skymind

畳み込みニューラル
ネットワークの基礎と応用

実践者向けディープラーニング勉強会　第二回

https://dl4-practitioners.connpass.com/event/124498/

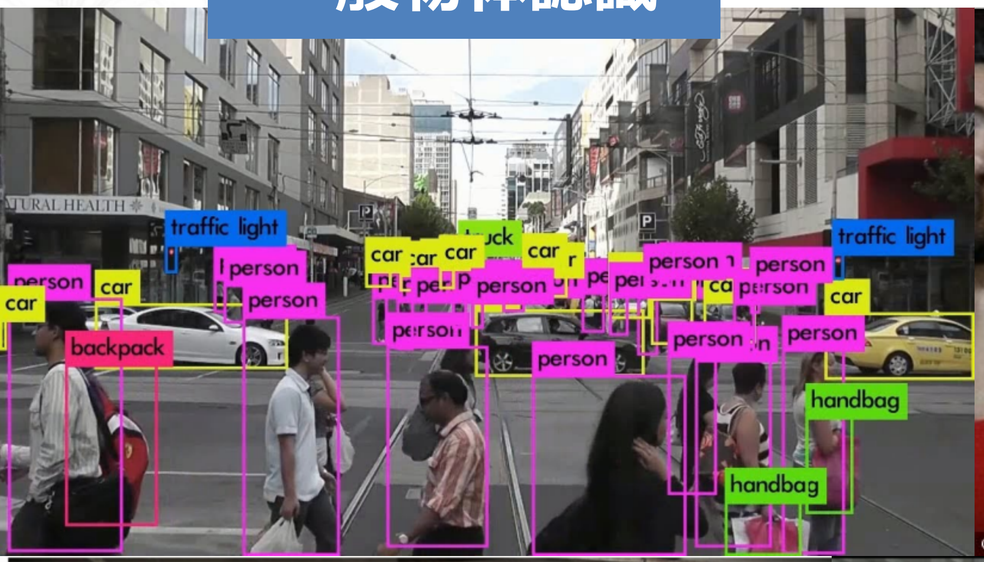
2019-04-17 (Wed) @ SB C&S

Agenda

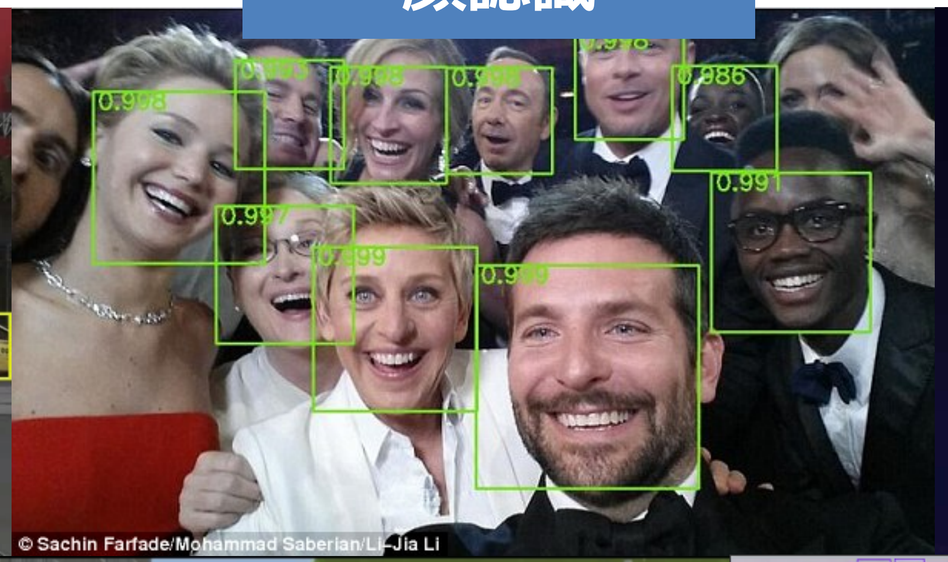
19:00 ～ 19:05 opening
19:05 ～ 19:20 **機械学習の導入**
19:20 ～ 19:30 **walkthrough** Kerasを用いたコーディングサンプル
19:30 ～ 19:45 **畳み込みニューラルネットワークの基礎**
19:45 ～ 20:00 **walkthrough** CNNのフィルタの理解
20:00 ～ 20:10 休憩
20:10 ～ 20:25 **breakout** CNNアーキテクチャの紹介
20:25 ～ 20:40 **Skymind Intelligent Layer (SKIL) の解説**
20:40 ～ 20:55 **walkthrough** SKILを用いたモデルのデプロイ
20:55 ～ 21:00 closing

skymind | 画像認識のアプリケーション

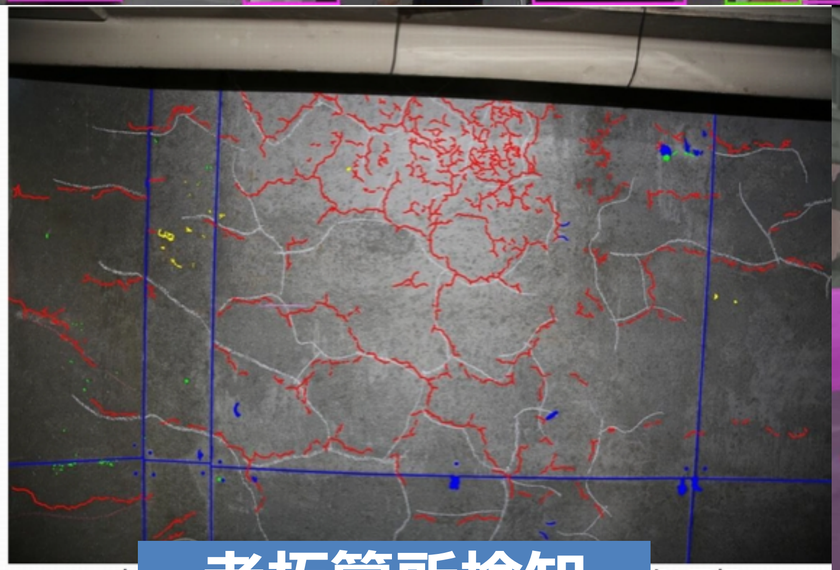
一般物体認識



顔認識

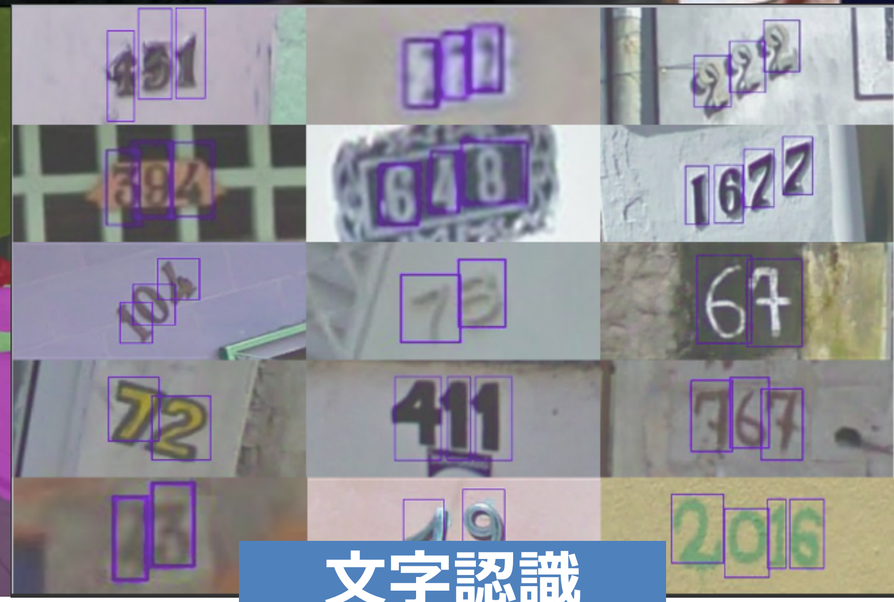


年齢推定



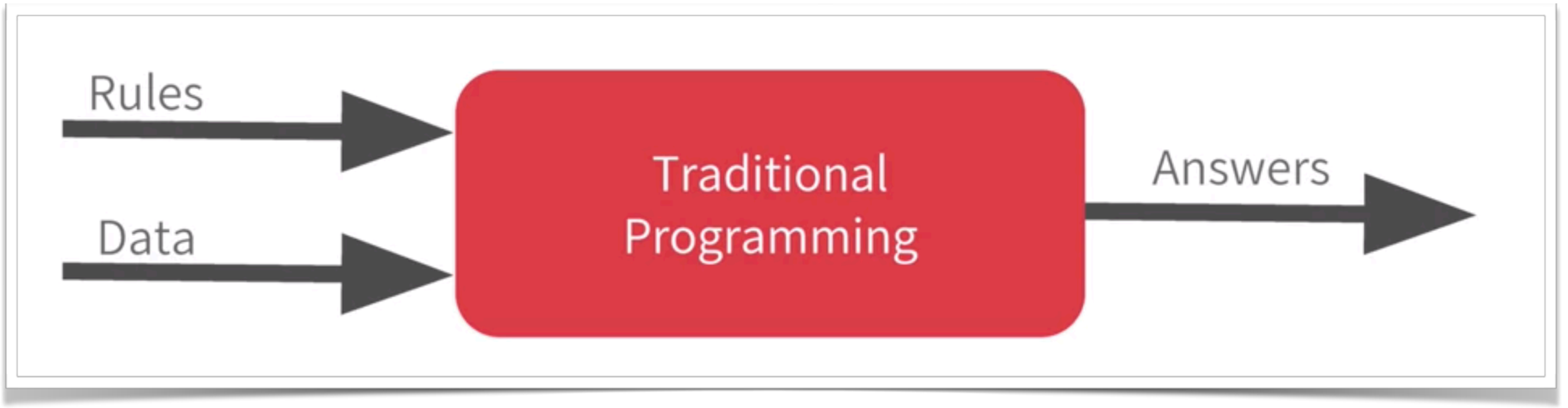
老朽箇所検知

セグメンテーション



文字認識

ニューラルネットワークの基礎



https://www.coursera.org/learn/introduction-tensorflow

Activity Recognition

```
if(speed<4){
    status=WALKING;
}
```

https://www.coursera.org/learn/introduction-tensorflow

Activity Recognition

```
if(speed<4){
    status=WALKING;
}
```

```
if(speed<4){
    status=WALKING;
} else {
    status=RUNNING;
}
```

https://www.coursera.org/learn/introduction-tensorflow

Activity Recognition

```
if(speed<4){
    status=WALKING;
}
```

```
if(speed<4){
    status=WALKING;
} else {
    status=RUNNING;
}
```

```
if(speed<4){
    status=WALKING;
} else if(speed<12){
    status=RUNNING;
} else {
    status=BIKING;
}
```

https://www.coursera.org/learn/introduction-tensorflow

Activity Recognition

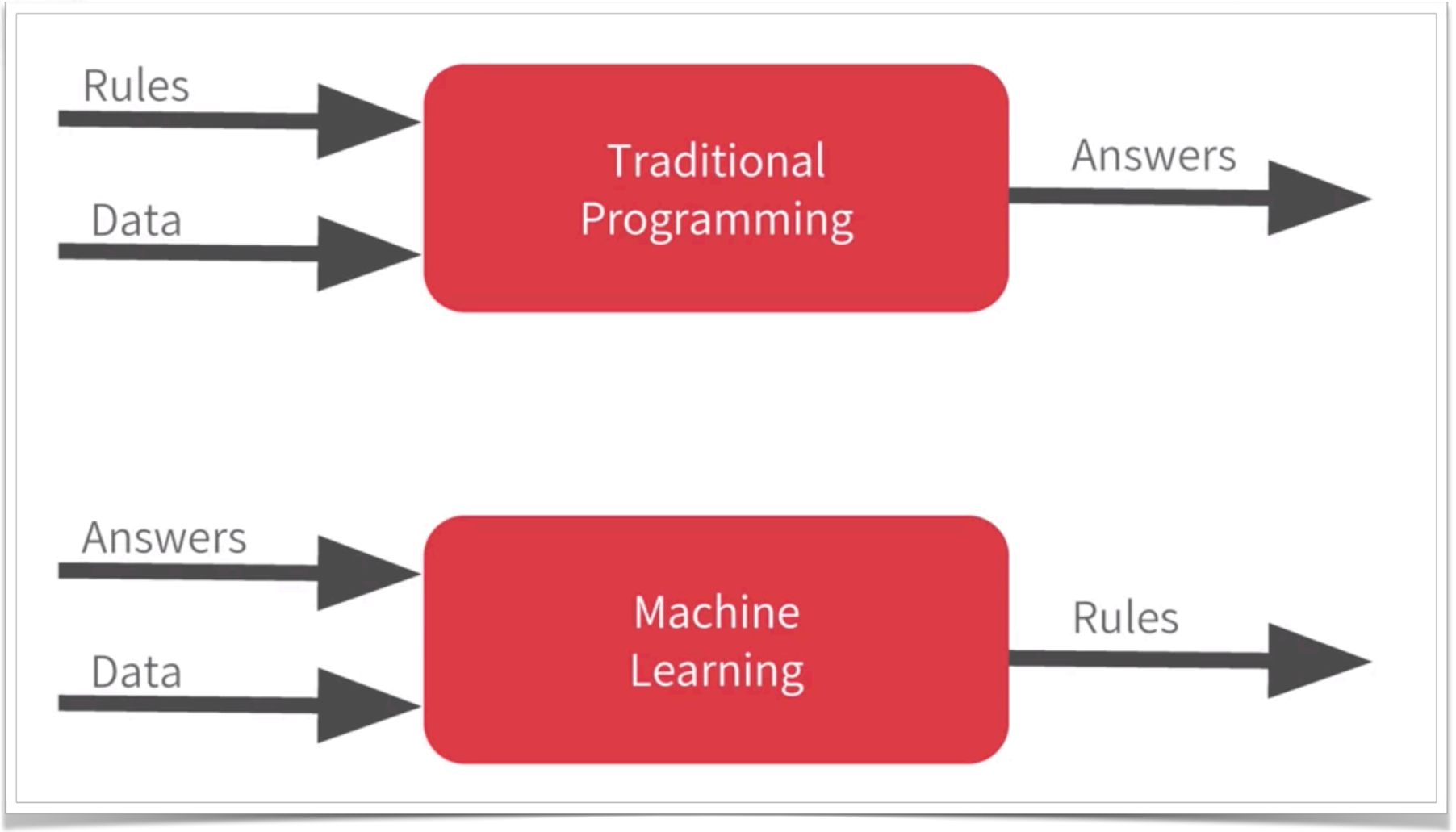
```
if(speed<4){
    status=WALKING;
}
```

```
if(speed<4){
    status=WALKING;
} else {
    status=RUNNING;
}
```

```
if(speed<4){
    status=WALKING;
} else if(speed<12){
    status=RUNNING;
} else {
    status=BIKING;
}
```

```
// Oh crap
```

https://www.coursera.org/learn/introduction-tensorflow



https://www.coursera.org/learn/introduction-tensorflow

Activity Recognition

```
01010010101001010101
10010101010010111101
01001010100101010010
01010010101001010101
```

Label = WALKING

```
10101001010010101010
01010100100100100001
00100111110101011111
10101001001111010111
```

Label = RUNNING

```
10010100111110101010
11010101110101011100
10101011110101010111
11111100011110101010
```

Label = BIKING

```
11111111110100111010
00111111010111101010
01011101010101011100
10101010101001111100
```

