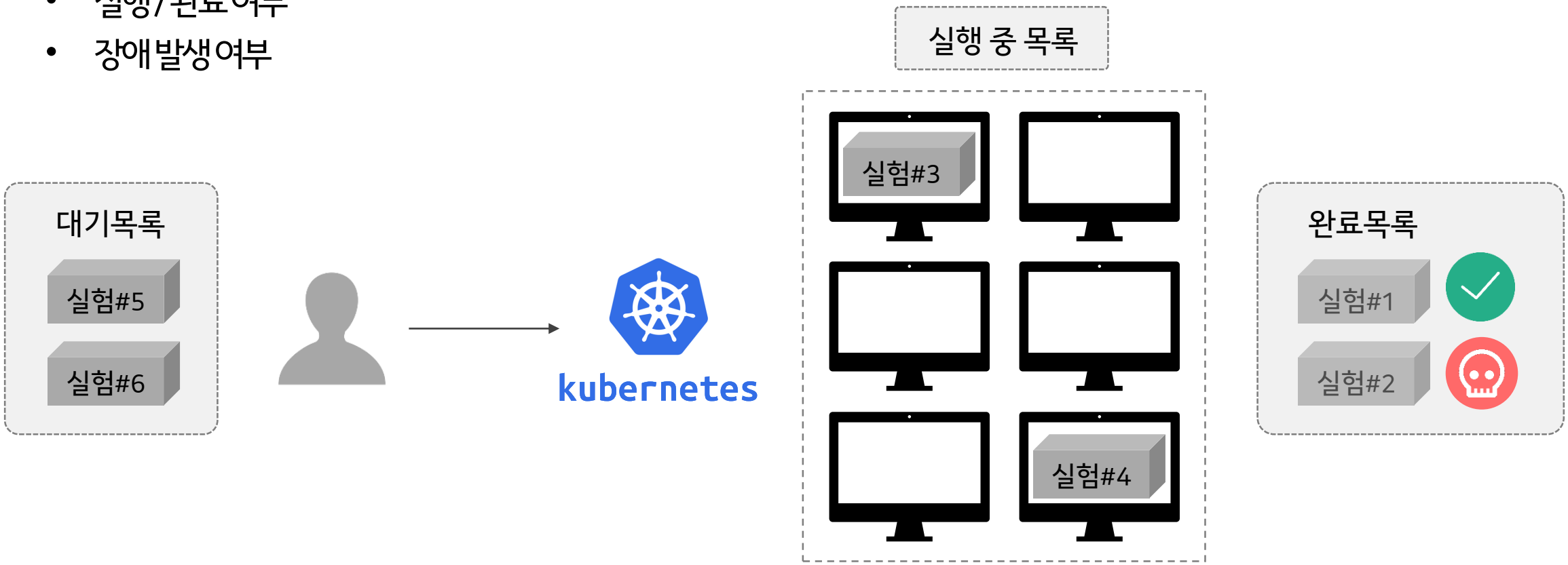
ML with k8s

- 확장이 용이해 집니다.



