KAIT 한국정보통신진흥협회
Korea Association for ICT Promotion

KAIT
ICT 기업의 성장 플랫폼

BM 과정 AI Architecture & Business Model

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1. AI 구축 Process
2. Process Step

1. AI 구축 Process

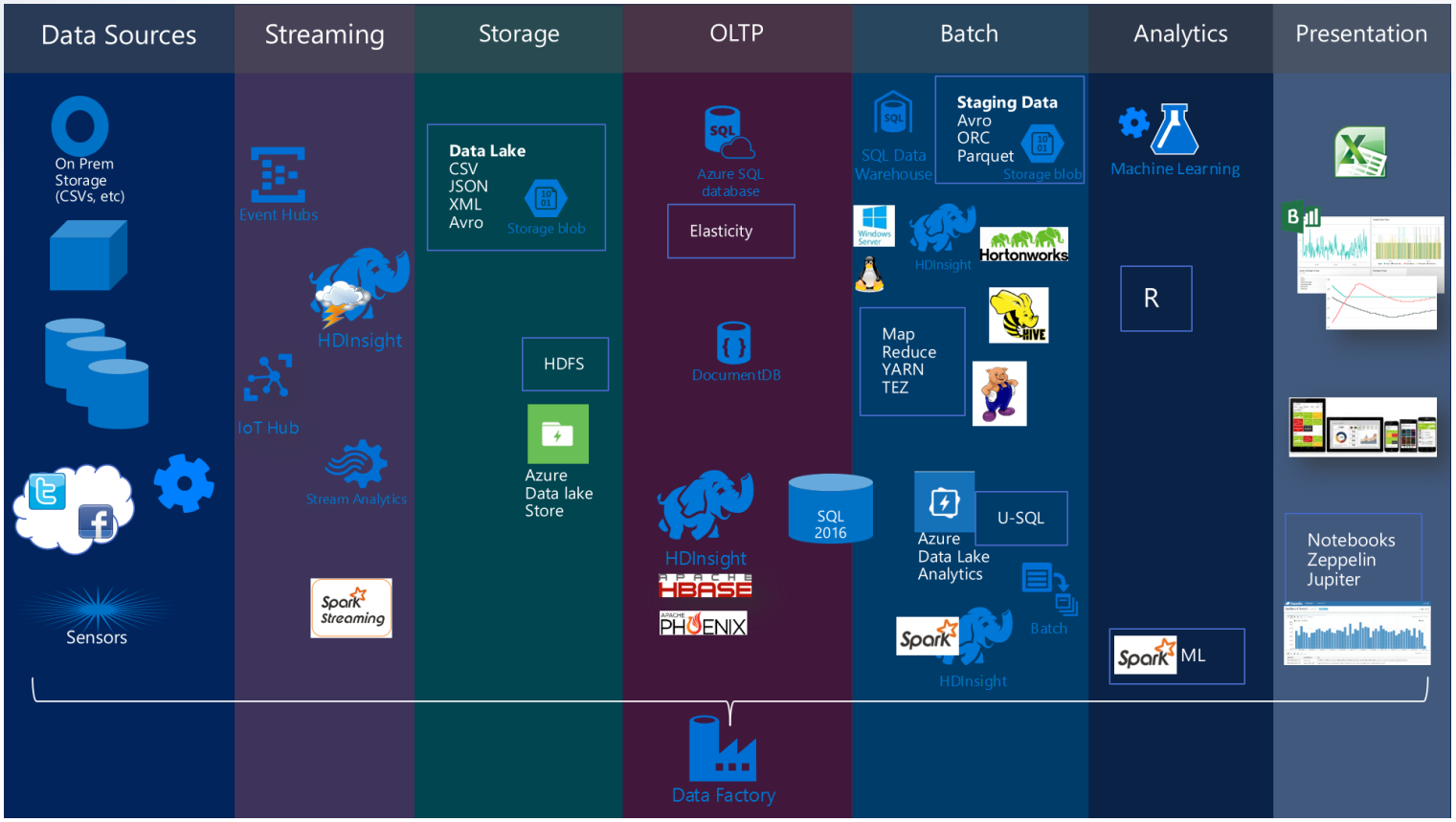
- AI 시스템의 다른 시스템과의 차이점

	일반적인 시스템	AI 시스템
정보의 성격	▪ 실무자 다수가 요구하는 실무 그 자체와 이의 요약 컨텐츠 ▪ 정보의 수요자는 제공 정보의 직관적 이해의 표현 및 정보량의 다양성 요구	▪ 목적의 구체성 ▪ 휴리스틱의 최대한 배제 ▪ 제공하는 계량 정보에 대한 사전 이해 필요
정보의 생산	▪ 요구 정보에 맞게 조건 정제 ▪ 비즈니스/업무 목적과 철차의 구현 ▪ 실세계의 비즈니스 흐름에 대해 다수의 공통된 관심를 반영하는 정보 ▪ 경험 규칙/Rule의 최대 반영 경향	▪ 요구 정보와 직접/간접 연결이 있는 대부분의 Data를 Model Input에 적용 ▪ 소수의 Supervisor가 수학/컴퓨터공학, 알고리즘으로 구성된 모델의 학습/검증 과정에서 Parameter Tuning을 통해 정보 생산
일반화	▪ 경험자와 해당 분야 전문가의 논리적/근거적 제시	▪ 서비스 하고자 하는 AI Model의 실세계 검증

[source] 저자의 강의 노트를 BM과정에 맞게 재정리함

1. AI 구축 Process

- AI 구축 절차 > Project Life-Cycle 측면
  - AI 시스템은 데이터 수집에서 서비스 제공에 이르는 일련의 과정 포함해야 함
  - 아래의 그림은 Microsoft의 Cloud 서비스인 Azure의 빅데이터 아키텍처의 제안임.
  - AI 구축 절차의 맥락은 이와 유사하지만, AI 생산 정보의 성격에 따라 유연하게 구조화 설계 필요

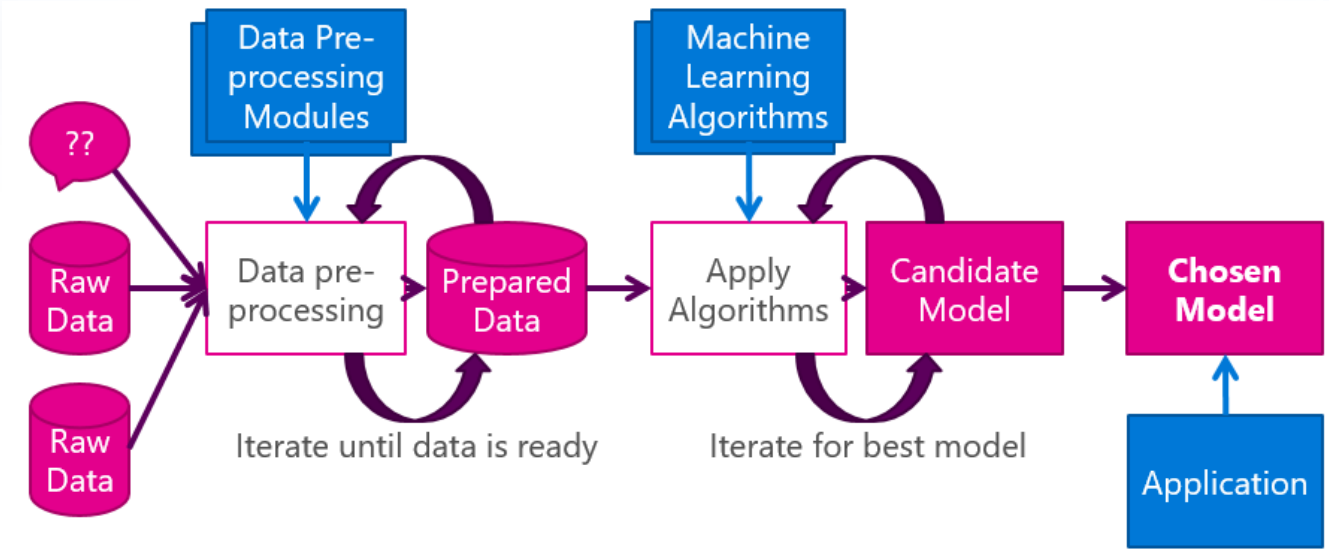


[source] https://blogs.msdn.microsoft.com/robinlester/2016/03/09/architecting-a-big-data-project-in-azure/