Label = GOLFING
(Sort of)

https://www.coursera.org/learn/introduction-tensorflow

機械学習の"Hello World”

```
x = -2, -1, 0, 1, 2, 3, 4
y = -3, -1, 1, 3, 5, 7, 9
```

$$y = f(x)$$

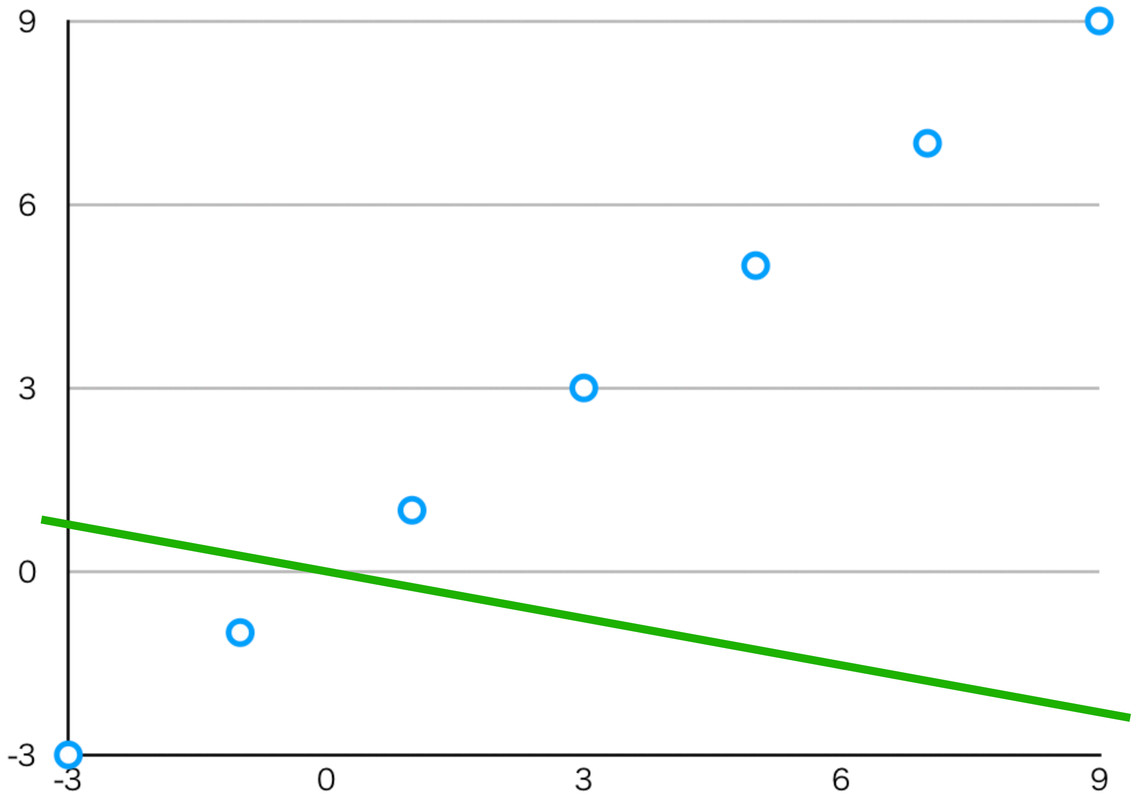
機械学習の"Hello World”

```
x = -2, -1, 0, 1, 2, 3, 4
y = -3, -1, 1, 3, 5, 7, 9
```

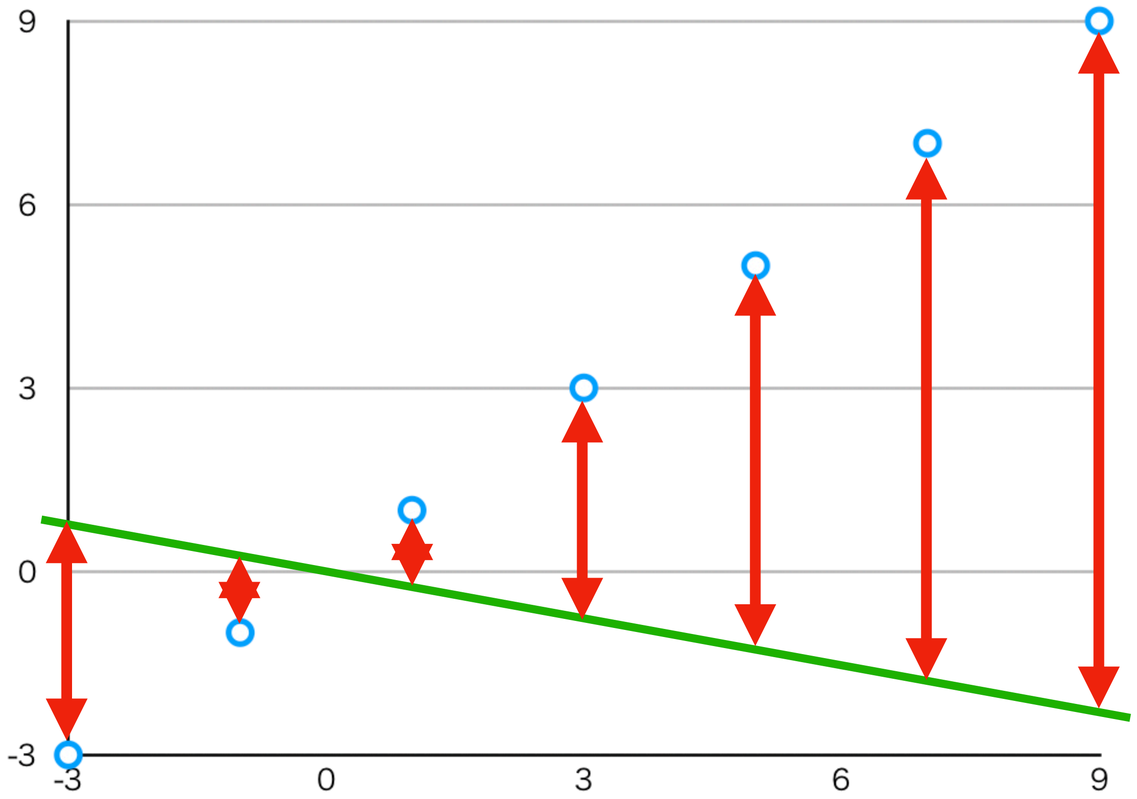
$$y = f(x) = 2x + 1$$

機械学習のアプローチ

- 適当にモデルを初期化 (y_=ax+b)

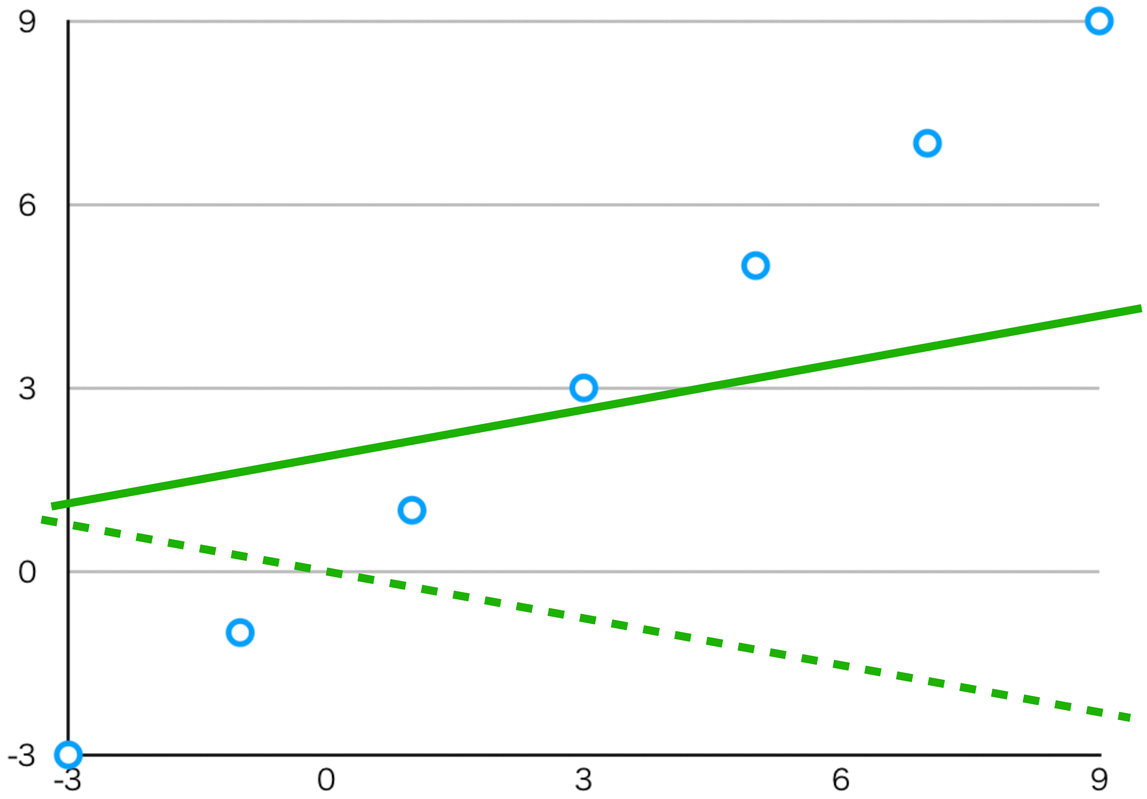


機械学習のアプローチ



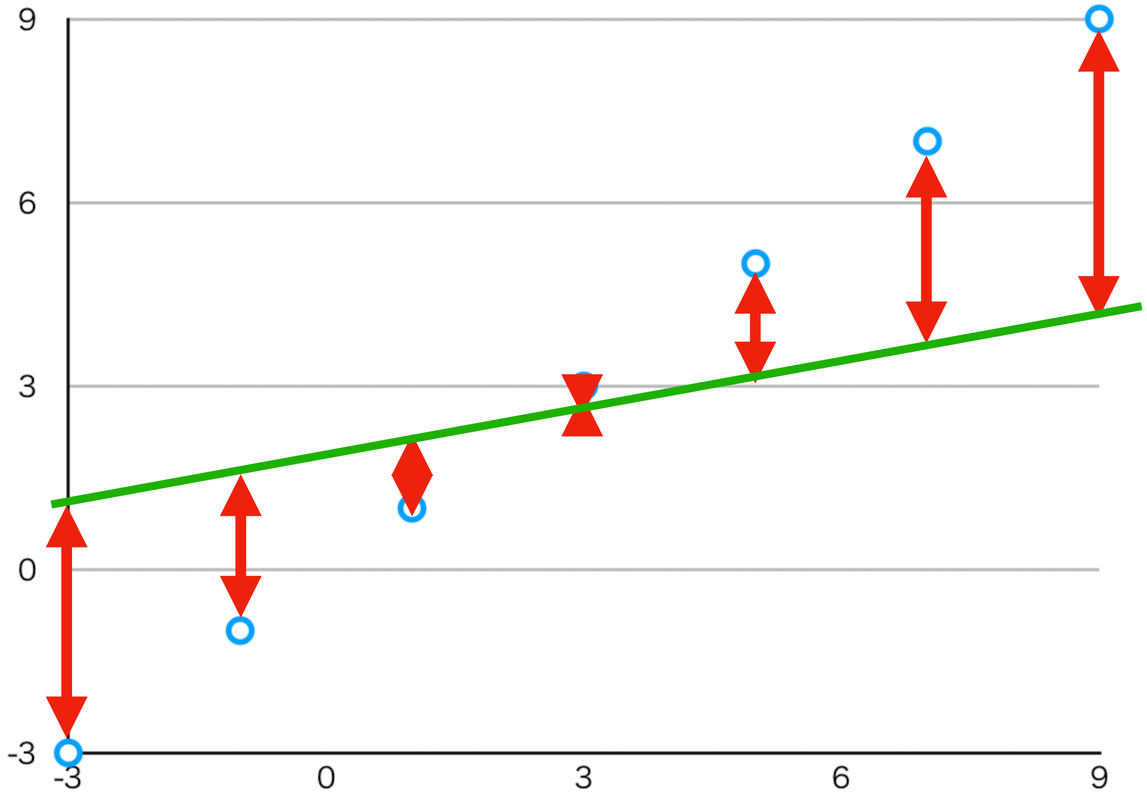
- 適当にモデルを初期化 ($y\_=ax+b$)
- **誤差（損失）を計算 ($L=1/N\ \Sigma(y-y\_)^2$)**

機械学習のアプローチ



- 適当にモデルを初期化 ($y\_=ax+b$)
- 誤差（損失）を計算 ($L=1/N\ \Sigma(y-y\_)^2$)
- **誤差が小さくなるようにパラメータ (a, b) を少し更新 ($a \leftarrow a - \eta\ \partial L/\partial a$)**

機械学習のアプローチ



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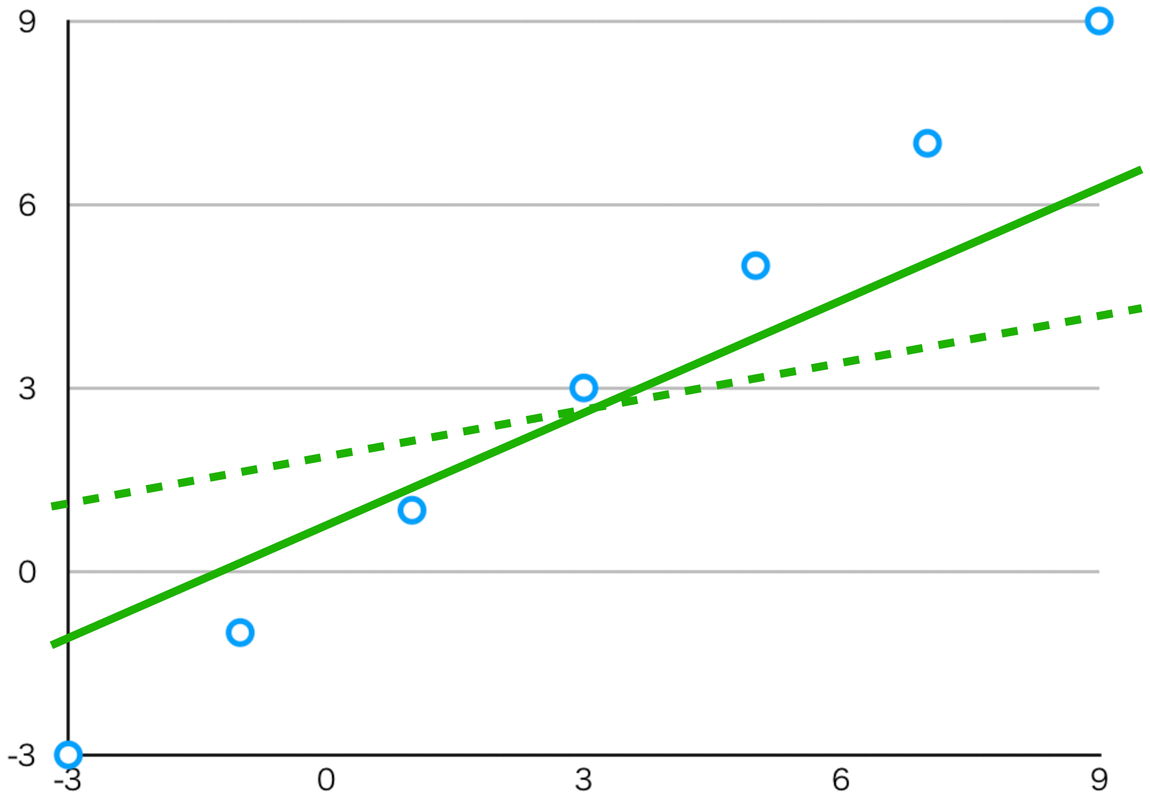
機械学習のアプローチ