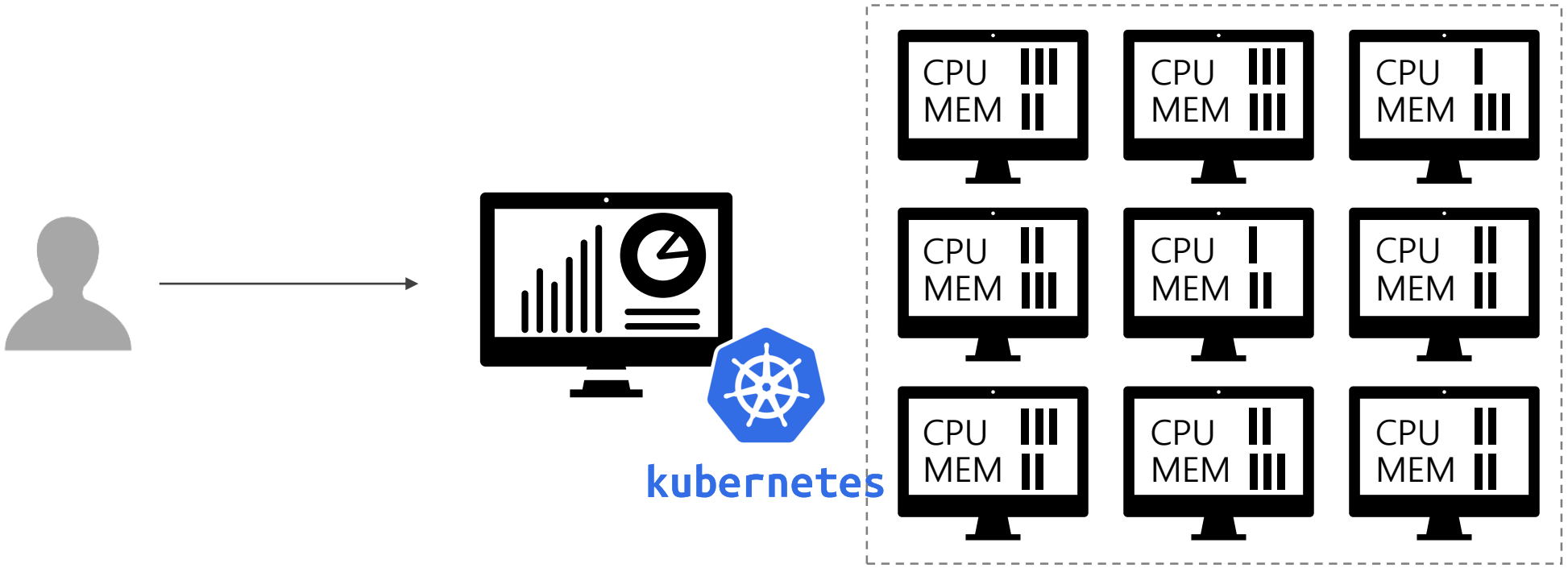
ML with k8s

- Job 관리가 편리해 집니다.
  - 실행/완료 여부
  - 장애 발생 여부



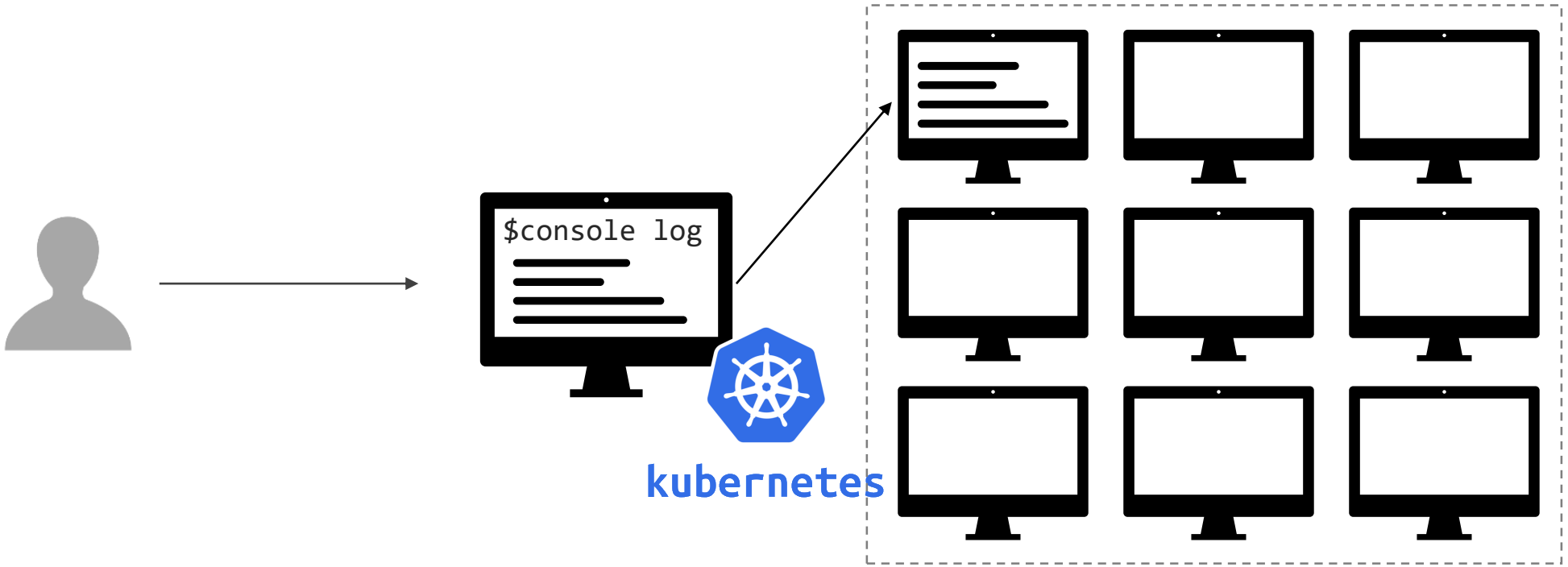
ML with k8s

- 모니터링이 편리해 집니다.