1. AI 구축 Process

- AI 구축 절차 > Model Application 측면

단계	내용
Data Pre-Processing	▪ Data 원천(Source)로 부터 AI시스템으로 Data 획득 ▪ Model Input 구조(Label & Feature, Model& Test, Iteration 등)로 Data 전처리
Modeling	▪ 다양한 모델(DT, RF, SVM, DNN, CNN, RNN/LSTM, Auto encoder 등) 중 목적에 부합하는 복수개의 기법을 선택 ▪ [Modeling ,Validation, Test] 과정의 반복 수행
Application	▪ 최종 모델을 서비스하고자 하는 시스템 또는 Device(Sensor Equipment, IoT 등)에 Embedding



[source] https://www.linkedin.com/pulse/from-data-processing-till-model-selection-machine-payam-mokhtarian

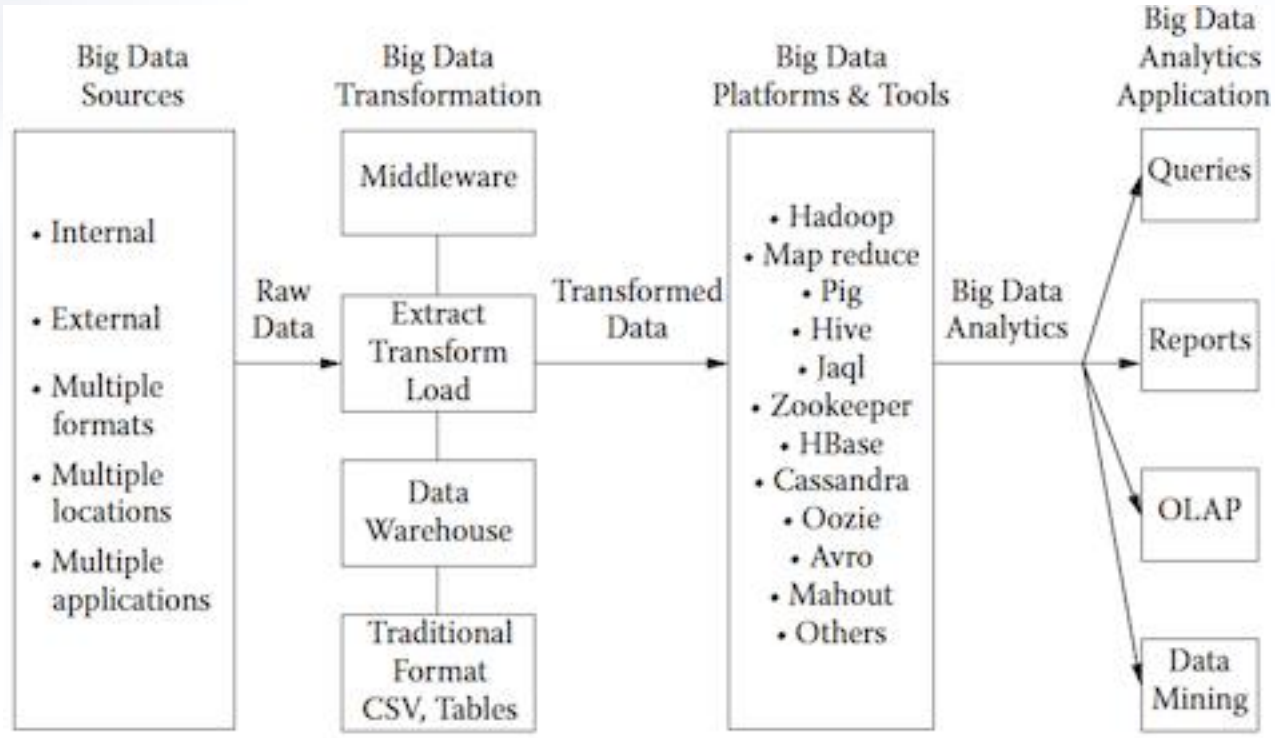
2. Process Step

1) Get Data from Source
2) Write Local Data into Hadoop
3) Data Processing for Analytic Work
4) Analytic Works
5) AI Model Save & Restore
6) AI Service

2. Process Step

1) Get Data from Source > Data Location 측면

- Data 원천(Source)로 부터 AI시스템으로 Data 획득
- Model Output과 직/간접 관련 모든 데이터를 AI 시스템 Repository로 ETL(Extract, Transformation, Loading)



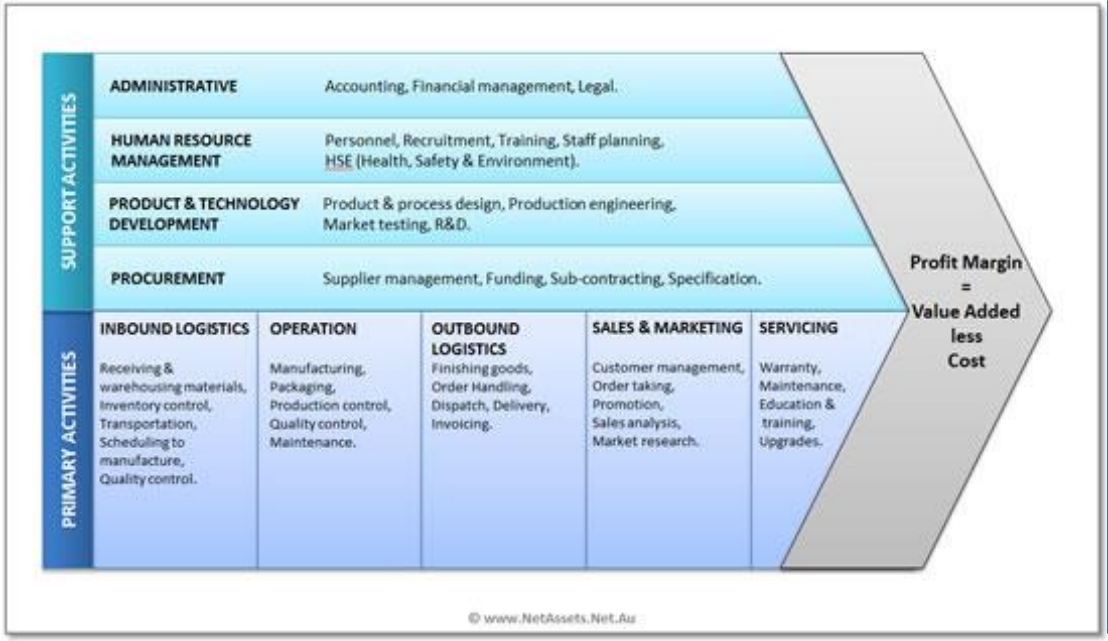
[source] http://www.ittoday.info/ITPerformanceImprovement/Articles/2014-07Raghupathi.html