- 適当にモデルを初期化 ($y\_=ax+b$)
- 誤差（損失）を計算 ($L=1/N\ \Sigma(y-y\_)^2$)
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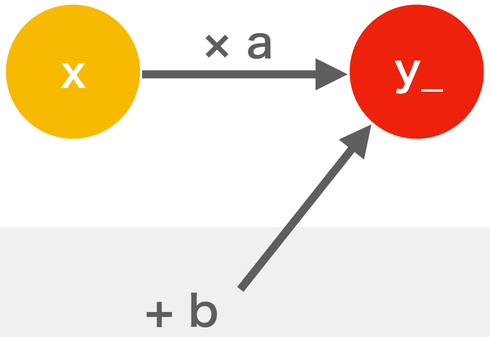
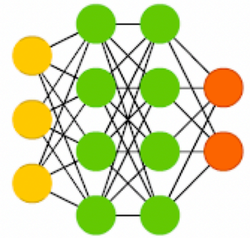
- **誤差が小さくなるようにパラメータ (a, b) を少し更新 ($a \leftarrow a - \eta\ \partial L/\partial a$)**
- …

```
import tensorflow as tf


model = tf.keras.Sequential([tf.keras.layers.Dense(units=1, input_shape=[1])])
model.compile(optimizer='sgd', loss='mean_squared_error')

xs = np.array([-1.0, 0.0, 1.0, 2.0, 3.0, 4.0], dtype=float)
ys = np.array([-3.0, -1.0, 1.0, 3.0, 5.0, 7.0], dtype=float)

model.fit(xs, ys, epochs=500)

>>>print(model.predict([10.0]))
[[18.977331]]
```





```
1  import tensorflow as tf
2
3
4  model = tf.keras.Sequential([tf.keras.layers.Dense(units=1, input_shape=[1])])
5  model.compile(optimizer='sgd', loss='mean_squared_error')
6
7  xs = np.array([-1.0, 0.0, 1.0, 2.0, 3.0, 4.0], dtype=float)
8  ys = np.array([-3.0, -1.0, 1.0, 3.0, 5.0, 7.0], dtype=float)
9
10 model.fit(xs, ys, epochs=500)
11
12 >>>print(model.predict([10.0]))
13 [[18.977331]]
```

```
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model.fit(xs, ys, epochs=500)

>>>print(model.predict([10.0]))
[[18.977331]]
```
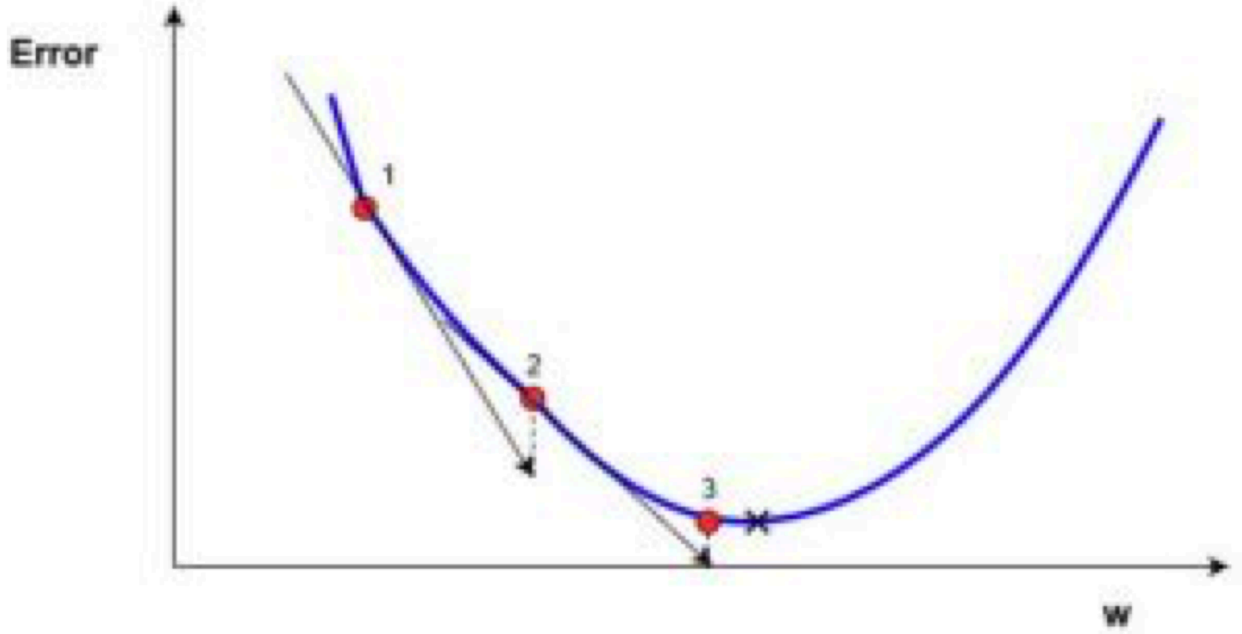

skymind

確率的勾配降下法 SGD, stochastic gradient descent.
デファクトスタンダード
（改良版：momentum, Nesterovの加速法, RMSProp, Adam, ...）



$$w \leftarrow w - \eta \frac{\partial L}{\partial w}$$

勾配降下法

https://www.yamakei-online.com/journal/detail.php?id=3185

$$w \leftarrow w - \eta \frac{\partial L}{\partial w}$$

「目隠しで足元の勾配情報のみを使って山の頂上を目指すようなもの」

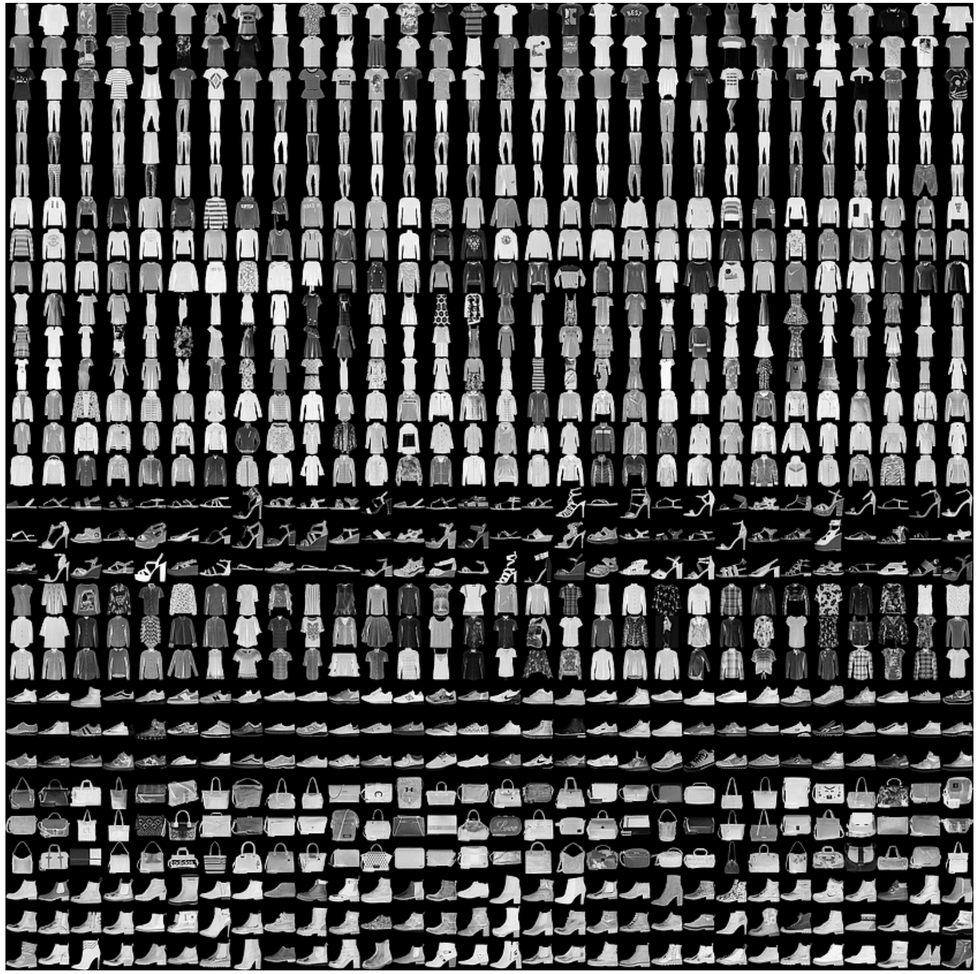
https://twitter.com/momiji_fullmoon/status/1110316960611368960

学習率 η は歩幅のイメージ（η小＝すり足、η大＝巨人の一歩）

Fashion MNIST Dataset

- 7万画像
- 10カテゴリ
- 28×28 pixels
- 実験用データセット

ラベル	記述
0	T-shirt/top
1	Trouser
2	Pullover
3	Dress
4	Coat
5	Sandal
6	Shirt
7	Sneaker
8	Bag
9	Ankle boot



https://github.com/zalandoresearch/fashion-mnist

```
import tensorflow as tf
import matplotlib.pyplot as plt

fashion_mnist = tf.keras.datasets.fashion_mnist
(train_images, train_labels), (test_images, test_labels) = fashion_mnist.load_data()
train_images = train_images / 255.
test_images = test_images / 255.
```

```
import tensorflow as tf
import matplotlib.pyplot as plt

fashion_mnist = tf.keras.datasets.fashion_mnist
(train_images, train_labels), (test_images, test_labels) = fashion_mnist.load_data()
train_images = train_images / 255.
test_images = test_images / 255.

model = tf.keras.Sequential([
    tf.keras.layers.Flatten(input_shape=(28, 28)),
    tf.keras.layers.Dense(128, activation=tf.nn.relu),
    tf.keras.layers.Dense(10, activation=tf.nn.softmax)
])
```

```
import tensorflow as tf
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fashion_mnist = tf.keras.datasets.fashion_mnist
(train_images, train_labels), (test_images, test_labels) = fashion_mnist.load_data()
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model = tf.keras.Sequential([
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    tf.keras.layers.Dense(128, activation=tf.nn.relu),
    tf.keras.layers.Dense(10, activation=tf.nn.softmax)
])

model.compile(optimizer=tf.train.AdamOptimizer(),
    loss='sparse_categorical_crossentropy', metrics=['accuracy'])
model.fit(train_images, train_labels, epochs=5, batch_size=128, verbose=1,
    validation_data=(test_images, test_labels))
```
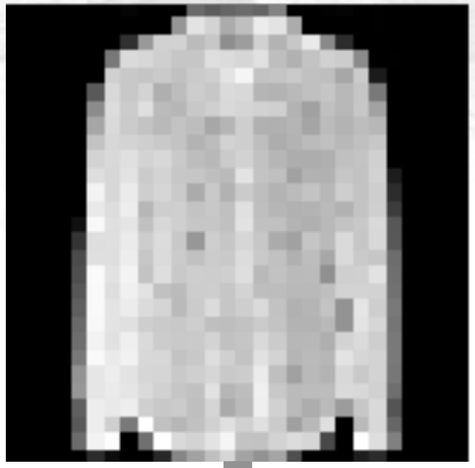
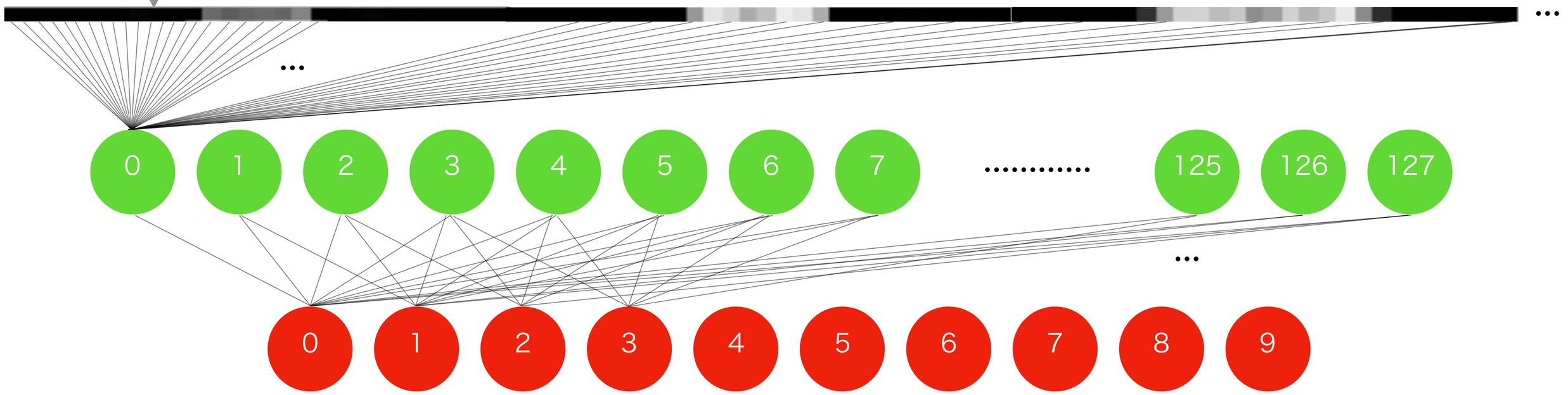



```
model = tf.keras.Sequential([
    tf.keras.layers.Flatten(input_shape=(28, 28)),
    tf.keras.layers.Dense(128, activation=tf.nn.relu),
    tf.keras.layers.Dense(10, activation=tf.nn.softmax)
])
```

Flatten: (28, 28) => (784)

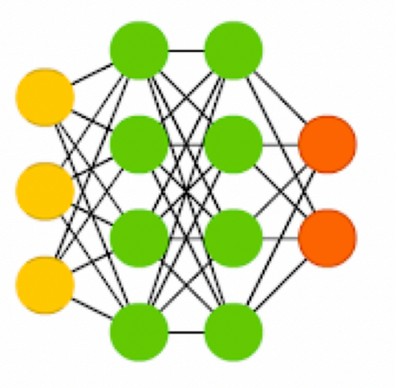


Dense Layer の欠点

- 入力のベクトルの**全要素**の相関をみている

  > 住宅価格予測みたいな話ならまだいい

  > もう作ってる特徴量と特徴量の組み合わせ



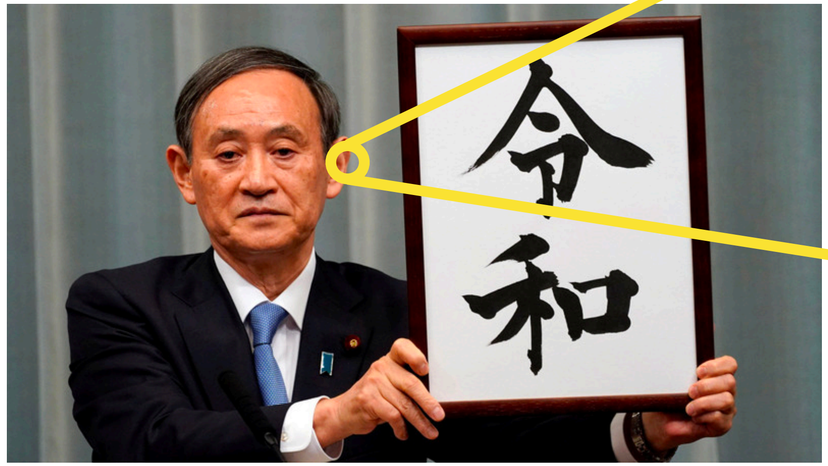
  - 例）東京墨田区 & 床面積 30m^2 & 1K & 風呂トイレ別 & 新築 => 家賃月10万円

- **「画像の特徴量」を抽出**してからDense Layerに渡せば効率的

畳込みニューラルネットワーク (Convolutional Neural Network; CNN)

畳み込みニューラルネットワークの基礎

畳み込み (Convolution)



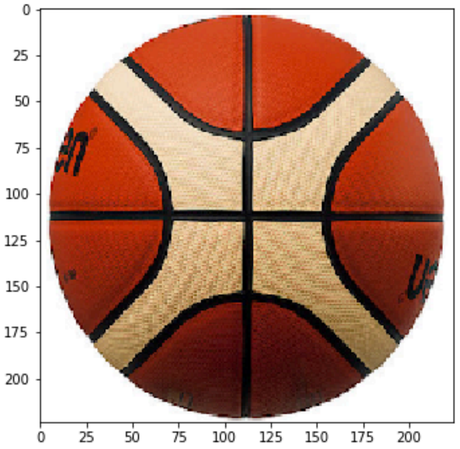
https://news.yahoo.co.jp/byline/yuasamakoto/20190403-00120722/

144	60	19
188	82	32
156	55	27

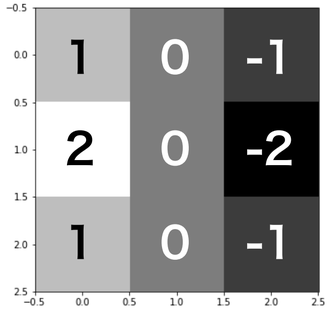
-1	0	-2
0.5	4.5	-1.5
1.5	2	-3

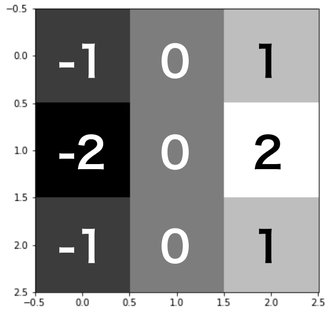
$$u_{ijm} = \sum_{k=0}^{K-1} \sum_{p=0}^{W-1} \sum_{q=0}^{H-1} z_{i+p,j+q,k}^{(l-1)} h_{pqkm} + b_{ijm}$$