  - 리소스 사용량



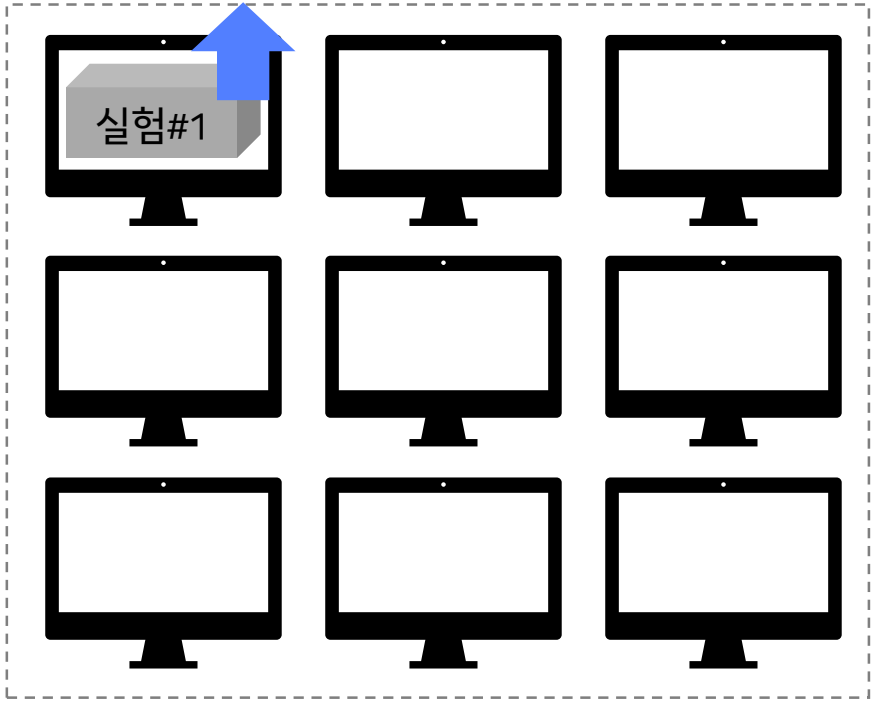
ML with k8s

- 모니터링이 편리해 집니다.
  - 기계학습 로그



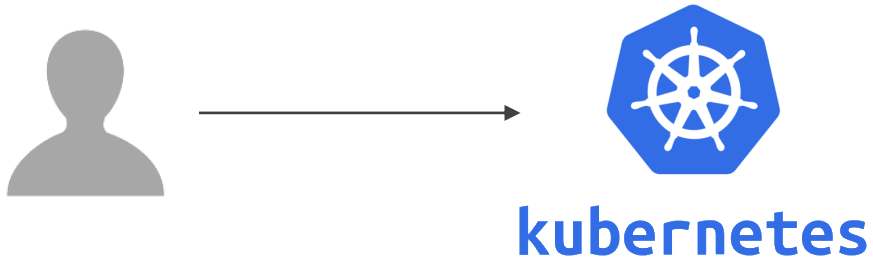
ML with k8s