2. Process Step

1) Get Data from Source > 내부 Data Contents 측면

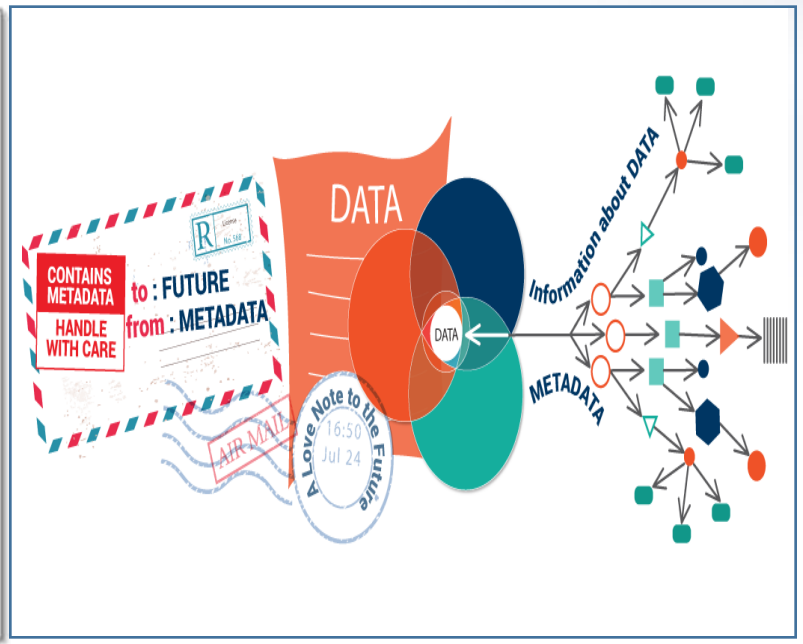
- Business Domain의 이해를 바탕으로 Business Value/Process를 Source Data와 Mapping하고 이의 Meta Data 정의 및 Entity Diagram 작성

Value Chain(Porter, 1985)



[source] http://www.data-group.com.au/business-intelligence-data-sources/

Metadata 정의



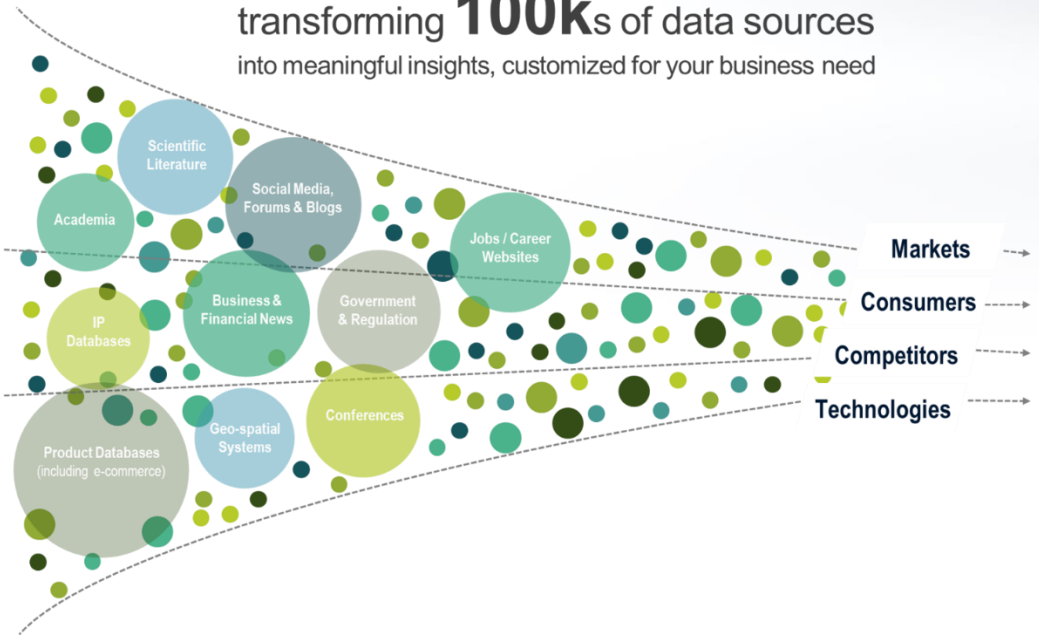
[source] https://www.ontotext.com/knowledgehub/fundamentals/metadata-fundamental/

2. Process Step

1) Get Data from Source > 외부 데이터 수집 측면

- 조직의 비즈니스와 관련있는 외부데이터의 수집은 정보 가치화의 필수이며 **Big Data 수집 기술**을 적용해야 누락없이 정확한 시간이 Tag 된 데이터 획득이 가능함
- 데이터의 수집 주기 : 실시간 Streaming, 주기적 Batch

[source] https://www.smartdatacollective.com/big-data-20-free-big-data-sources-everyone-should-know/



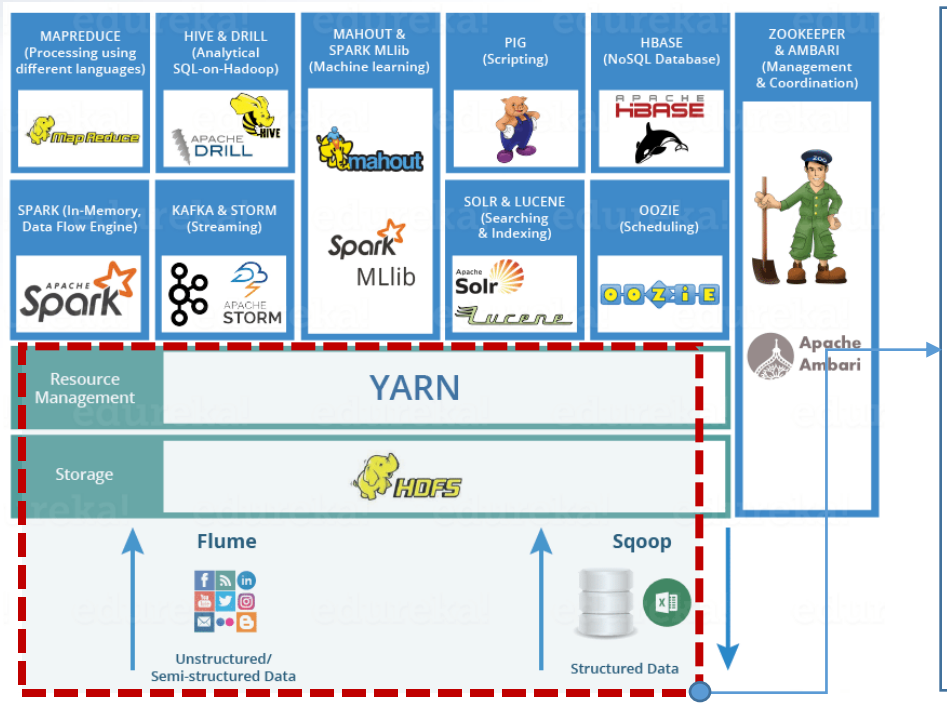
[source] https://signals-analytics.com/blog/signals-analytics-approach-to-data-interview-with-asaf-frige-0#