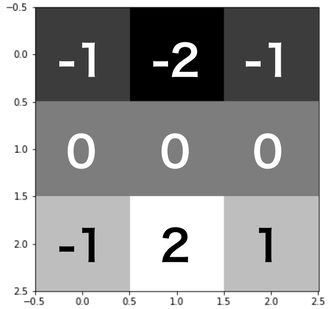
```
CURRENT_PIXEL_VALUE = 82

NEW_PIXEL_VALUE =
   (-1 * 144) + (0 * 60) + (-2 * 19)
+ (0.5 * 188) + (4.5 * 82) + (-1.5 * 32)
+ (1.5 * 156) + (2 * 55) + (-3 * 27)
```

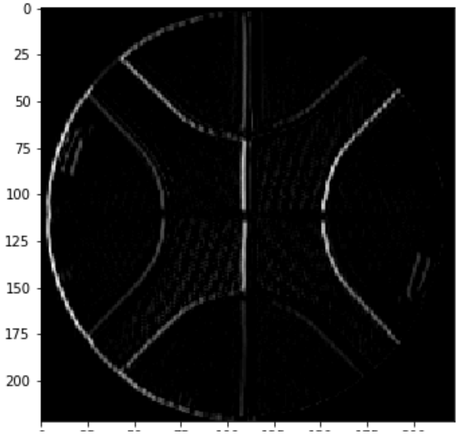


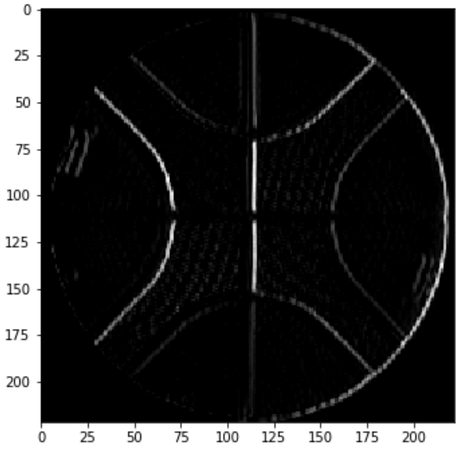
https://www.bbkong.net/fs/alleyoop/molten_BGL7

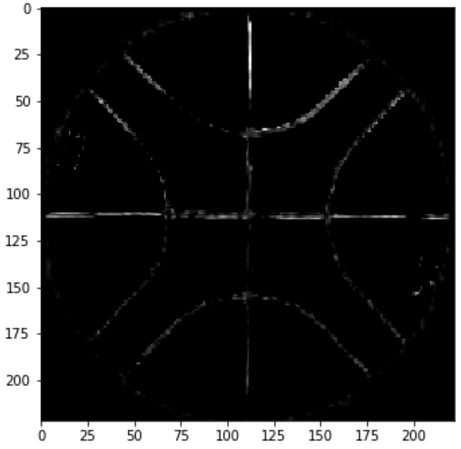












stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(1, 1), padding='valid'

stride=(2, 2), padding='valid'

stride=(2, 2), padding='valid'

stride=(2, 2), padding='valid'

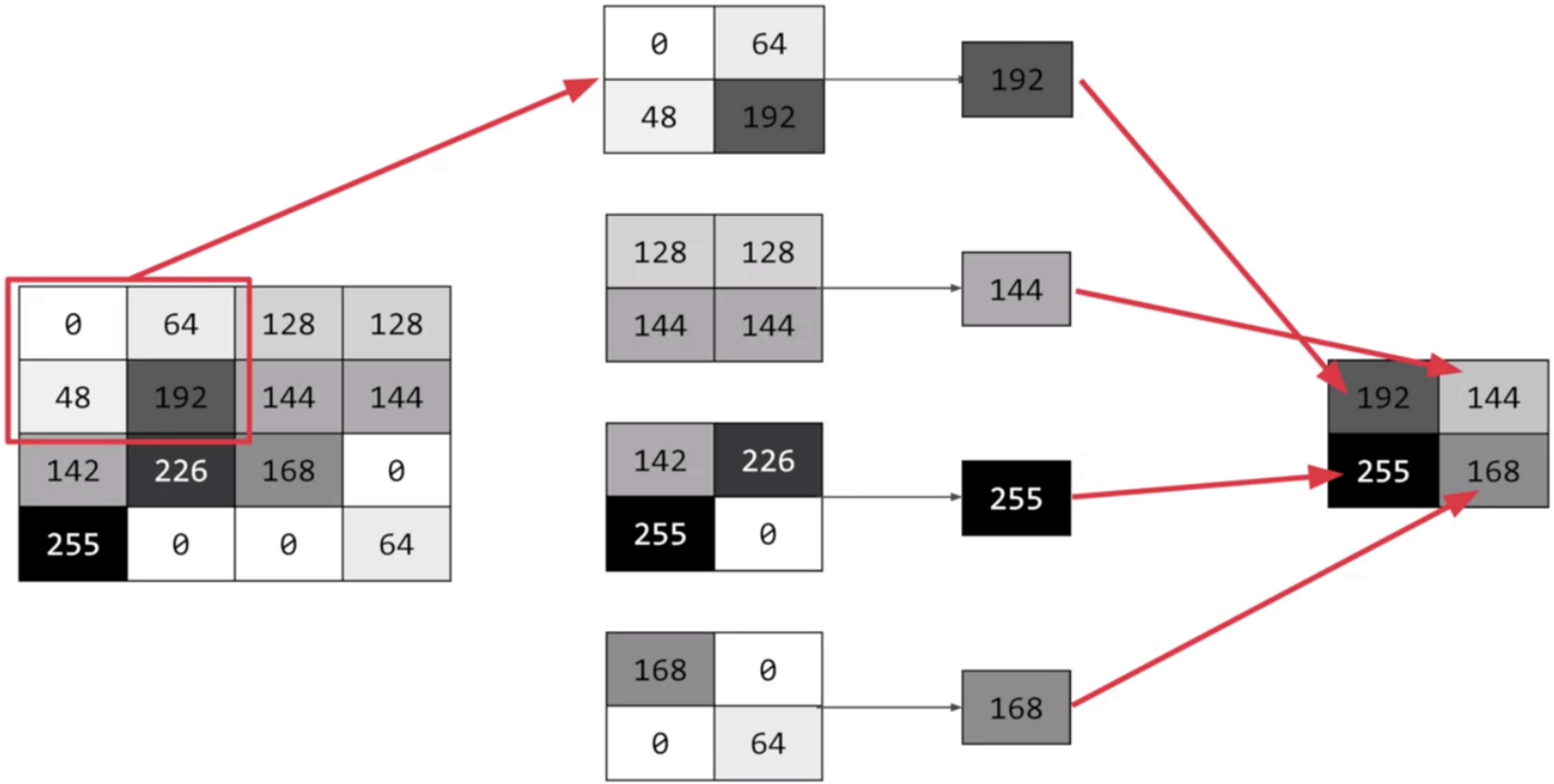
stride=(1, 1), padding='same'

stride=(1, 1), padding='same'

stride=(1, 1), padding='same'

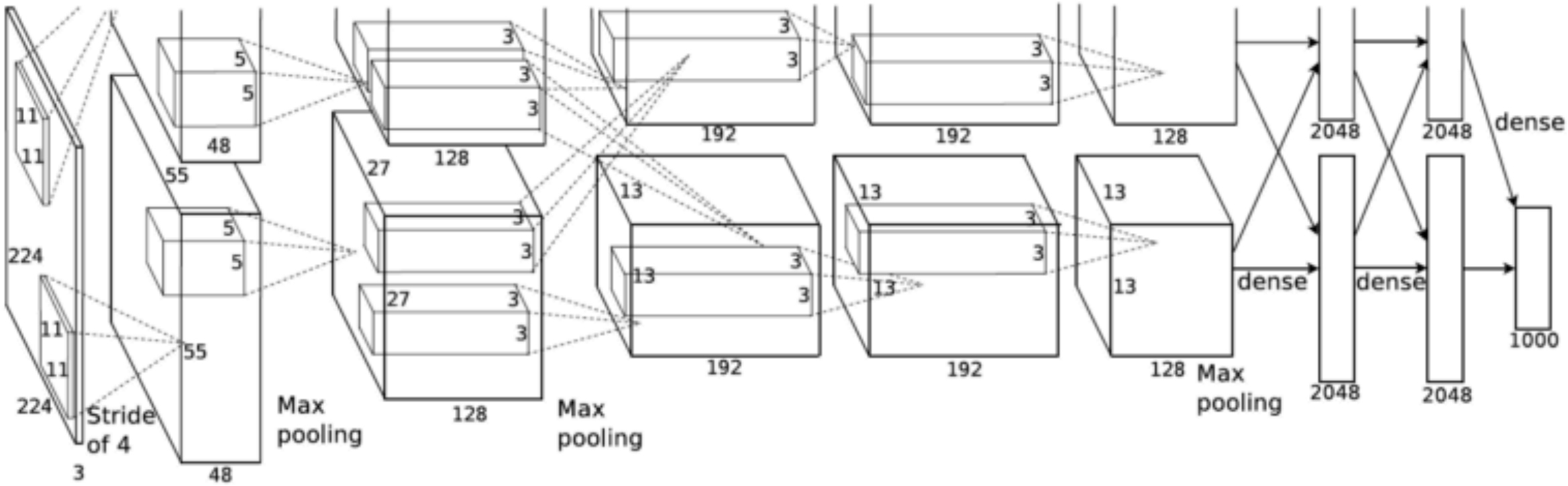
stride=(1, 1), padding='same'

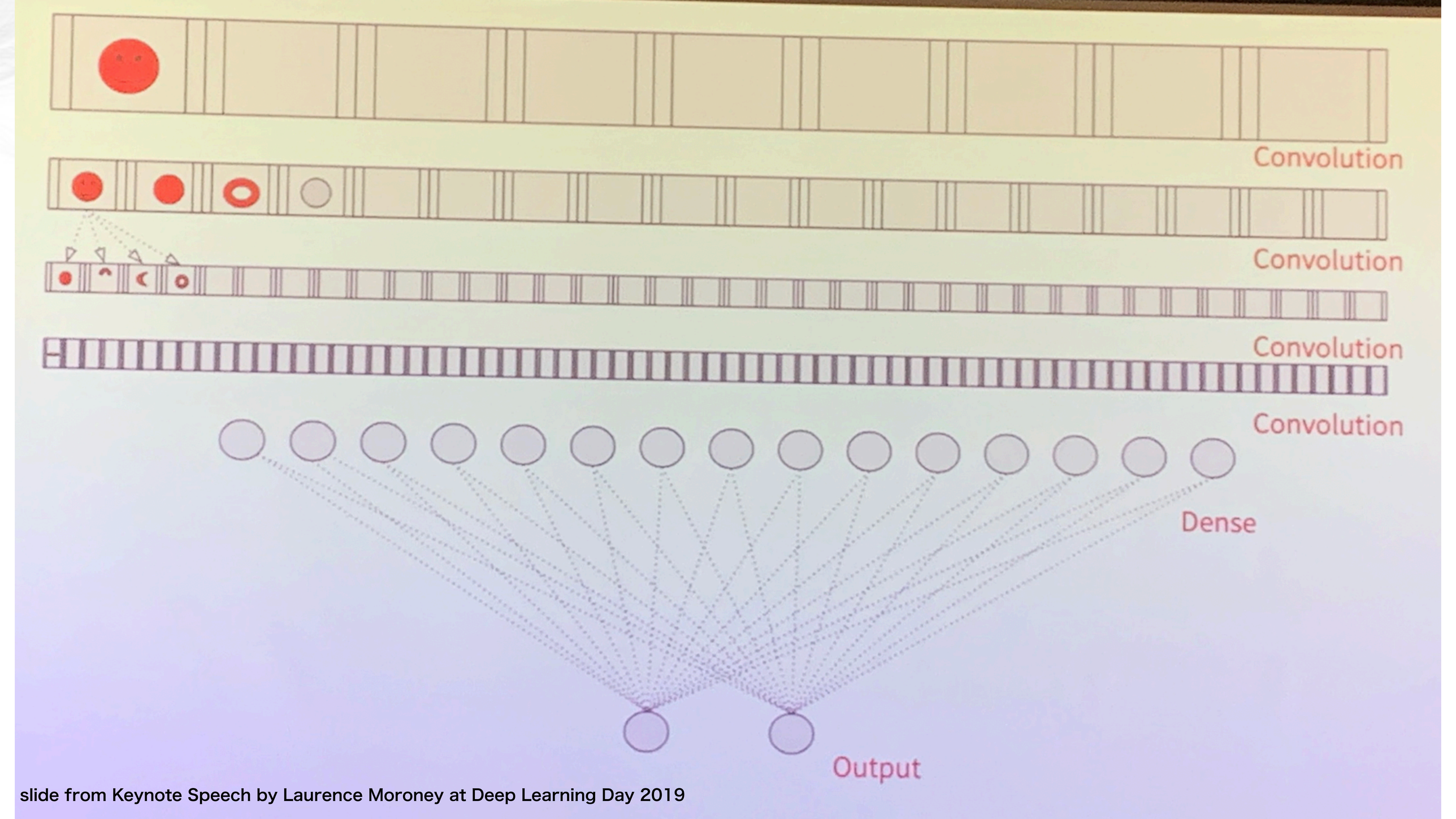
Max Pooling



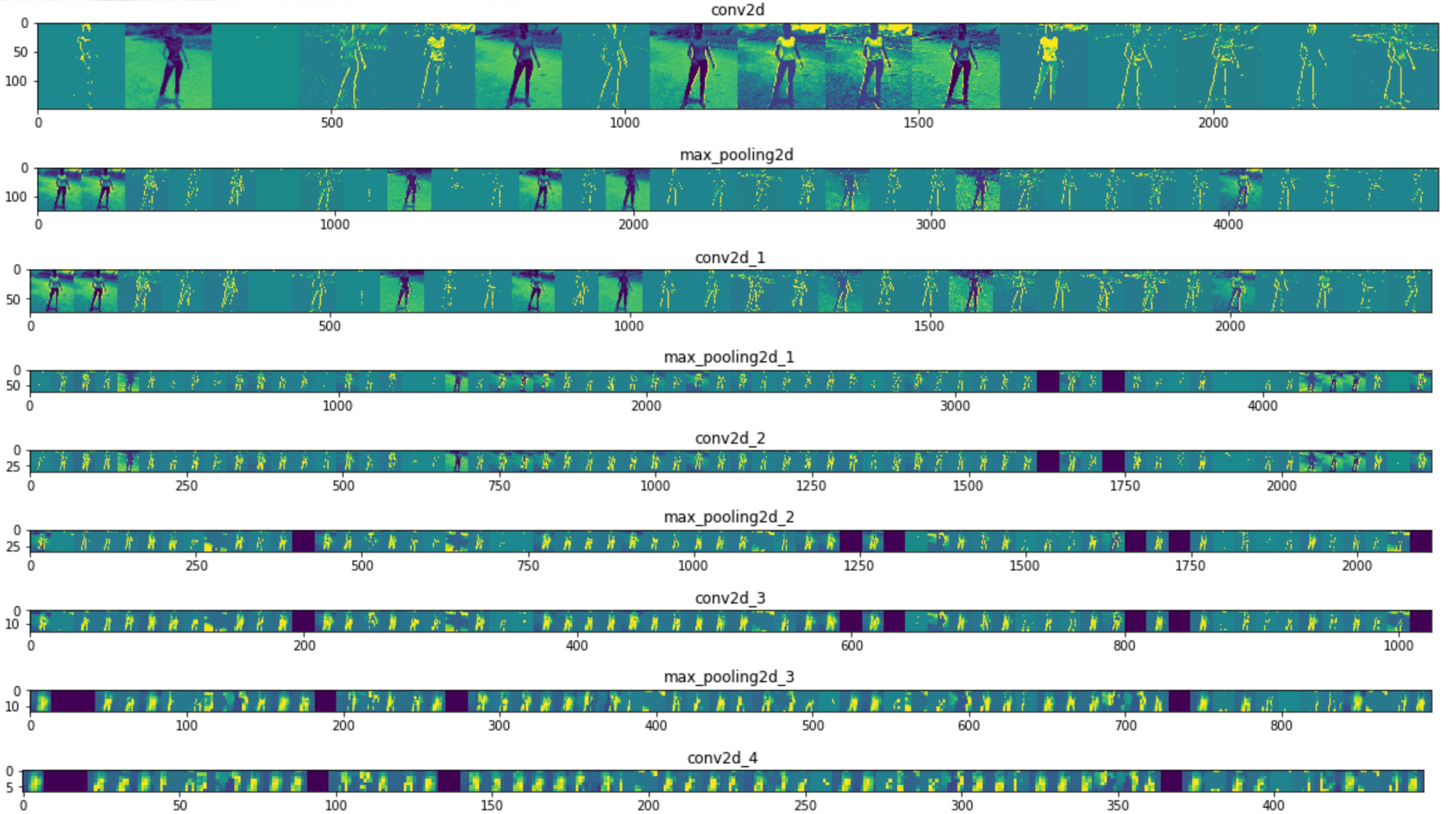
https://www.coursera.org/learn/introduction-tensorflow