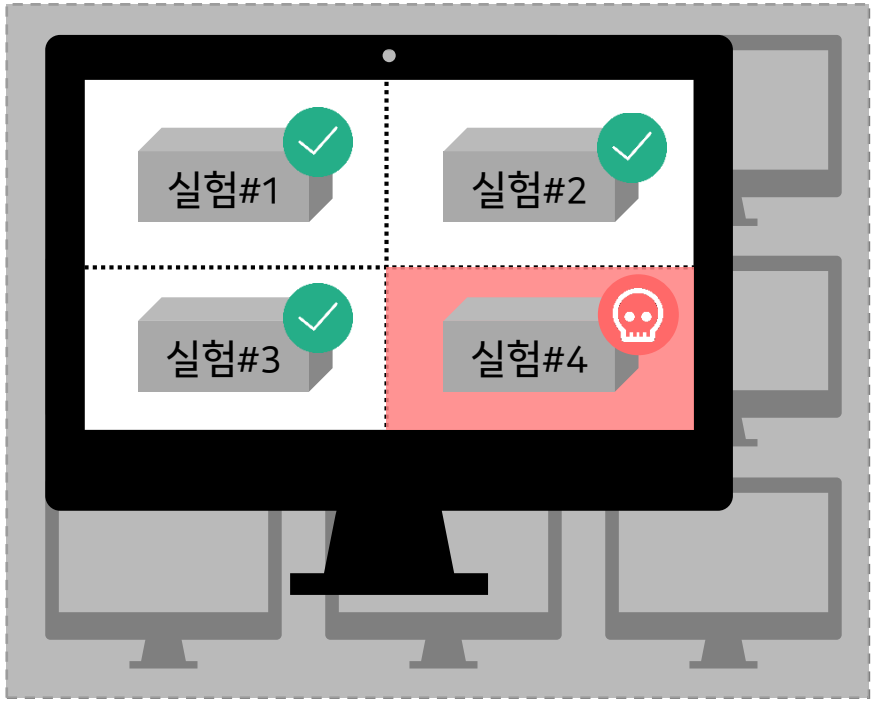
- 배포가 쉬워집니다.
  - 라이브러리 관리
  - 소스코드 관리



ML with k8s

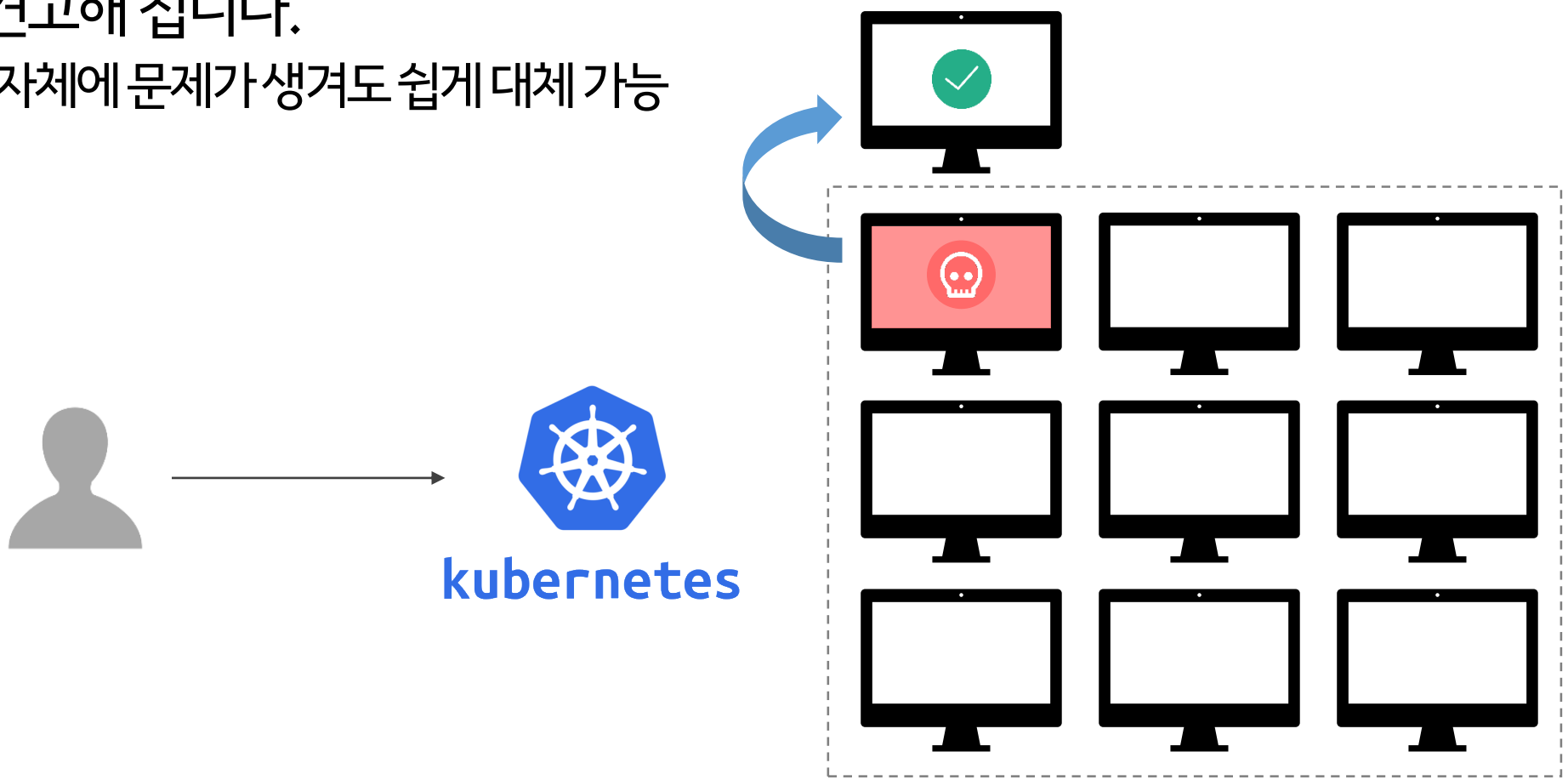
- 장애에 견고해 집니다.
  - 문제가 되는 한 개의 Job만 장애 발생