2. Process Step

2) Write Local Data into Hadoop

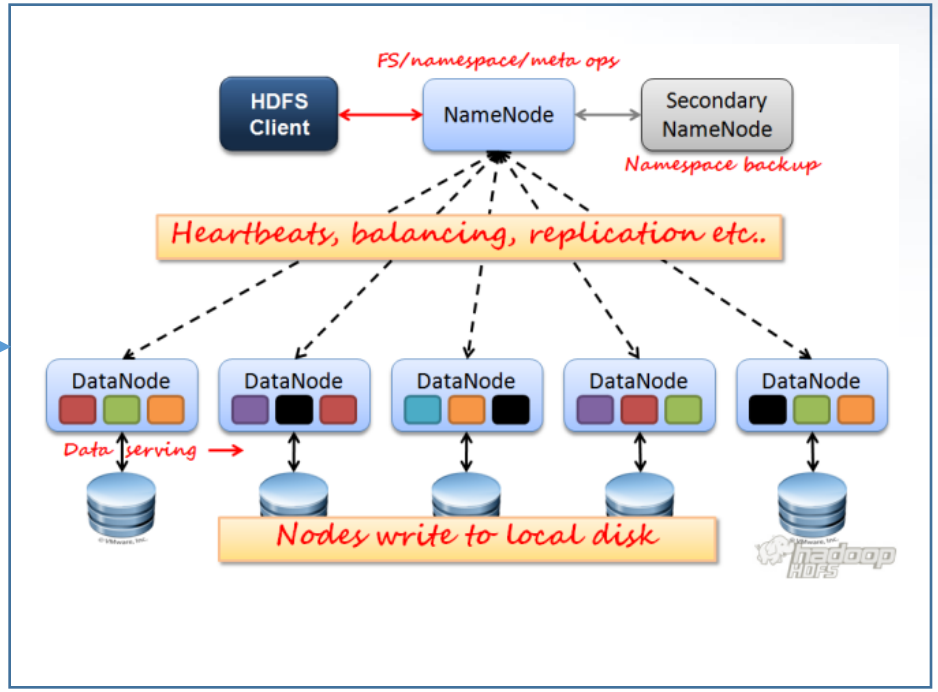
- Local Data : DBMS, Flat File(CSV, TEXT), 시스템 Log 등(외부로 부터 수집하는 데이터 포함)
- AI의 학습용 데이터를 제공할 Input Data의 repository가 반듯이 Hadoop일 필요는 없음. 소규모 biz model은 DBMS를 활용해도 무방함. 하지만 대규모의 데이터를 학습해야 하는 경우라면 Hadoop이나 이와 동등 수준의 Repository로 구성해야 함.

Hadoop Eco-System



[source] https://www.edureka.co/blog/hadoop-ecosystem/

Hadoop Data 저장 구조



[source] https://yoyoclouds.wordpress.com/tag/hdfs/

2. Process Step

2) Write Local Data into Hadoop

- AI 구축을 위한 Hadoop의 명령어의 활용
  - AI Model에 활용할 Data의 가장 기본적인 수준의 탐색
  - AI Model Input Data의 잠정적 확정

▣ 자주 활용하는 Hadoop/HDFS Command

Command	설 명
hdfs dfs -version	▪ Hadoop Version Check
hdfs dfs -ls	▪ Hadoop File & Directory 조회
hdfs dfs -cat	▪ File 내용을 Console에 display
Hdfs dfs -get	▪ Hadoop File을 Local Diretory로 복사
hdfs dfs -put	▪ Local File과 Directory를 Hadoop에 복사
hdfs dfs -copyFromLocal	▪ put과 동일
hdfs dfs -copyToLocal	▪ get과 동일
hdfs dfs -cp	▪ File 복사
hdfs dfs -mv	▪ File 이동