AlexNet

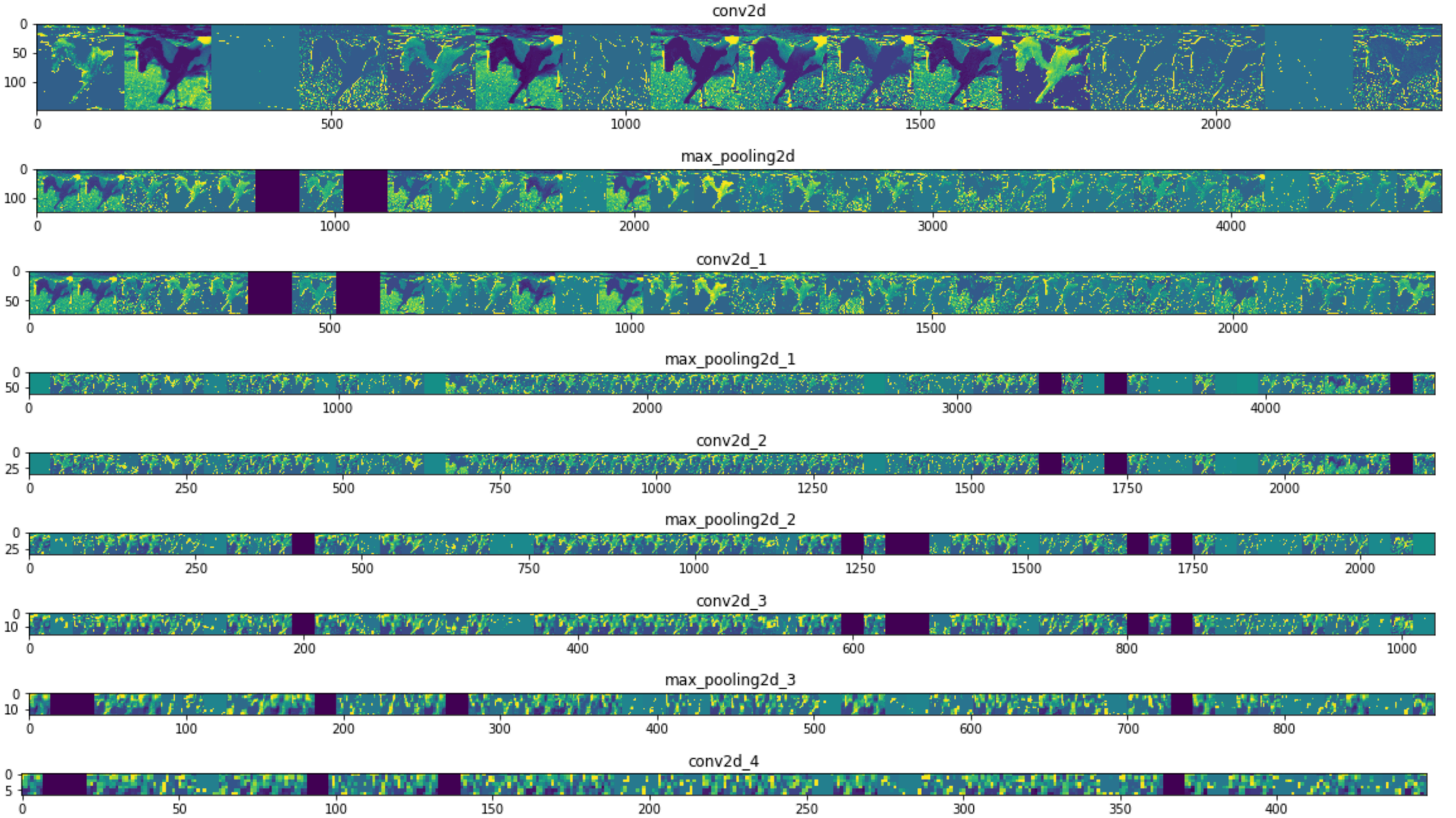

11
11
224
224
3
Stride
of 4
5
5
48
55
48
5
5
55
11
11
Max
pooling
3
3
3
128
27
128
3
3
27
3
3
128
Max
pooling
3
3
192
3
3
192
13
13
13
192
3
3
13
3
3
192
13
13
128
Max
pooling
dense
2048
2048
dense
dense
2048
2048
dense
1000



slide from Keynote Speech by Laurence Moroney at Deep Learning Day 2019



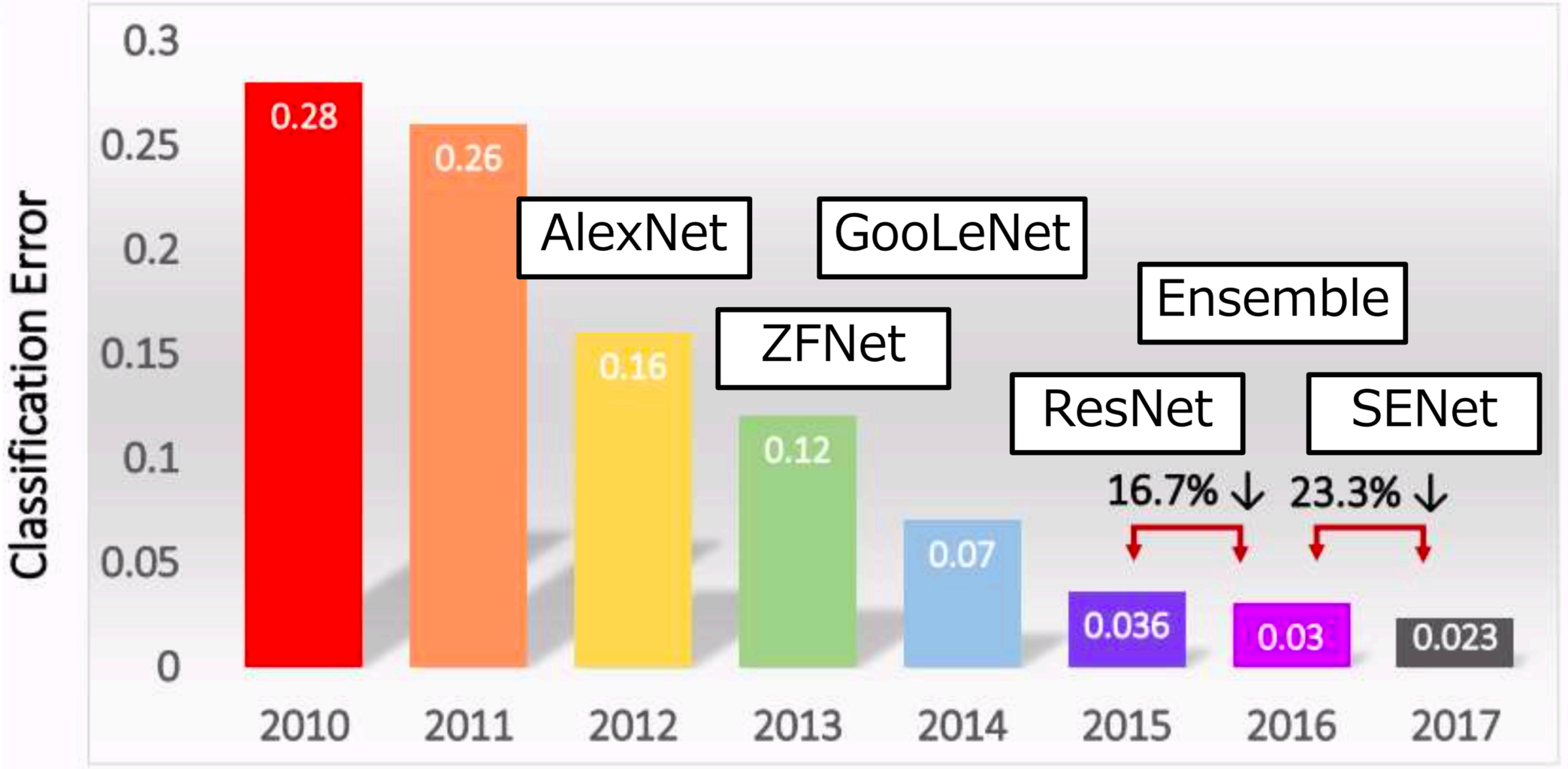
https://medium.com/@lmoroney_40129/codelabs-from-googlemlsummit-f9d53cac8d24



https://medium.com/@lmoroney_40129/codelabs-from-googlemlsummit-f9d53cac8d24

応用的なCNNアーキテクチャの紹介

ImageNet コンペの優勝モデル

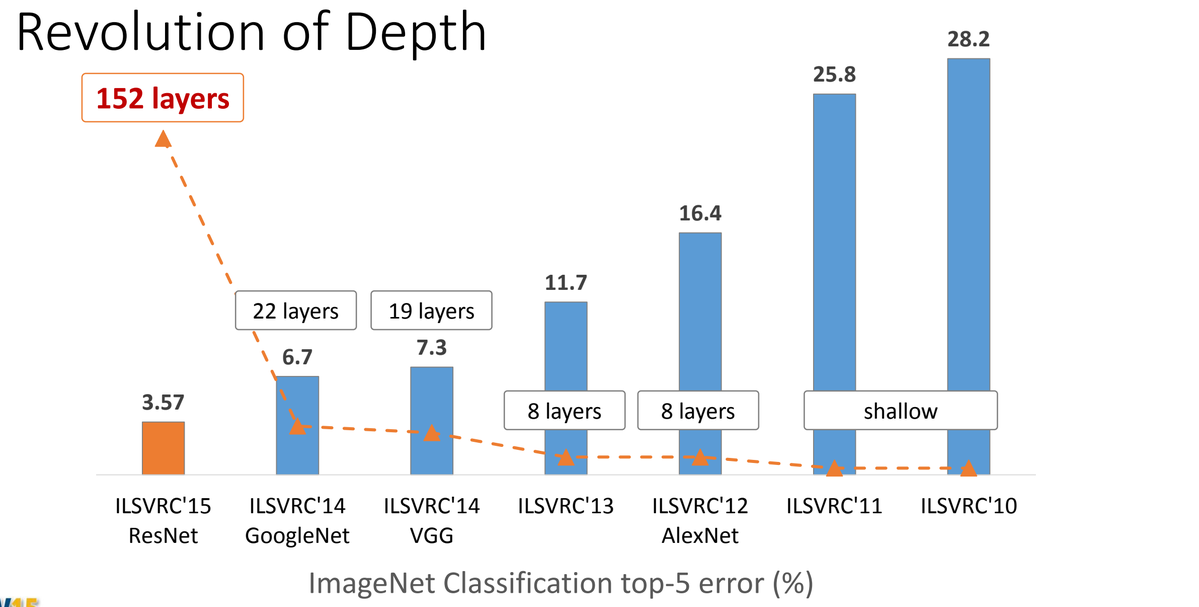


https://www.slideshare.net/ren4yu/ss-84282514

ResNet

- 2015年のImageNetコンペ (ILSVRC) 優勝モデル
- Residualモジュール（ショートカット機構）の導入

Microsoft Research



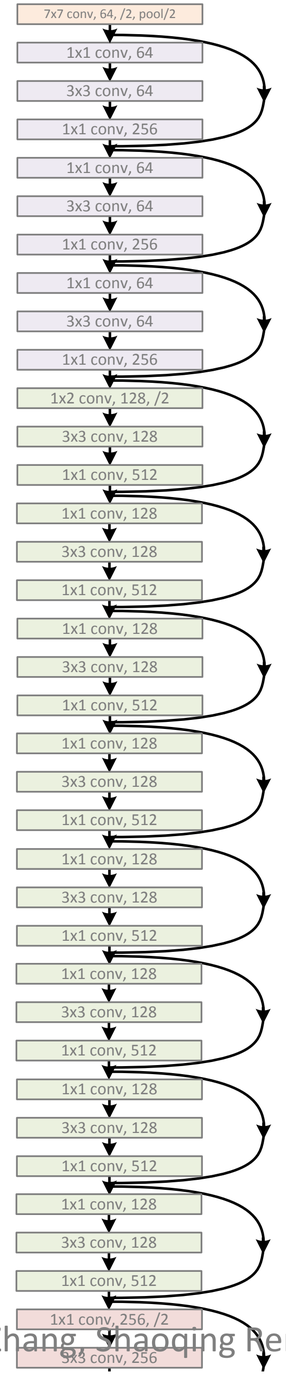
ICCV15 International Conference on Computer Vision

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. “Deep Residual Learning for Image Recognition”. arXiv 2015.

http://image-net.org/challenges/talks/ilsvrc2015_deep_residual_learning_kaiminghe.pdf

Revolution of Depth

ResNet, 152 layers



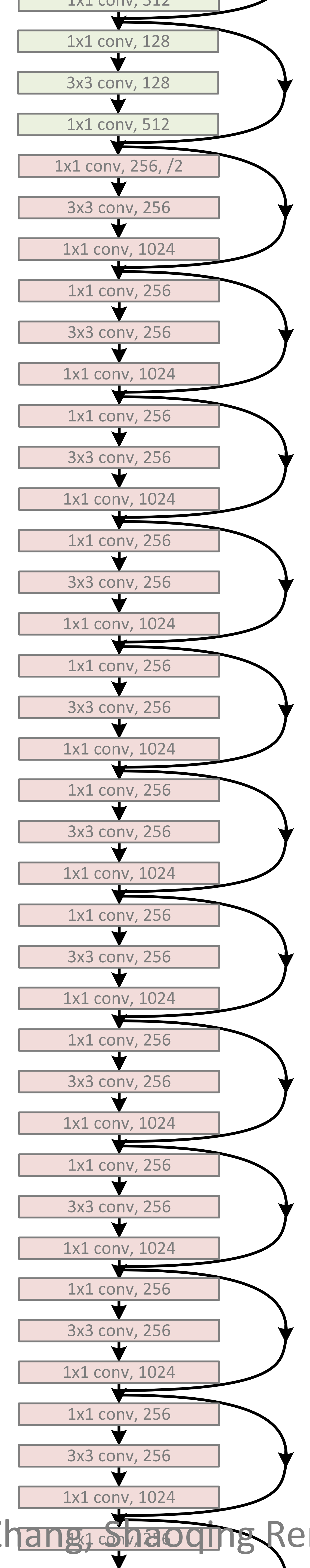
(there was an animation here)

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. “Deep Residual Learning for Image Recognition”. arXiv 2015.

Microsoft Research

Revolution of Depth

ResNet, 152 layers



(there was an animation here)

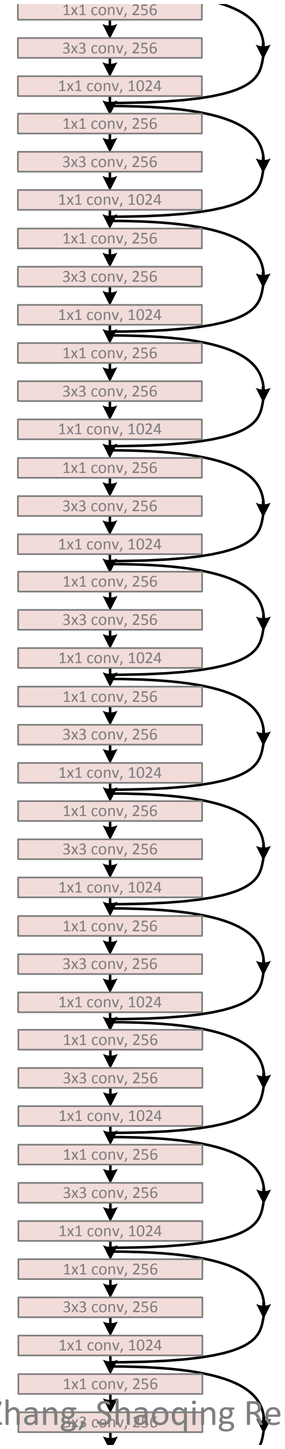
ICCV15 International Conference on Computer Vision

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. “Deep Residual Learning for Image Recognition”. arXiv 2015.