ML with k8s

- 장애에 견고해 집니다.
  - 서버 자체에 문제가 생겨도 쉽게 대체 가능

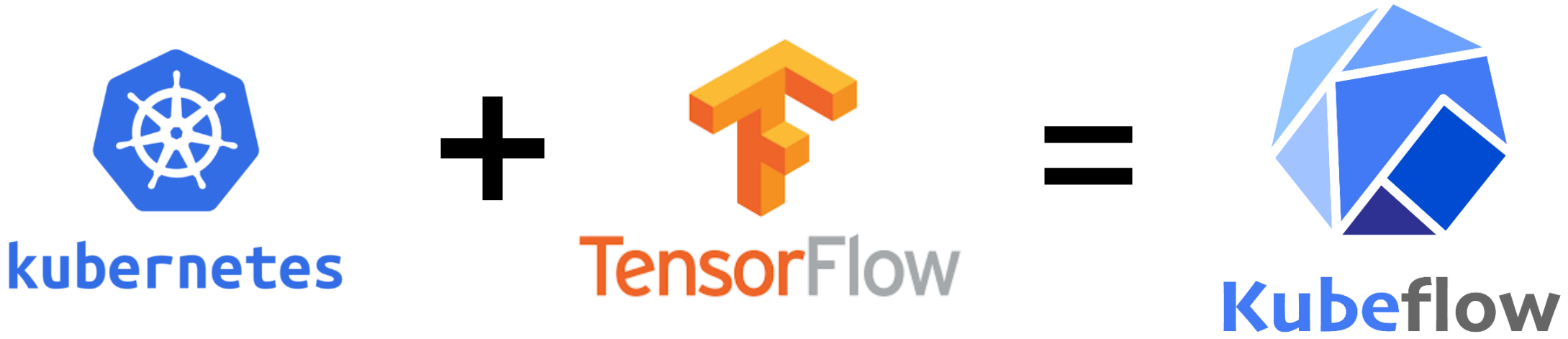


ML with k8s

- 이 모든 것이 쿠버네티스 Job만 잘 활용해도 가능합니다!