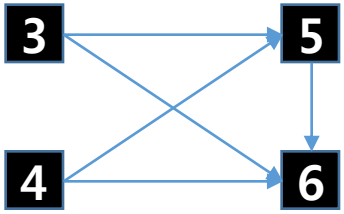
2. Process Step

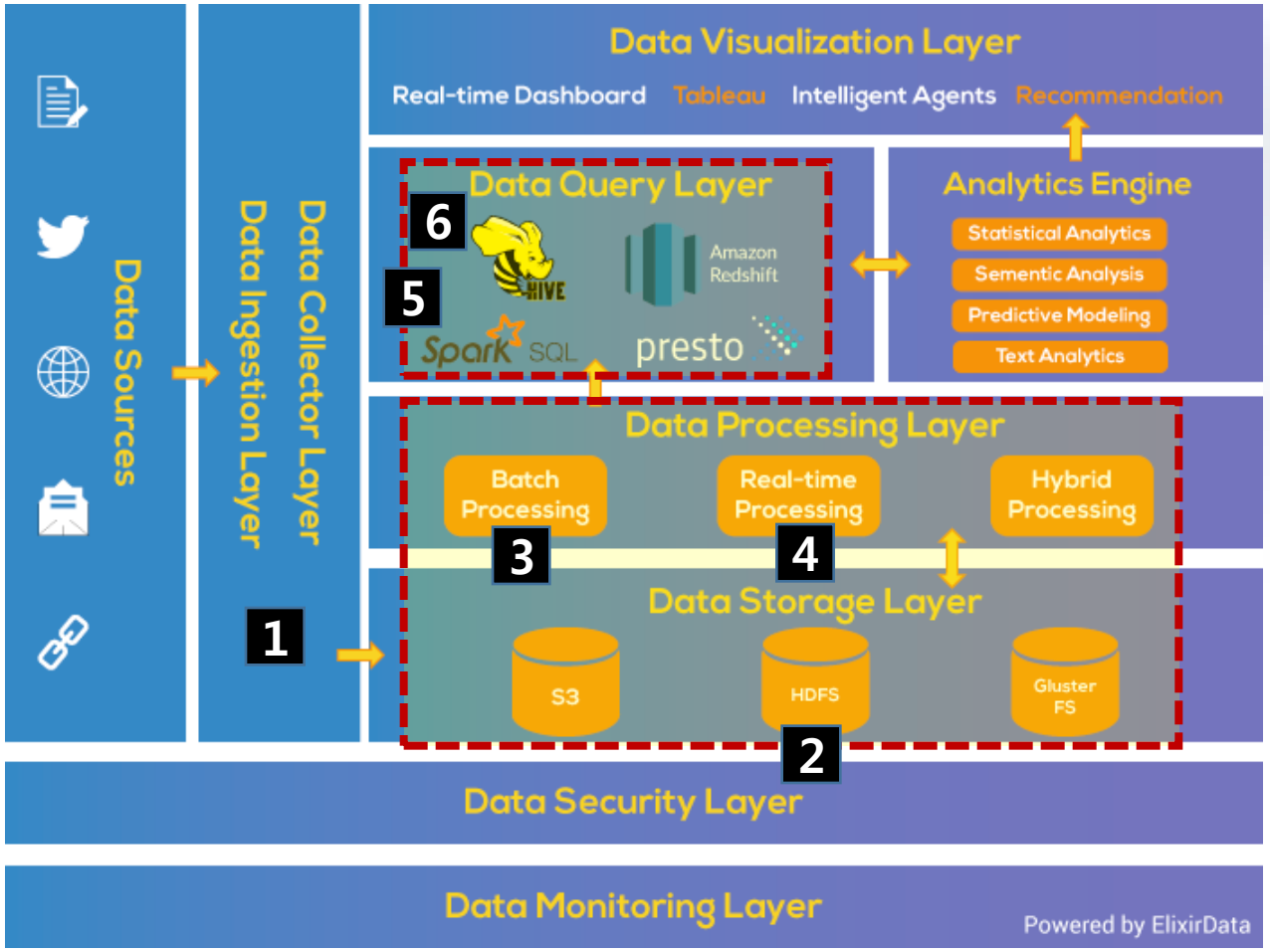
3) Data Processing for Analytic Work

- Data 획득 주기
  - Batch 

  - Streaming 

- Processing
  - Exploration
  - Model Input



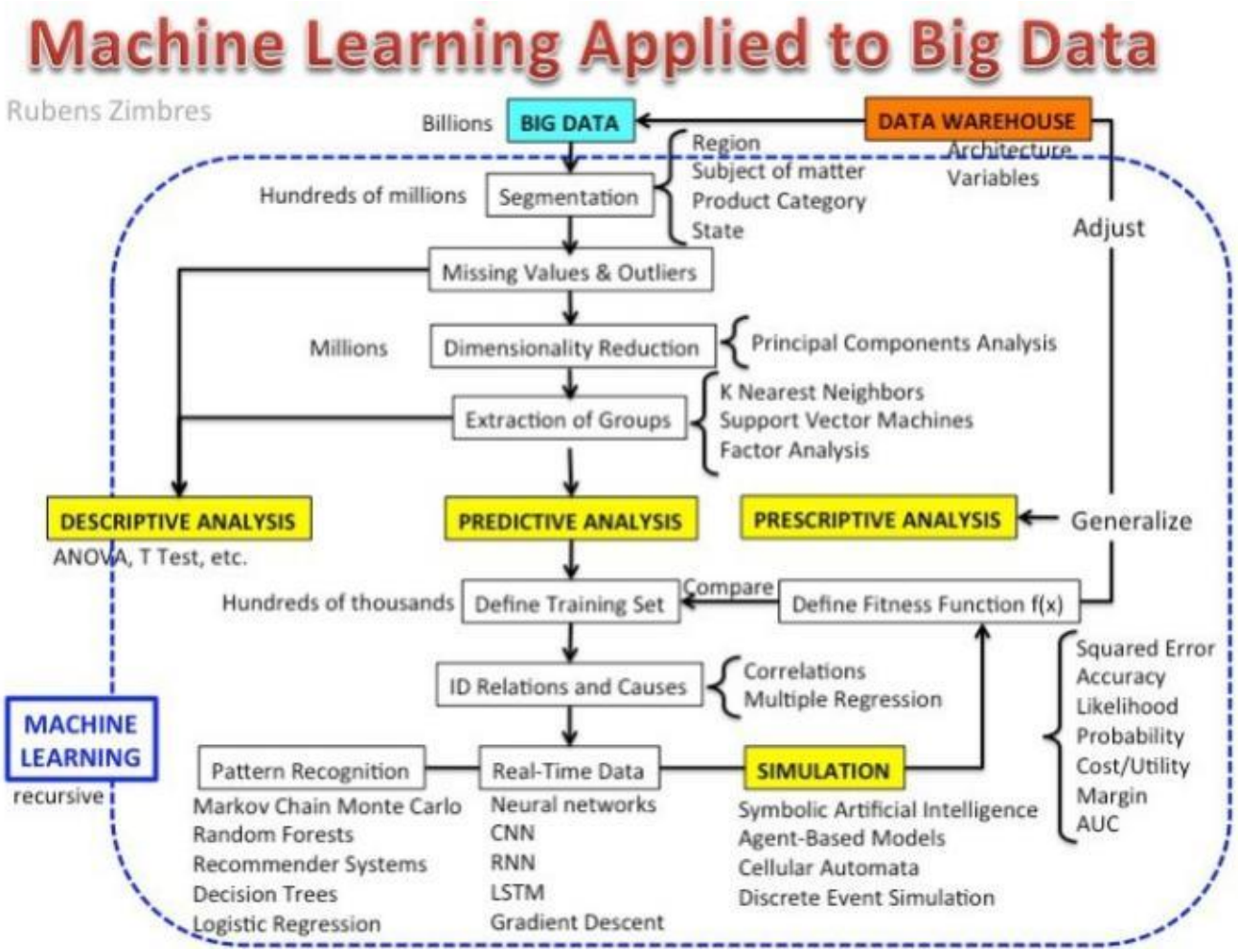


[source] https://www.xenonstack.com/blog/ingestion-processing-big-data-iot-stream/

2. Process Step

4) Analytic Works

- Data Source에의 접근
  - hdfs://<host:port>/<file-path>
  - file///<file-path>
- Pre-Processing
- 특징 탐색
  - 기술통계
  - Visualization
- Project 정의
  - 인과관계의 규명(RCA)
  - 예측
    - Prediction
    - Forecasting
- Project Life-Cycle
  - Model Selection
  - Training & Test
  - Evaluation
  - Tuning



[source] https://www.kdnuggets.com/2017/07/machine-learning-big-data-explained.html

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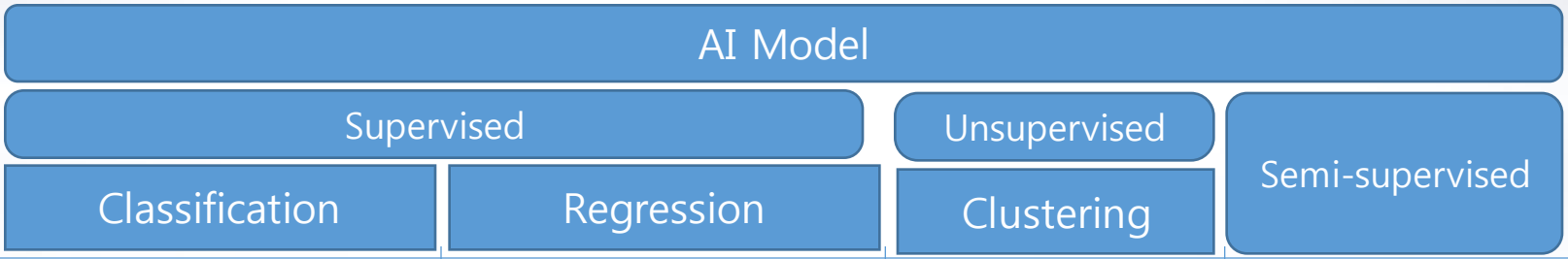
2. Process Step

4) Analytic Works

Model 선택 | Training & Testing | Evaluation | Tuning

- Business Model에 따른 적합한 알고리즘 선택
  - 개별 알고리즘 고유의 원리와 특징 이해 필요



Label Type	Categorical	Continuous	n/a	Categorical
Machine Learning	• Decision Tree Classification • Random Forest Classification • Support Vector Classification • Naïve Bayes Classification • kNN Classification • 기타	• Decision Tree Regression • Random Forest Regression • Support Vector Regression • Naïve Bayes Regression • kNN Regression • 기타	• K-Means • kNN Clustering • SVD • PCA • TSNE • 기타	
Deep Learning	• MLP Classification • CNN Classification • RNN/LSTM Classification	• MLP Regression • CNN Regression • RNN/LSTM Regression	• Autoencoder • GAN	• Reinforcement Learning • RBM • Word2Vec

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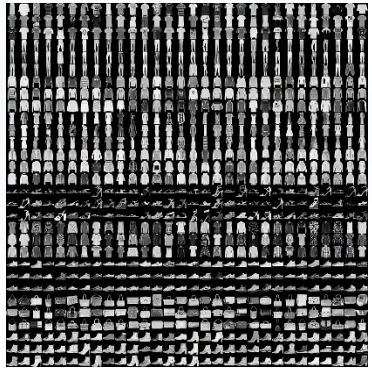
2. Process Step

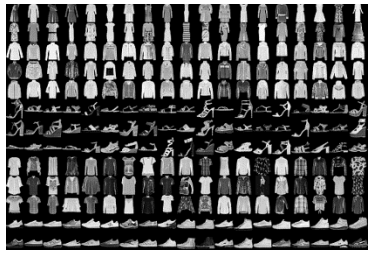
4) Analytic Works

Model 선택 | **Training & Testing** | Evaluation | Tuning

- 실세계에 적용할 AI Model의 일반화 과정
  - 다양한 보편적인 실세계 조건에 부합하는 모델의 생성
  - 과적합 방지를 위한 반복 테스트



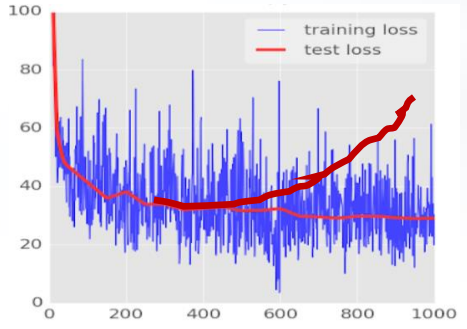
Training Data



Test Data

```
sess.run(
  cross_entropy
, feed_dict = {features : train_batch_features
               , label : train_batch_label}
)
```

```
sess.run(
  cross_entropy
, feed_dict = {features : test_features
               , label : test_label}
)
```