Microsoft Research

Revolution of Depth

ResNet, 152 layers



(there was an animation here)

ICCV15 International Conference on Computer Vision

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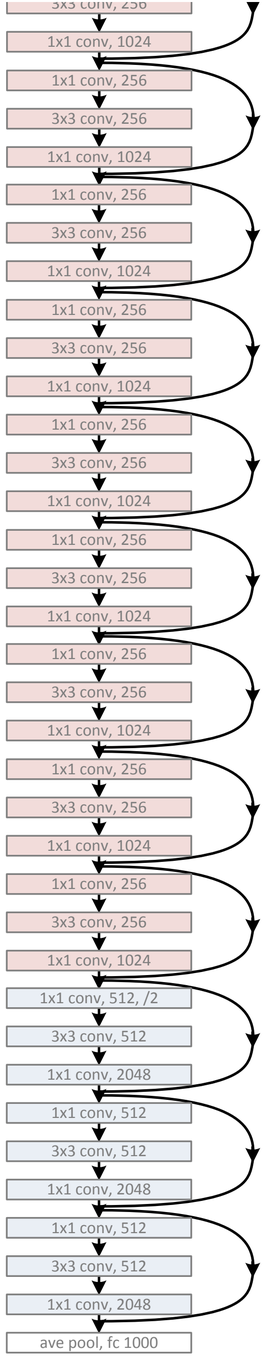
Microsoft Research

Revolution of Depth

ResNet, 152 layers



(there was an animation here)

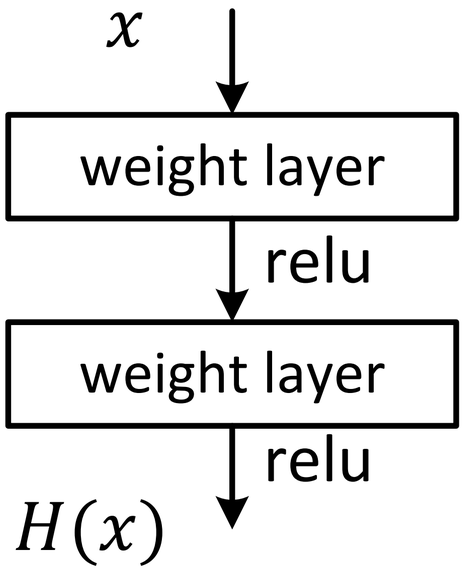
ICCV15 International Conference on Computer Vision

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. “Deep Residual Learning for Image Recognition”. arXiv 2015.

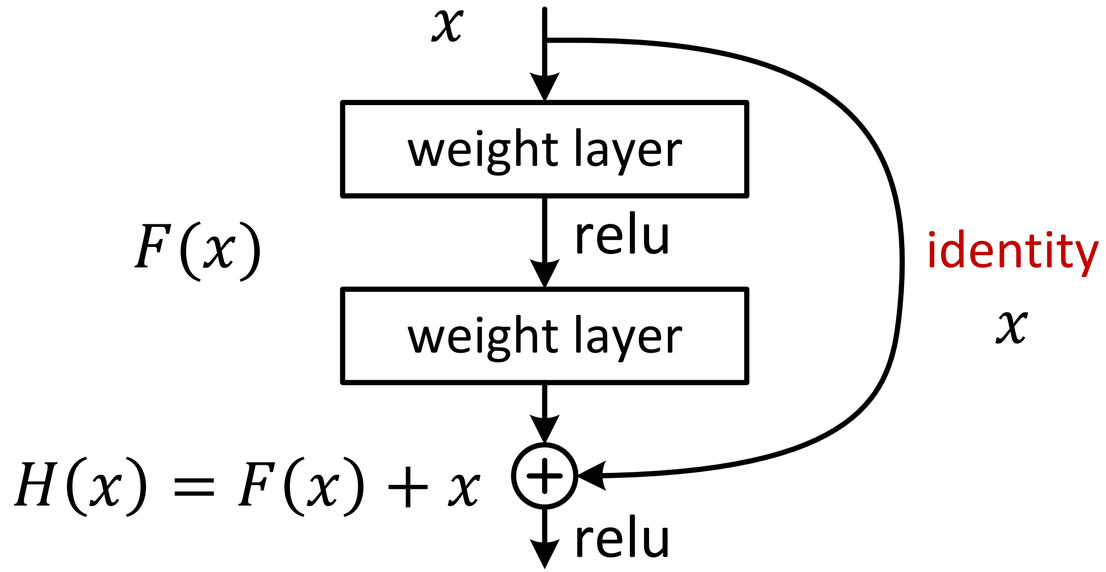
ResNet

- Plaint net

any two stacked layers

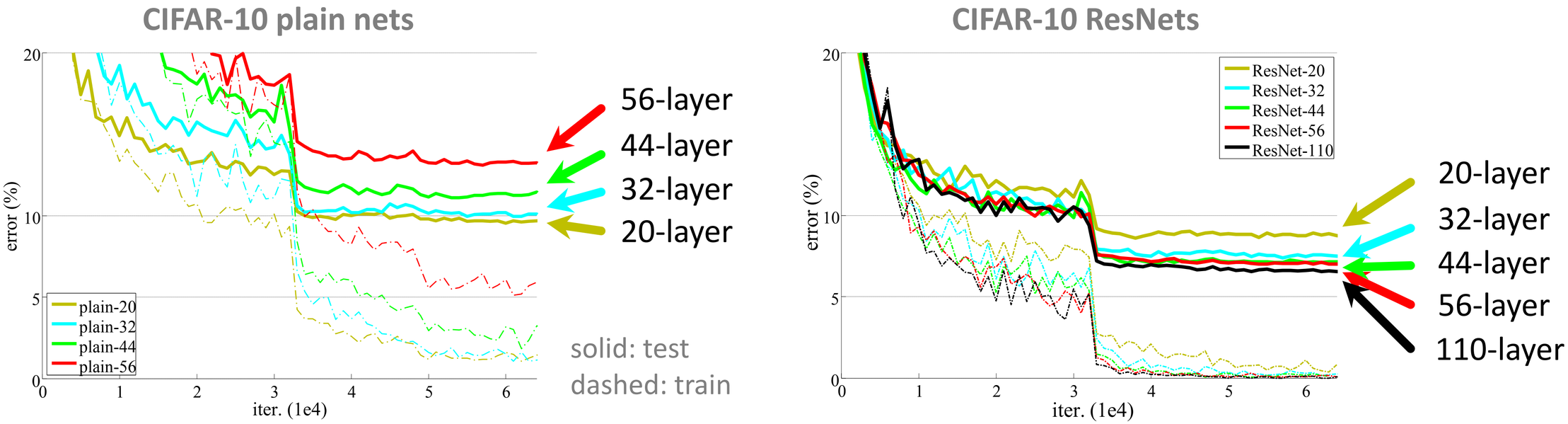


- Residual net



http://image-net.org/challenges/talks/ilsvrc2015_deep_residual_learning_kaiminghe.pdf

CIFAR-10 experiments



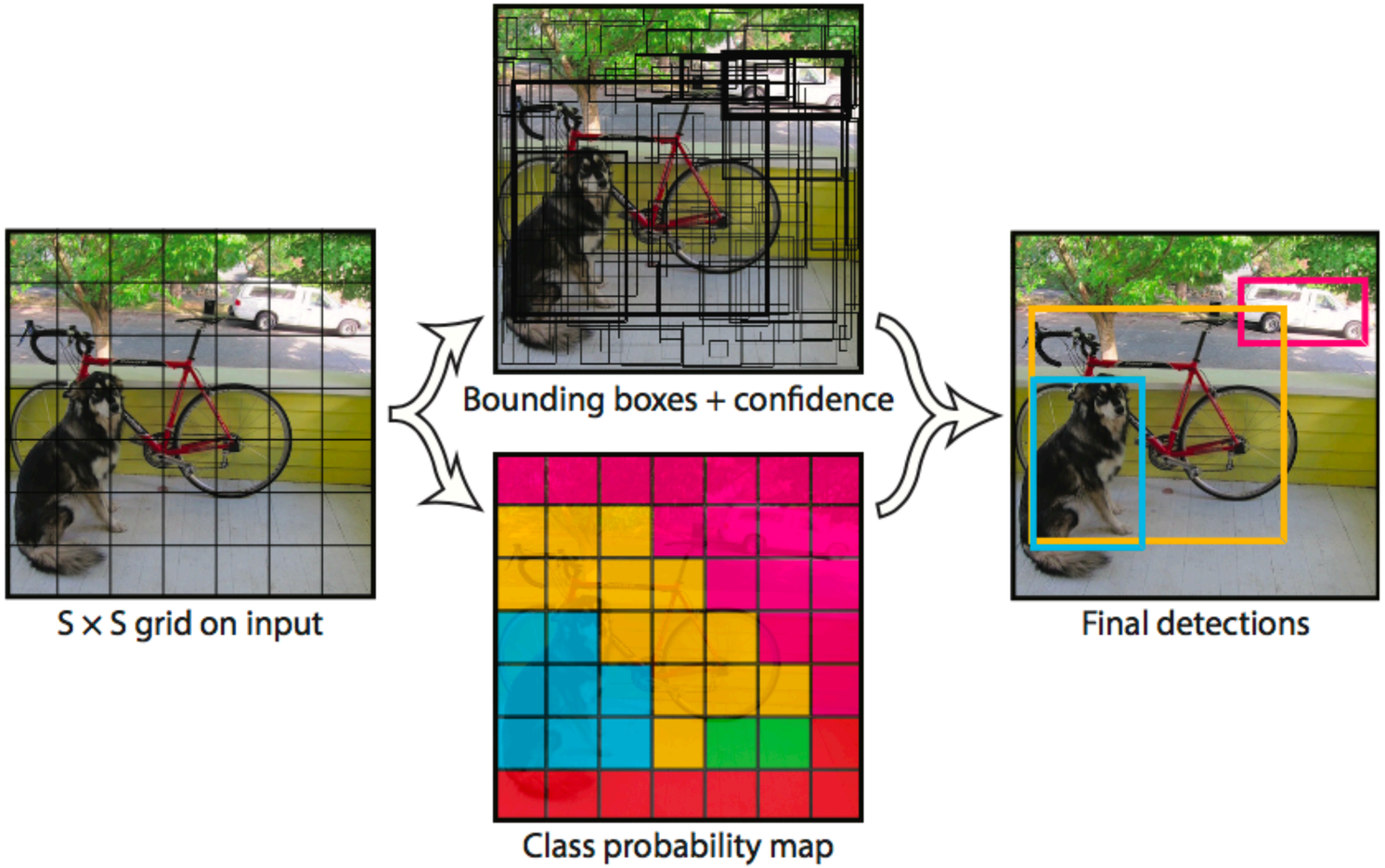
- Deep ResNets can be trained without difficulties
- Deeper ResNets have **lower training error**, and also lower test error

Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. “Deep Residual Learning for Image Recognition”. arXiv 2015.

Further Reading

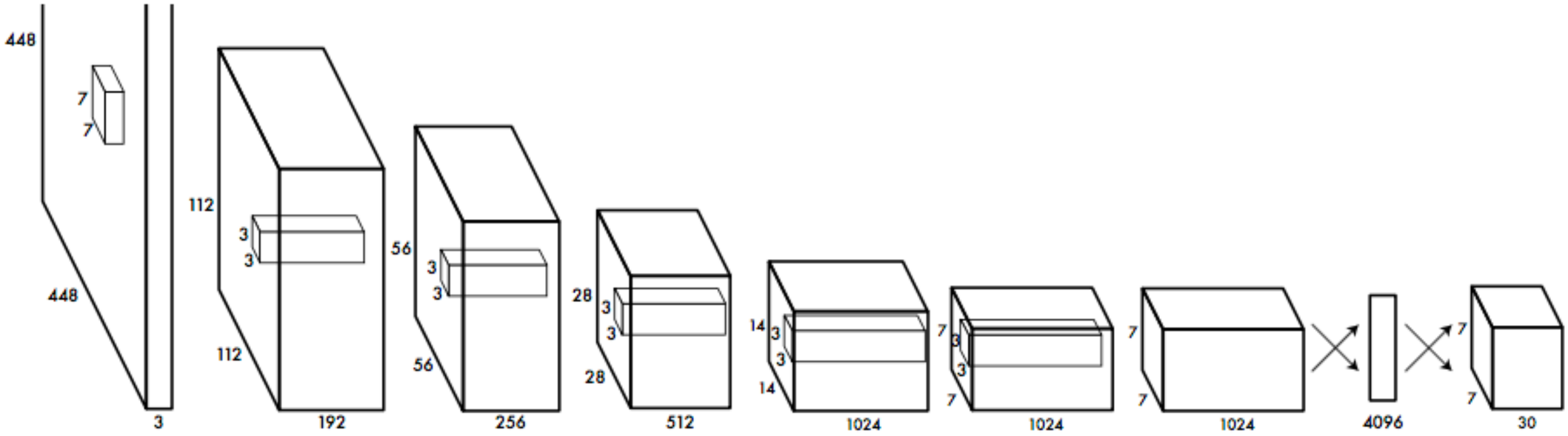
- 一年半前 (2017-12) の資料ですが素晴らしいスライドです
  - 畳み込みニューラルネットワークの研究動向 by DeNA 内田さん
  - https://www.slideshare.net/ren4yu/ss-84282514

YOLO (You Only Look Once)



https://www.youtube.com/watch?v=MPU2HistivI

YOLOのアーキテクチャ



Conv. Layer
7x7x64-s-2
Maxpool Layer
2x2-s-2

Conv. Layer
3x3x192
Maxpool Layer
2x2-s-2

Conv. Layers
1x1x128
3x3x256
1x1x256
3x3x512
Maxpool Layer
2x2-s-2

Conv. Layers
1x1x256
3x3x512
} ×4
1x1x512
3x3x1024
Maxpool Layer
2x2-s-2

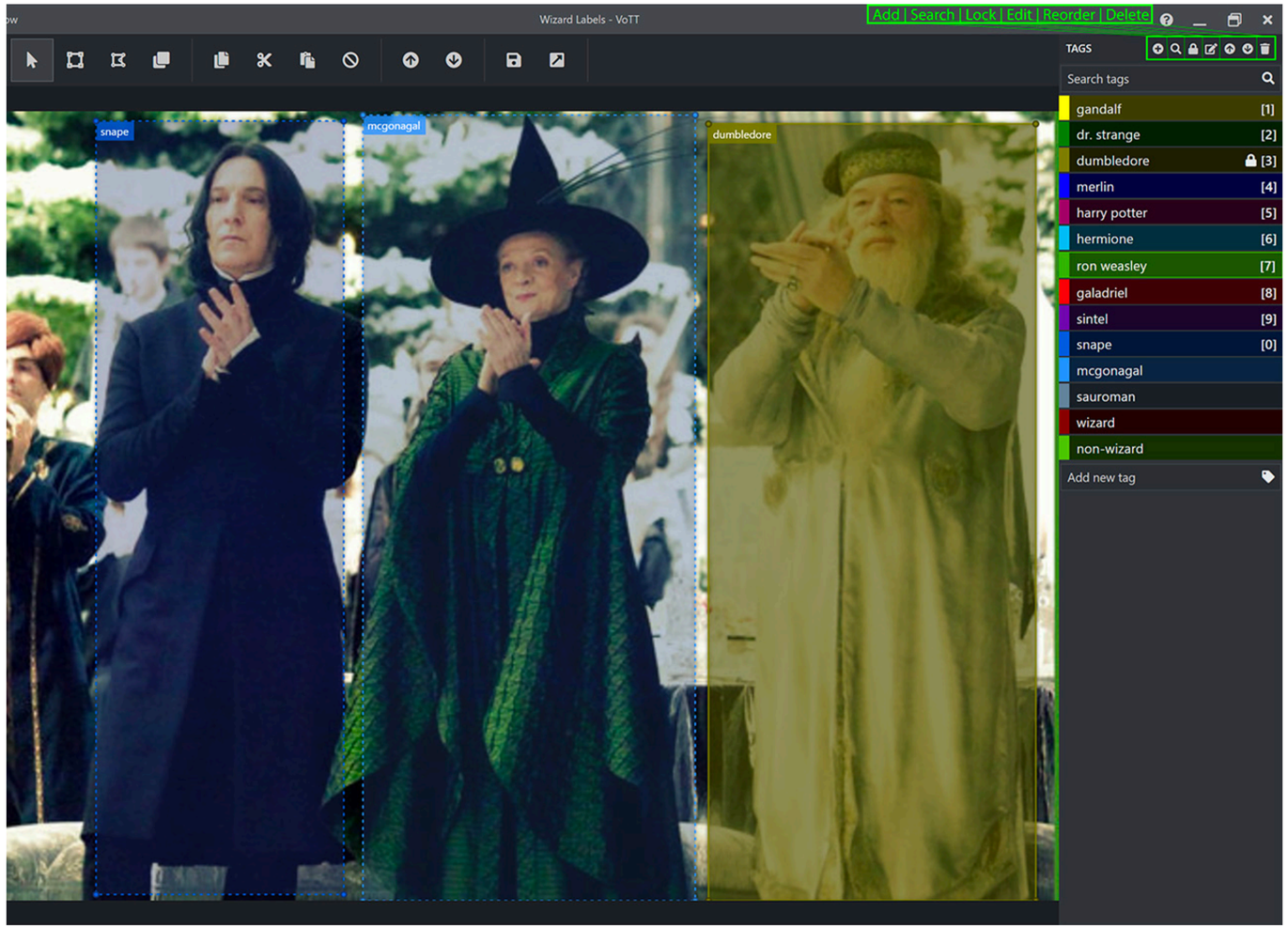
Conv. Layers
1x1x512
3x3x1024
} ×2
3x3x1024
3x3x1024-s-2