마무리 전

- kubeflow 소개



https://www.kubeflow.org/

마무리 전

EDA: Jupyter

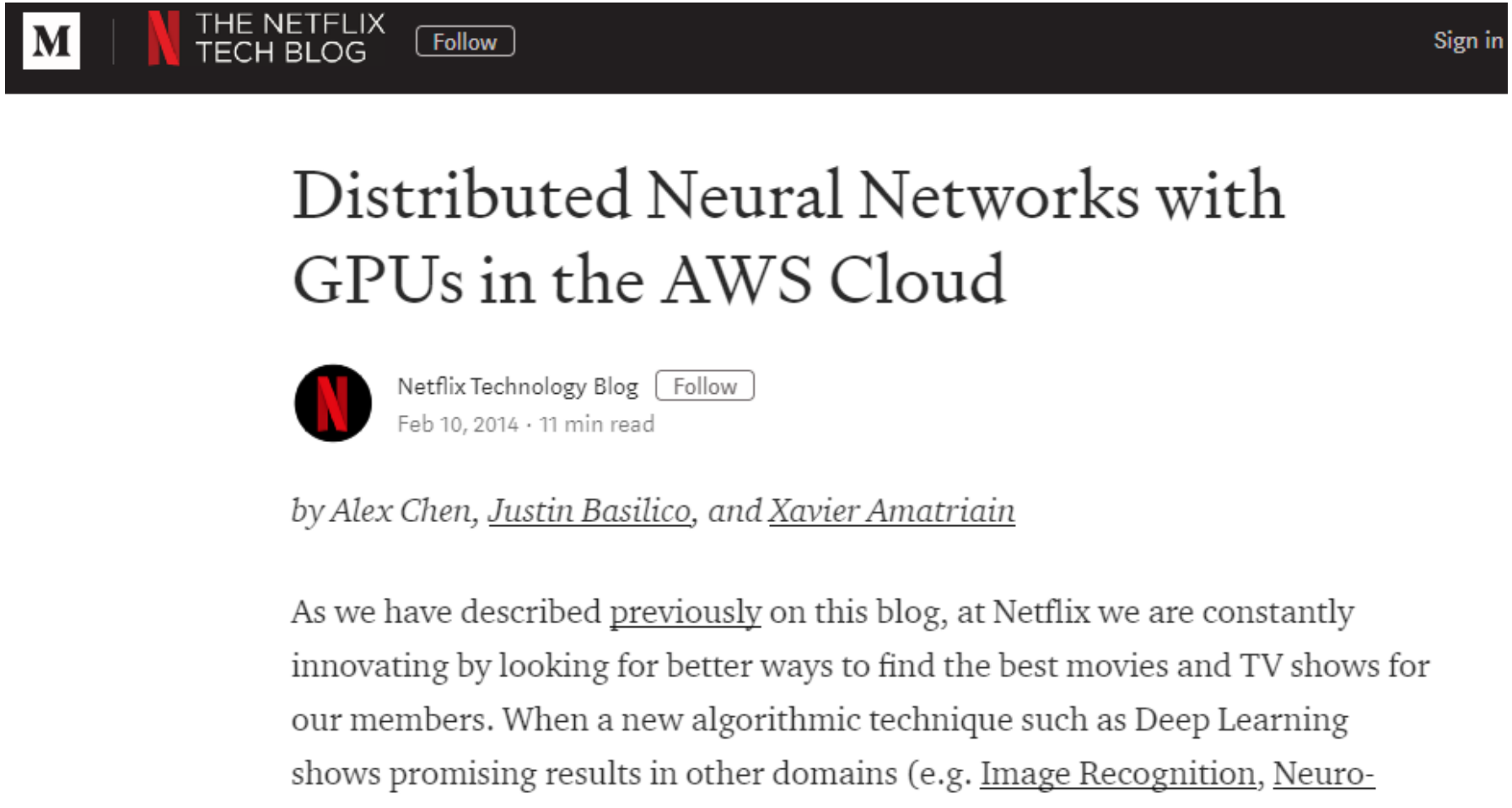
Train: tf-job

Deploy: tf-serving

https://www.kubeflow.org/

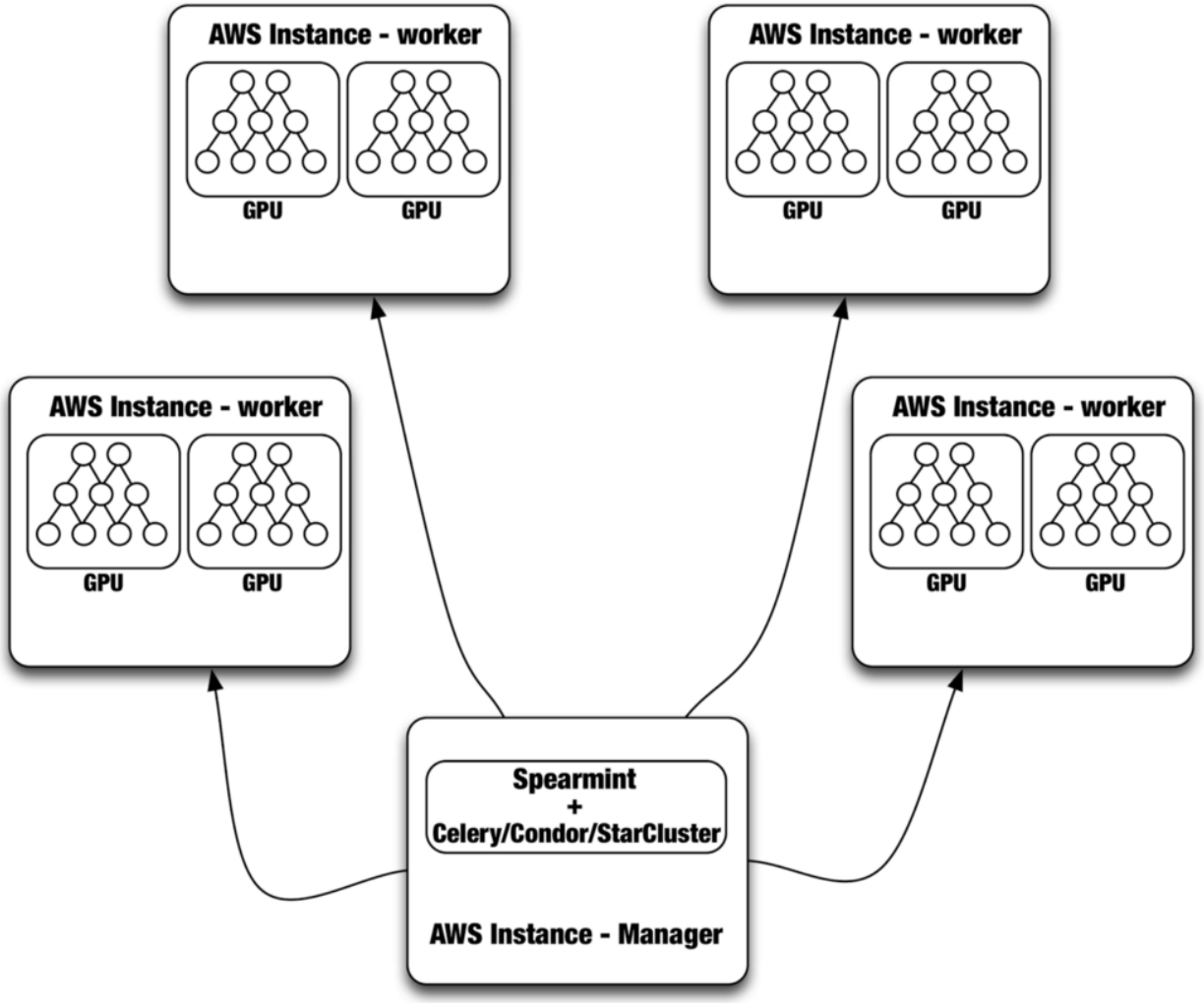
마무리 전

- 2014년 Netflix 블로그: 분산 딥러닝 framework 소개



https://medium.com/netflix-techblog/distributed-neural-networks-with-gpus-in-the-aws-cloud-ccf71e82056b

마무리 전



AWS EC2 + MIT StarCluster + Celery (distributed Job Queue)

마무리

- 오늘 저와 함께 쿠버네티스를 통해 기계학습 모델들을 쉽게 확장해 봅시다!

kubernetes