Author Yi-Beck Lee(Yibeck.Lee@gmail.com)

2. Process Step

4) Analytic Works

Model 선택 | Training & Testing | **Evaluation** | Tuning

- Binary Class Classification
  - **평가 지표** : Accuracy, Recall, Precision, Recall, ROC/AUC

		True condition			
	Total population	Condition positive	Condition negative	Prevalence = $\frac{\Sigma \text{ Condition positive}}{\Sigma \text{ Total population}}$	Accuracy (ACC) = $\frac{\Sigma \text{ True positive} + \Sigma \text{ True negative}}{\Sigma \text{ Total population}}$
Predicted condition	Predicted condition positive	**True positive**, Power	**False positive**, Type I error	Positive predictive value (PPV), Precision = $\frac{\Sigma \text{ True positive}}{\Sigma \text{ Predicted condition positive}}$	False discovery rate (FDR) = $\frac{\Sigma \text{ False positive}}{\Sigma \text{ Predicted condition positive}}$
	Predicted condition negative	**False negative**, Type II error	**True negative**	False omission rate (FOR) = $\frac{\Sigma \text{ False negative}}{\Sigma \text{ Predicted condition negative}}$	Negative predictive value (NPV) = $\frac{\Sigma \text{ True negative}}{\Sigma \text{ Predicted condition negative}}$
		True positive rate (TPR), Recall, Sensitivity, probability of detection = $\frac{\Sigma \text{ True positive}}{\Sigma \text{ Condition positive}}$	False positive rate (FPR), Fall-out, probability of false alarm = $\frac{\Sigma \text{ False positive}}{\Sigma \text{ Condition negative}}$	Positive likelihood ratio (LR+) = $\frac{\text{TPR}}{\text{FPR}}$	Diagnostic odds ratio (DOR) = $\frac{\text{LR+}}{\text{LR−}}$
		False negative rate (FNR), Miss rate = $\frac{\Sigma \text{ False negative}}{\Sigma \text{ Condition positive}}$	Specificity (SPC), Selectivity, True negative rate (TNR) = $\frac{\Sigma \text{ True negative}}{\Sigma \text{ Condition negative}}$	Negative likelihood ratio (LR−) = $\frac{\text{FNR}}{\text{TNR}}$	F_1 score = $2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}$

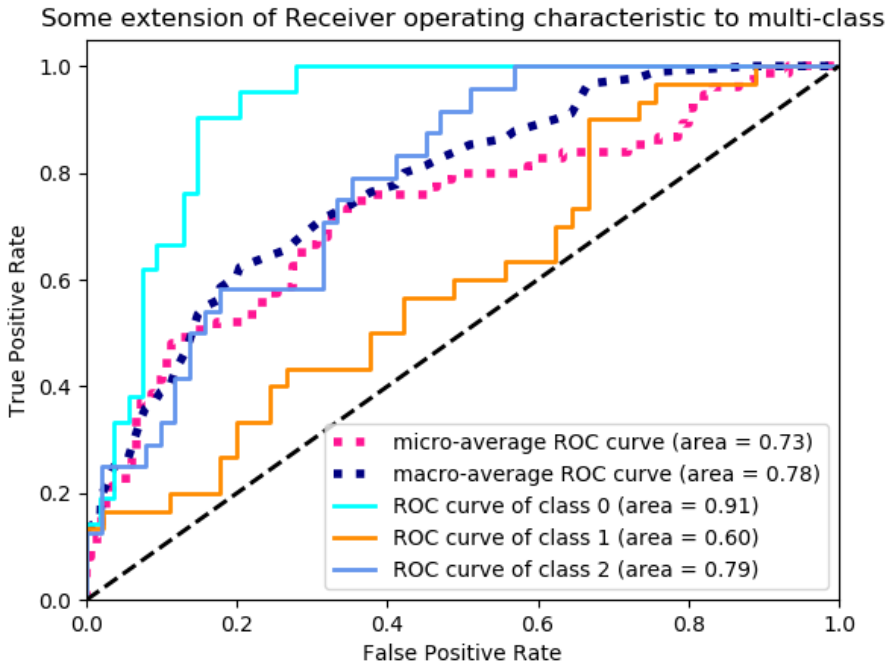
[source] https://en.wikipedia.org/wiki/Evaluation_of_binary_classifiers

2. Process Step

4) Analytic Works

Model 선택 | Training & Testing | **Evaluation** | Tuning

- Binary Class Classification
  - ROC / AUC



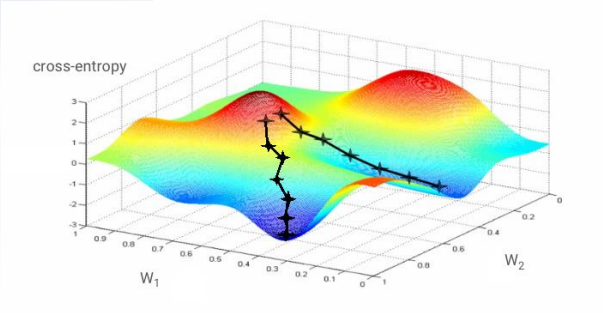
[source] https://scikit-learn.org/stable/modules/model_evaluation.html

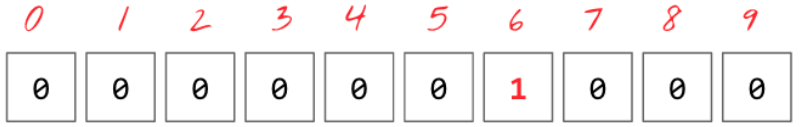
2. Process Step

4) Analytic Works

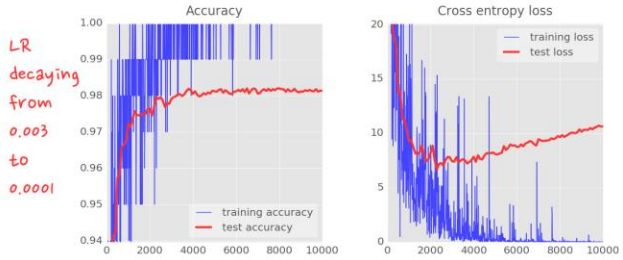
Model 선택 | Training & Testing | **Evaluation** | Tuning

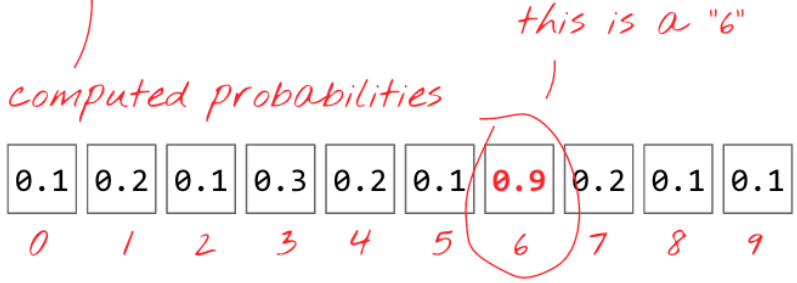
- Multi-Class Classification
  - **평가 지표** : Cross-Entropy