Conv. Layers
3x3x1024
3x3x1024

Conn. Layer

Conn. Layer

Labeling / Annotation



https://github.com/Microsoft/VoTT

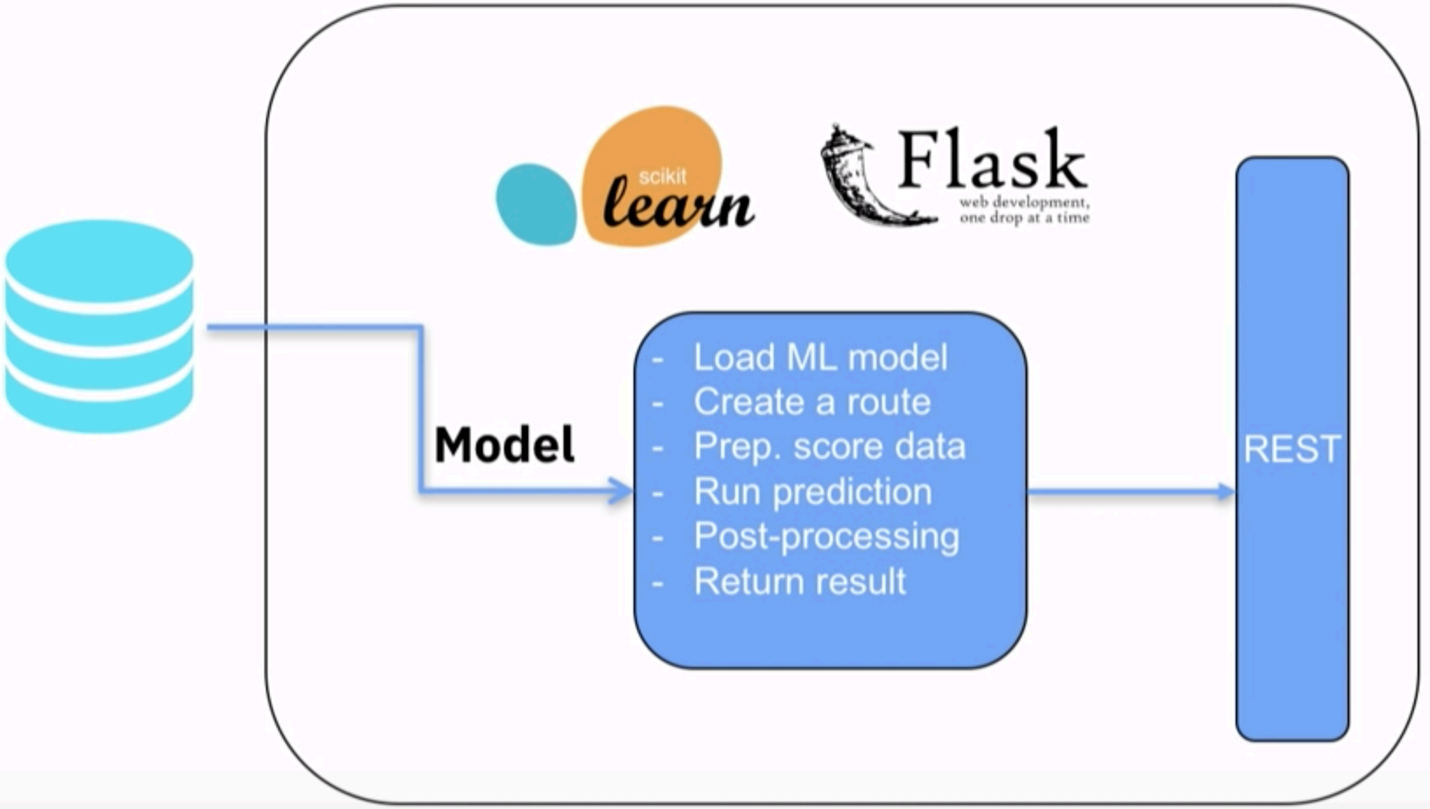
AIモデルの運用・デプロイ

https://www.programming-fun.net/article/article_40.html

Deployment with Cloud Foundry

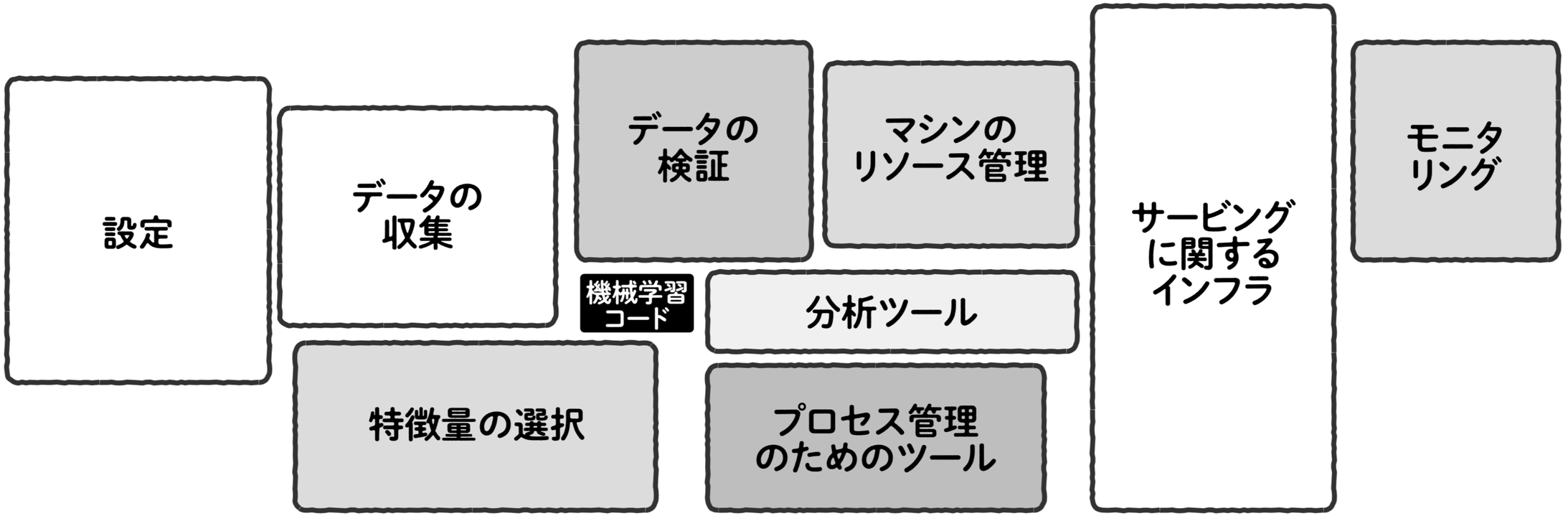
Python App - REST API
Endpoint: /v1/xyz/prediction : POST

Questions
- How to configure the app ?
- How many instances ?
- How much RAM ?
- Zero downtime deployment ?
- Connection to DB?
- Logging ?
- Crashes and recovery?
- Routing ?
- Workload scaling ?
- Integration with other tools?
- ...



https://www.youtube.com/watch?v=-UYyyeYJAoQ

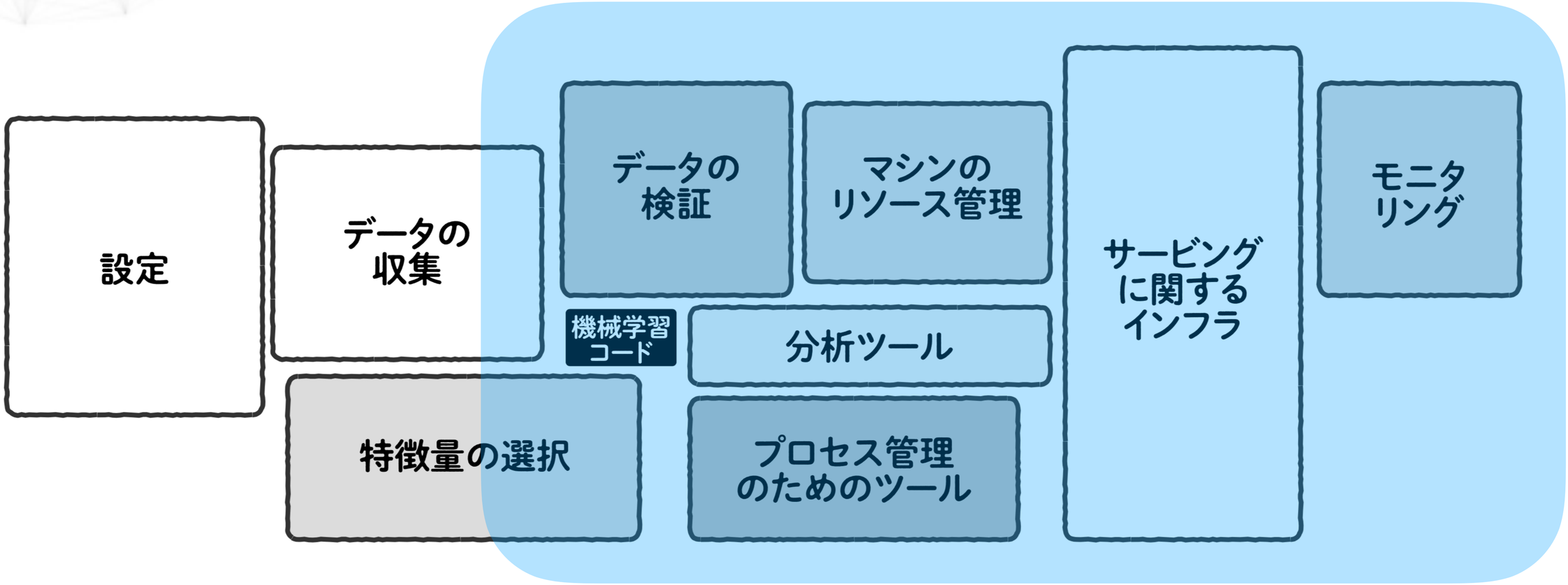
モデルの利用



▶ 図 3.1　機械学習のモデリングのコードの割合は少ない（[2] 中の図を翻訳して引用）

n月間ラムダノートVol.1, No.1より

モデルの利用

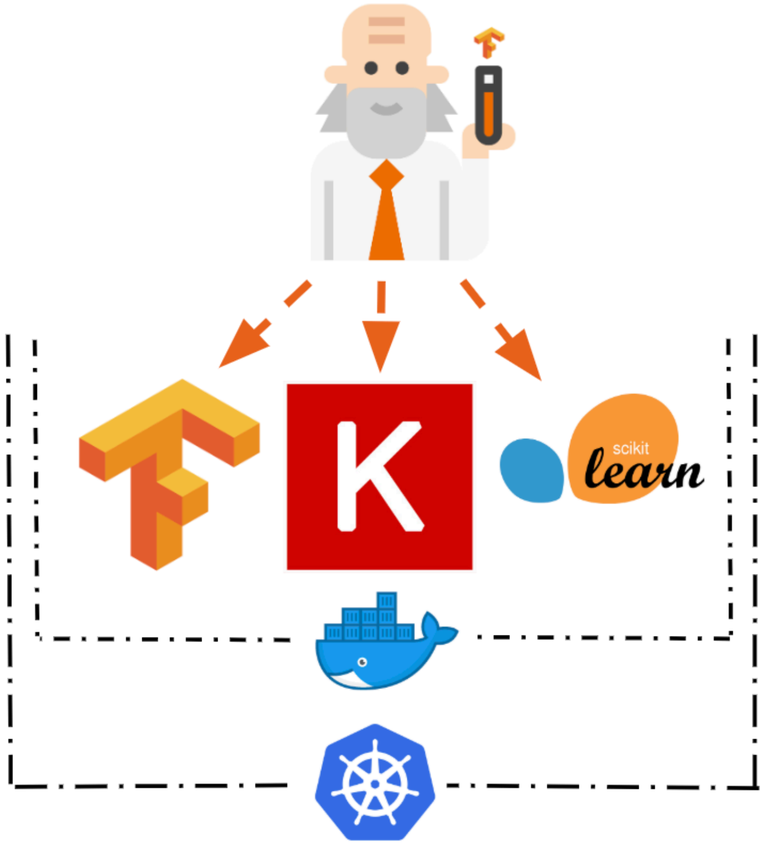


▶ 図 3.1　機械学習のモデリングのコードの割合は少ない（[2] 中の図を翻訳して引用）

skymind

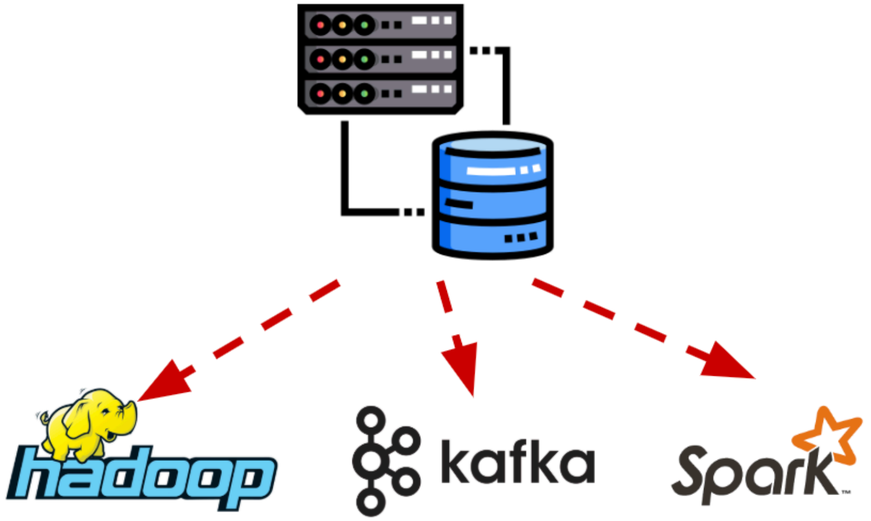
Most AI Frameworks Not Built for Enterprise

Development



≠

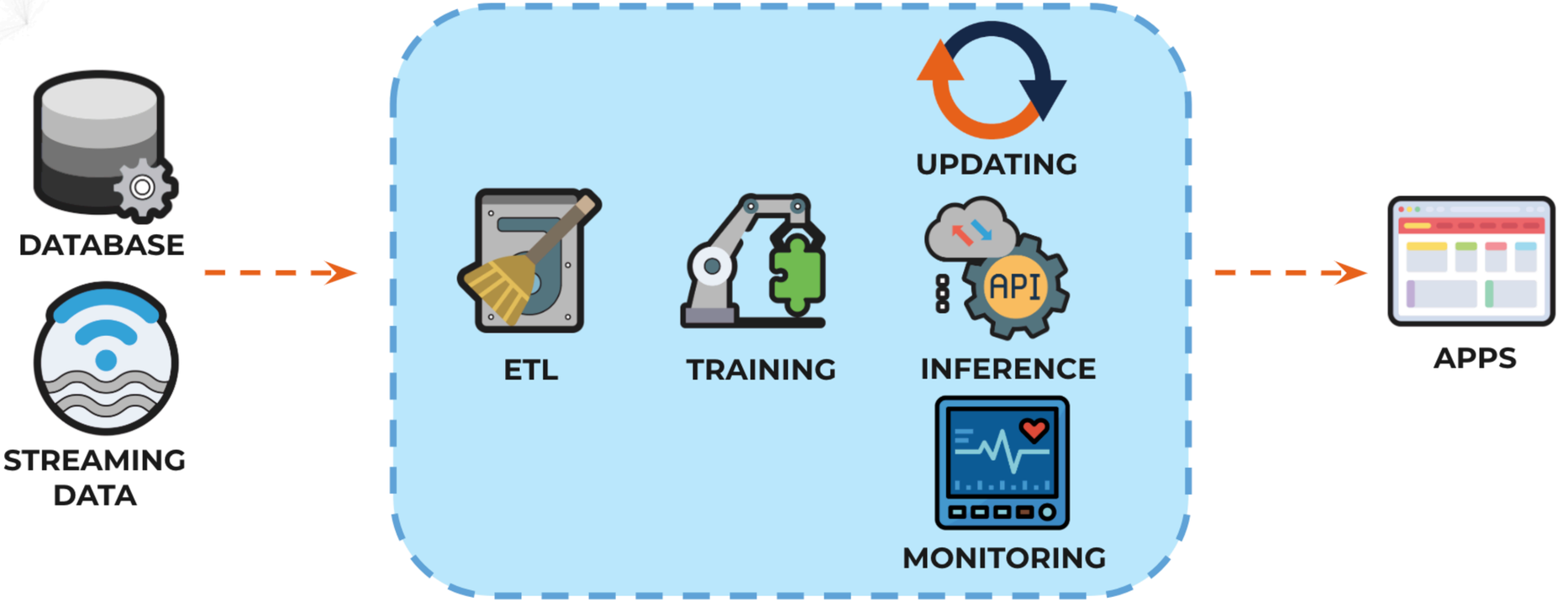
Production



- Petabytes of data
- Distributed clusters for data processing
- SLAs mandatory
  - Uptime guarantees!

skymind

SKIL provides a solution



Standardized AI infrastructure lets teams unify practices.

Configurable clusters: Adapts to opinionated ops teams and messy environments

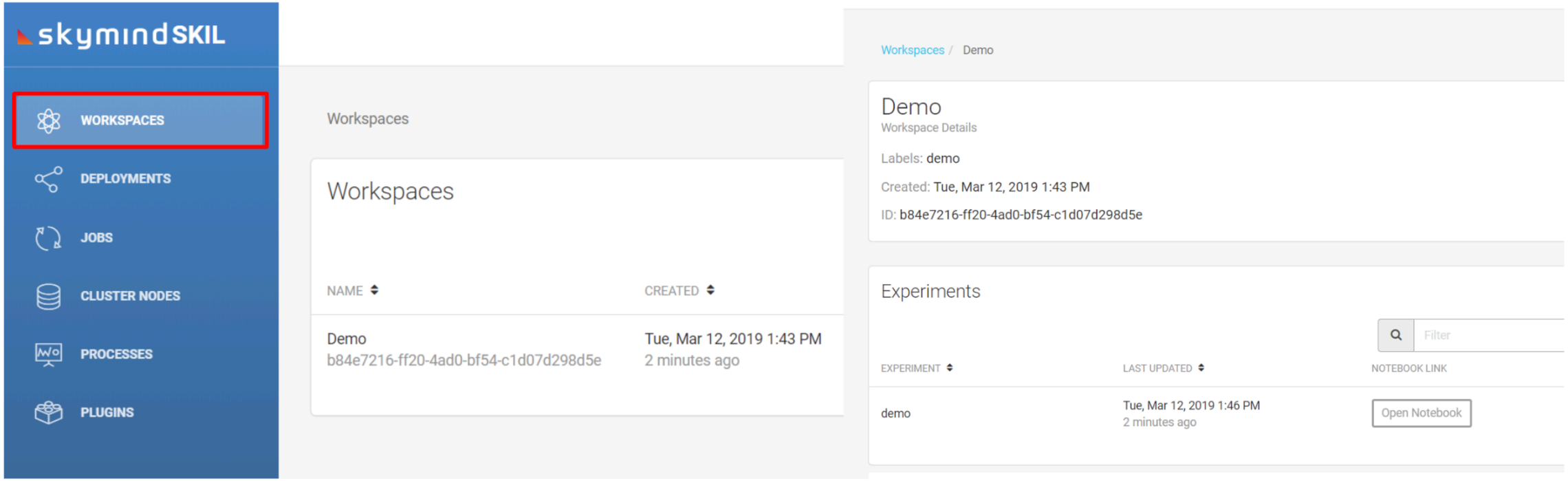
A managed software distribution for popular ML/AI frameworks

Ingests AI models from any ML vendor/tool, allowing data scientists to keep favorite tools

skymind | SKIL User Interface

Workspaces, Experiments

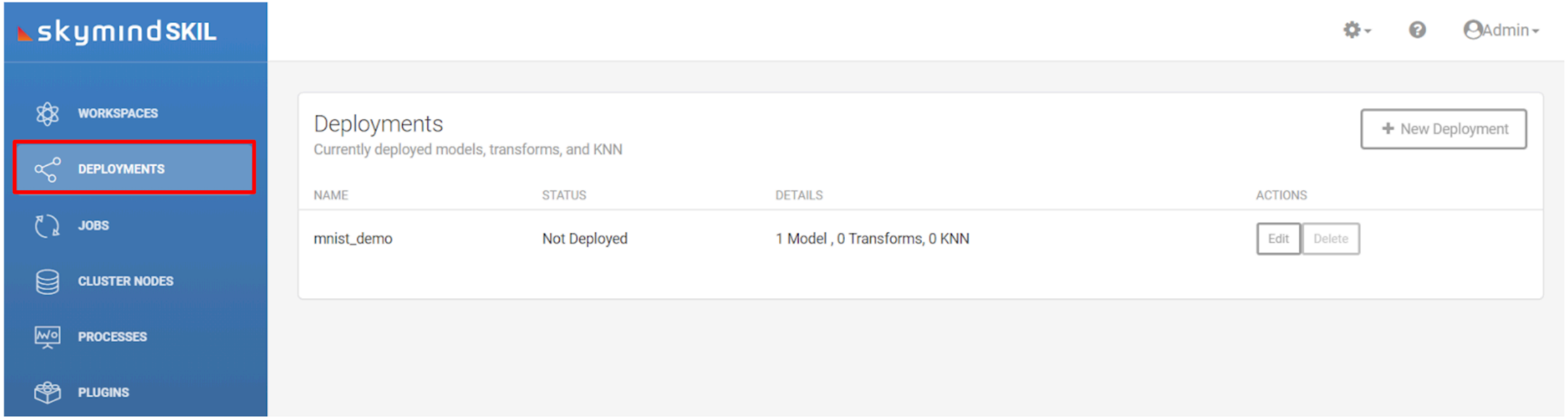
- **Workspaces** are a shared lab to conduct a set of “experiments” centered around a particular project.
- **Experiments** are different configurations of neural net models and data pipelines applied to a given problem



skymind | SKIL User Interface

Deployments

- When mark a model as “deployed”, it serve as **REST API endpoint** to use by client applications
- Endpoint example: *http://[host]:9008/endpoints/deployment/model/kerasmodel/default*



skymind | Key Components of Model Management

SKIL Job System

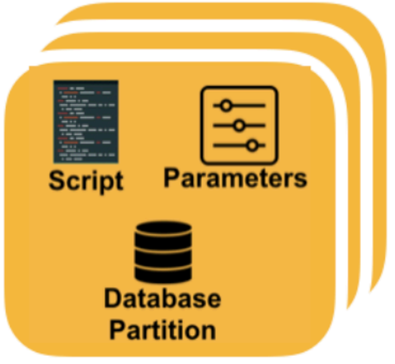
SKIL servers inside a tenant are triggered to run job/scripts with specific parameters on tenant resources.

Model History Server

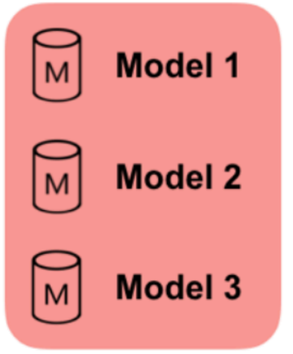
Keeps lists of models with performance results. APIs allow them to be compared to report the best models for deployment.

Deployment System

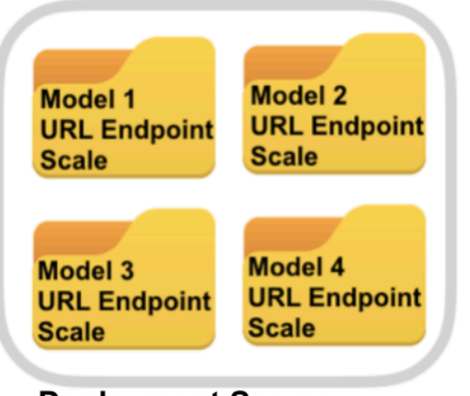
Deployment server handles deployment, scaling and versioning of models.



Jobs



Model History Server



Deployment Server

Best model on real data can Be used with transfer learning To fine tune model with latest data.

Real-time feedback requests are stored back in DB to monitor model performance on real data stream

CNNモデルのデプロイ

```
import skil

skilContext = skil.SkilContext(sc)

# モデルの訓練

model_id = skilContext.addModelToExperiment(z, model, "Keras Fashion MNIST Model")
skilContext.addEvaluationToModel(z, model_id, model, test_images, test_labels,
                                 "Keras_cnn_" + str(epochs) + "epochs")
```

Models | Notebook

Best Model

NAME, ID	CREATED	LABELS
Keras Fashion MNIST Model 67389ec8-60ad-11e9-8e8a-5d8b0e8c00e1	Wed, Apr 17, 2019 10:09 AM 7 hours ago	

Models

Recently created models

NAME, ID	CREATED	LABELS
Keras Fashion MNIST Model 67389ec8-60ad-11e9-8e8a-5d8b0e8c00e1	Wed, Apr 17, 2019 10:09 AM 7 hours ago	

Details - Keras Fashion MNIST Model

Mark Best | Delete | Deploy

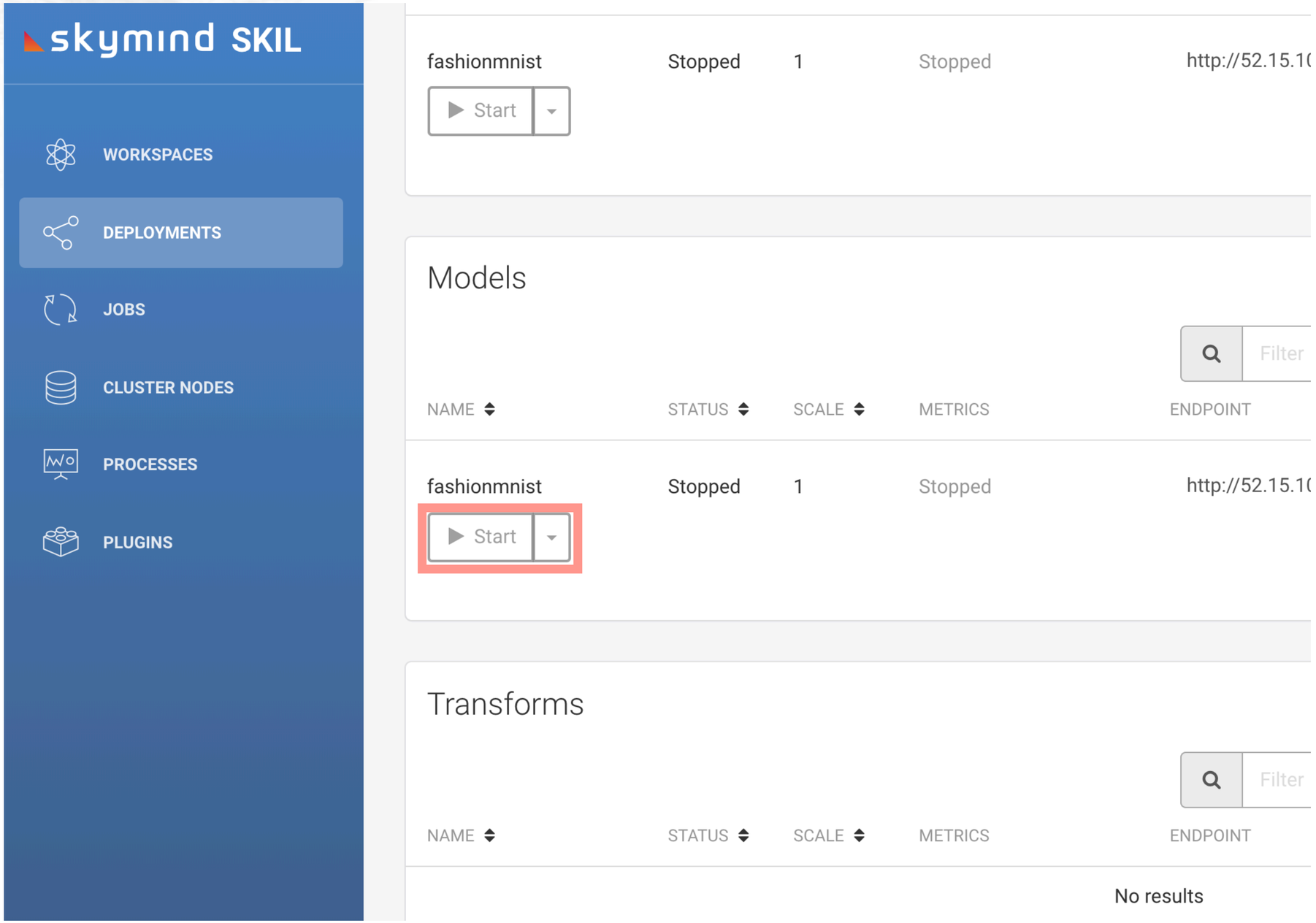
ID	67389ec8-60ad-11e9-8e8a-5d8b0e8c00e1
Created	7 hours ago
Labels	
ETL JSON	
Input Formats	
URI	file:///var/skil/storage/models/675e8d9a-60ad-11e9-8e8a-5d8b0e8c00e1.h5

Evaluation Results

CREATED »	NAME	ACCURACY »	PRECISION »	F1 »	AUC »	RECALL »	RM
7 hours ago	Keras mlp 10 epochs	0.9115	0	0.9122	0	0.9115	0

Revision History

CREATED	NAME, ID


skymind SKIL
WORKSPACES
DEPLOYMENTS
JOBS
CLUSTER NODES
PROCESSES
PLUGINS
fashionmnist
Stopped
1
Stopped
http://52.15.1(
Start
Models
Filter
NAME
STATUS
SCALE
METRICS
ENDPOINT
fashionmnist
Stopped
1
Stopped
http://52.15.1(
Start
Transforms
Filter
NAME
STATUS
SCALE
METRICS
ENDPOINT
No results

fashionmnist

Stop

STATUS	SCALE	ID
Starting	1	5

Usage

Endpoints | cURL | Java | Python | RPA

http://52.15.103.124:9008/endpoints/fashionmnist/model/fashionmnist/default

```
curl -F image=@image.jpg -H "Authorization: Bearer <auth_token>" "http://52.15.103.1
```

Copy

Version History

Filter

VERSION NUMBER	CREATED	UPDATED	
0	Wed, Apr 17, 2019 10:14 AM 7 hours ago	a few seconds ago	Rollback

Transactions

Not started

Latency


```
curl --request POST \
  --url http://<SKILhostIP>:9008/login \
  --header 'accept: application/json' \
  --header 'content-type: application/json' \
  --data '{"userId":"<userId>","password":"<password>"}'
```

Links

- SKIL Download Page
  - https://skymind.ai/download
- SKIL Documentation
  - https://docs.skymind.ai/docs
- SKIL REST API reference
  - https://docs.skymind.ai/reference?newApiExplorer=true
- SKIL Clients
  - https://github.com/SkymindIO/skil-clients

まとめ