Cross entropy: $-\sum Y'_i . log(Y_i)$





[source] https://codelabs.developers.google.com/codelabs/cloud-tensorflow-mnist/

2. Process Step

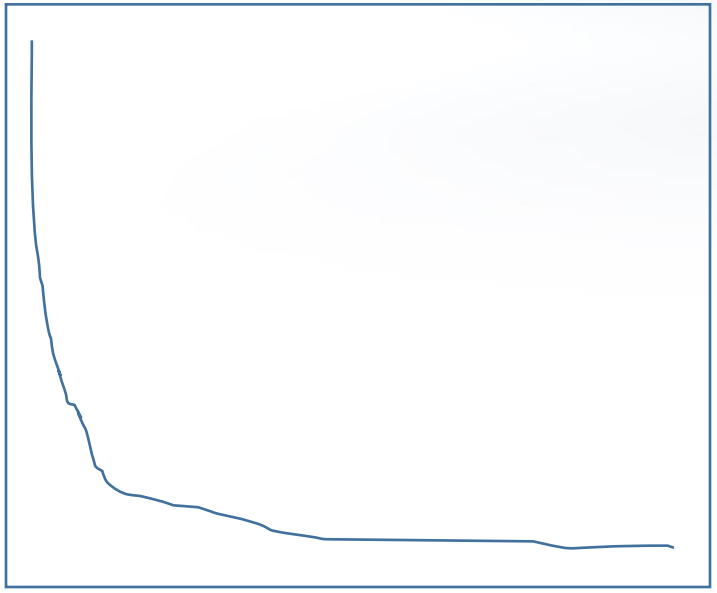
4) Analytic Works

Model 선택 | Training & Testing | **Evaluation** | Tuning

- Regression
  - **평가지표** : MSE[, RMSE, MAE, MAPE], Average Cost

Mean squared error	$\mathrm{MSE} = \frac{1}{n}\sum_{t=1}^{n} e_t^2$
Root mean squared error	$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}$
Mean absolute error	$\mathrm{MAE} = \frac{1}{n}\sum_{t=1}^{n} \lvert e_t \rvert$
Mean absolute percentage error	$\mathrm{MAPE} = \frac{100\%}{n}\sum_{t=1}^{n} \left\lvert \frac{e_t}{y_t} \right\rvert$

MSE



Number Of Iteration

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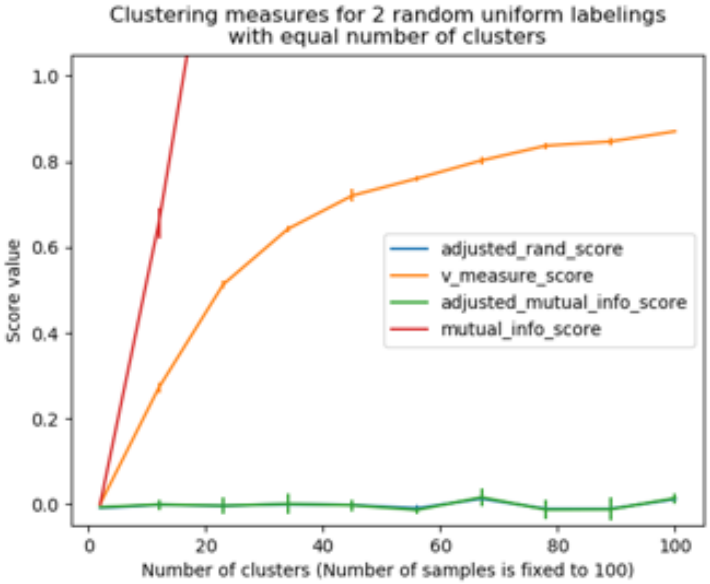
2. Process Step

4) Analytic Works

Model 선택 | Training & Testing | **Evaluation** | Tuning

- Unsupervised Model
  - Clustering 주요 지표 : Adjusted Mutual Information Score 外

- Adjusted Mutual Information Score
- Adjusted Rand Score
- Completeness Score
- Fowikes mallows Score
- Homogeneity Score
- Mutual Information Score
- Normalized Mutual Information Score
- V Measure Score



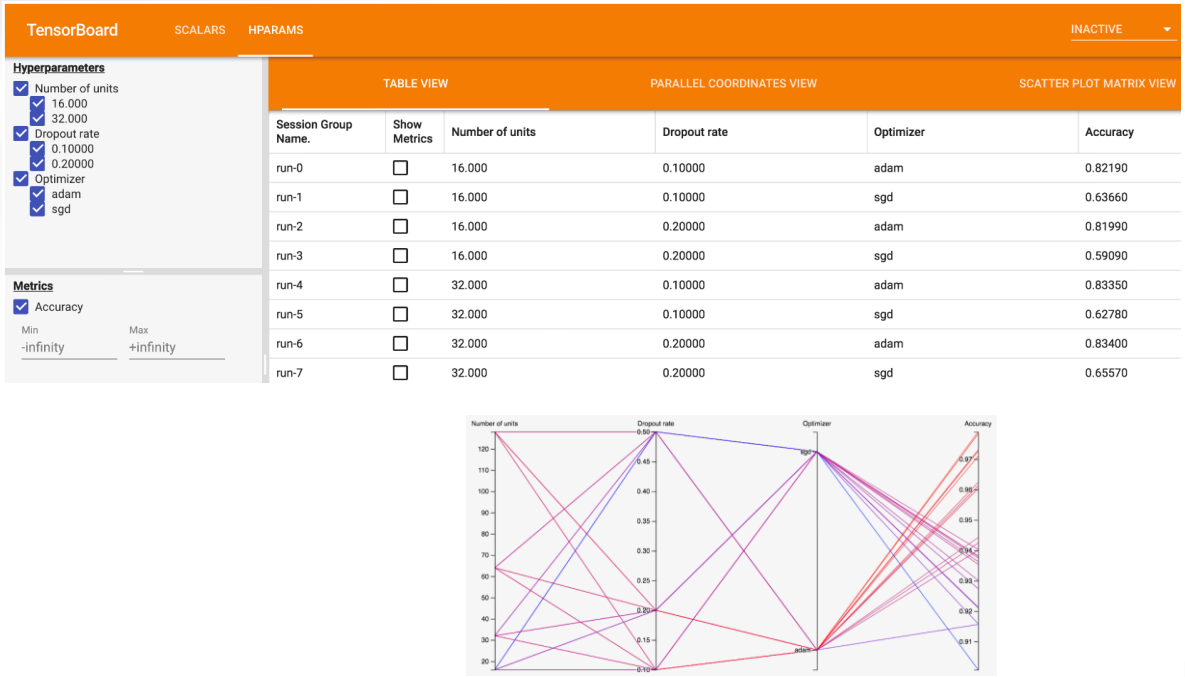
[source] https://scikit-learn.org/stable/modules/generated/sklearn.metrics.adjusted_mutual_info_score.html

2. Process Step

4) Analytic Works

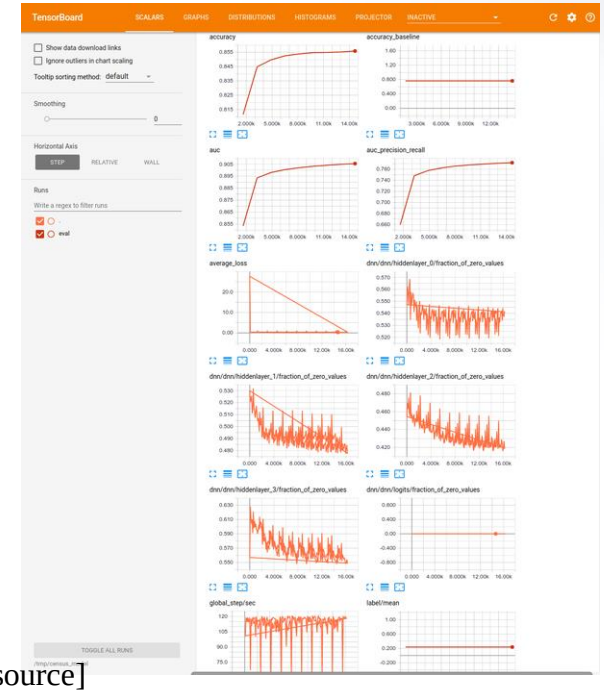
Model 선택 | Training & Testing | Evaluation | **Tuning**

- Business Model에 따른 적합한 알고리즘 선택
  - 알고리즘의 서로 다른 특징의 이해 필요



Session Group Name.	Show Metrics	Number of units	Dropout rate	Optimizer	Accuracy
run-0	☐	16.000	0.10000	adam	0.82190
run-1	☐	16.000	0.10000	sgd	0.63660
run-2	☐	16.000	0.20000	adam	0.81990
run-3	☐	16.000	0.20000	sgd	0.59090
run-4	☐	32.000	0.10000	adam	0.83350
run-5	☐	32.000	0.10000	sgd	0.62780
run-6	☐	32.000	0.20000	adam	0.83400
run-7	☐	32.000	0.20000	sgd	0.65570

[source] https://www.tensorflow.org/tensorboard/r2/hyperparameter_tuning_with_hparams



[source] https://bookdown.org/max/FES/model-optimization-and-tuning.html

2. Process Step

4) Analytic Works

Model 선택 | Training & Testing | Evaluation | **Tuning**

- Business Model에 따른 적합한 알고리즘 선택
  - 알고리즘의 서로 다른 특징의 이해 필요

Units	Dropout	Batch Size	Learn Rate	Grad. Scaling	Decay	Act. Fun.	ROC
7	0.3368	11348	0.00385	0.55811	1.16e-04	sigmoid	0.838
5	0.4023	36070	0.04142	0.95232	3.84e-02	sigmoid	0.837
12	0.6619	38206	0.25837	0.63325	3.09e-02	sigmoid	0.837
6	0.4720	38651	0.02634	0.80618	4.94e-05	sigmoid	0.834
7	0.3918	17235	0.01681	0.36270	2.90e-04	tanh	0.830
3	0.1190	16369	0.22210	0.22683	4.02e-02	relu	0.830
10	0.4979	19103	0.04818	0.83560	1.92e-03	relu	0.828
7	0.6139	38198	0.30864	0.68575	1.67e-03	sigmoid	0.824
2	0.3797	22255	0.10597	0.93841	4.27e-05	sigmoid	0.824
4	0.0694	18167	0.45844	0.94679	2.97e-03	tanh	0.811
14	0.6279	33800	0.18082	0.33286	1.08e-05	tanh	0.810
10	0.1466	33139	0.44443	0.72107	6.22e-05	tanh	0.810
20	0.0497	29465	0.40072	0.49598	7.07e-02	sigmoid	0.804
17	0.1068	17953	0.43256	0.87800	1.99e-04	tanh	0.794
13	0.5570	13558	0.13159	0.20389	5.96e-05	relu	0.793
7	0.6183	30606	0.82481	0.71944	2.61e-03	sigmoid	0.792
14	0.3866	30514	0.92724	0.38651	3.36e-03	tanh	0.782
2	0.0903	33439	0.63991	0.00398	1.92e-03	tanh	0.776
11	0.5909	32417	0.61446	0.63142	3.08e-04	tanh	0.731
10	0.4234	34655	0.49455	0.25216	3.05e-04	relu	0.698

[source] https://bookdown.org/max/FES/model-optimization-and-tuning.html

2. Process Step

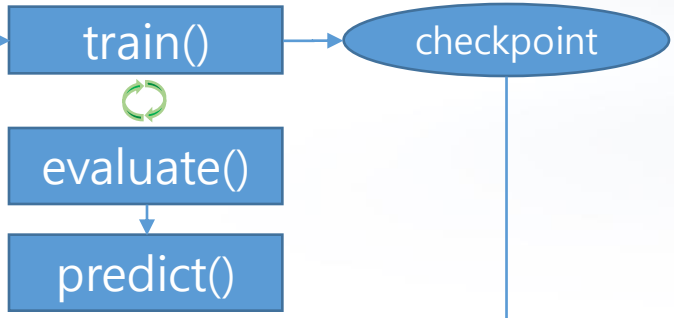
5) AI Model Save & Restore > TensorFlow Case

- Model Save : 수행 모델의 저장(save)
- Model Restore : 저장된 모델의 재학습을 위한 복원(restore)
- 모델링 수행 성과의 추적 가능 - checkpoint

▣ Model Save and Restore - TensorFlow

Model Save

```
saver  = tf.train.Saver()
…
saver.save(sess, 'model')
```



Model Restore

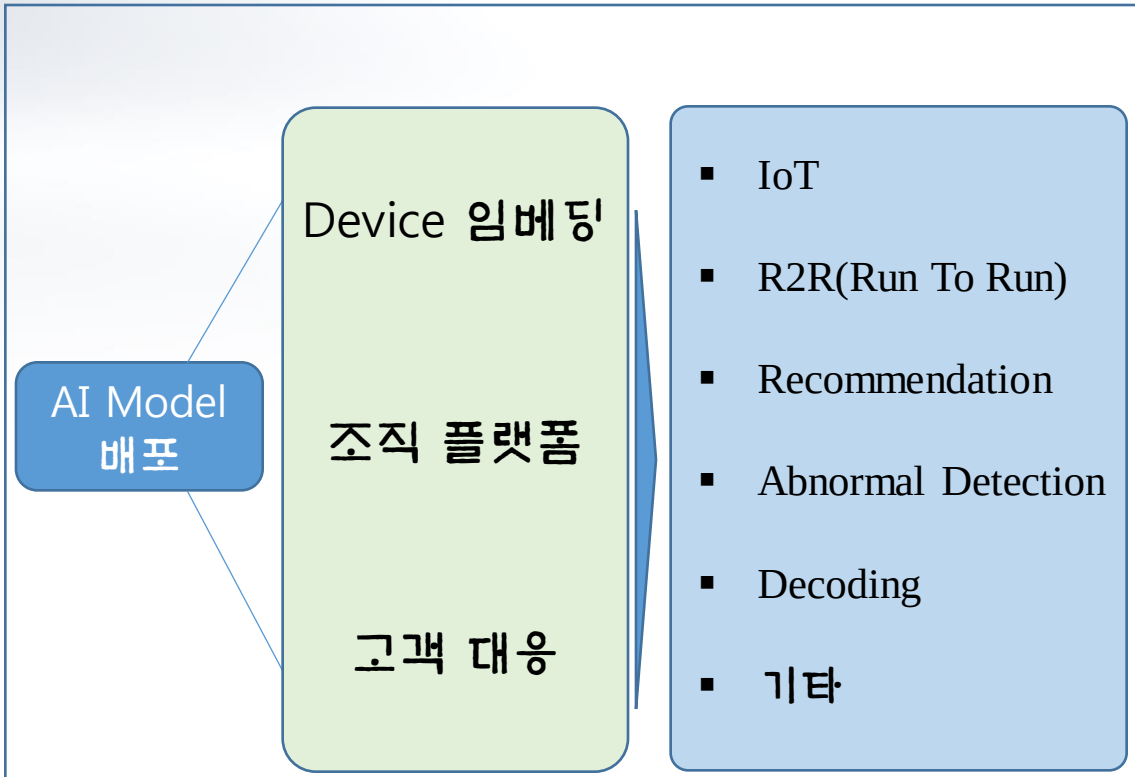
```
tf.reset_default_graph()
restored = tf.train.import_meta_graph("model.meta")
…
restored.restore(sess, tf.train.lastest_checkpoint('./'))
```

2. Process Step

6) AI Model Service

- AI Model의 배포(Deploy)
  - AI Server에서 학습되어 검증된 모델의 실세계 서비스 시스템에 배포

▣ AI Service Model의 다양한 Case들

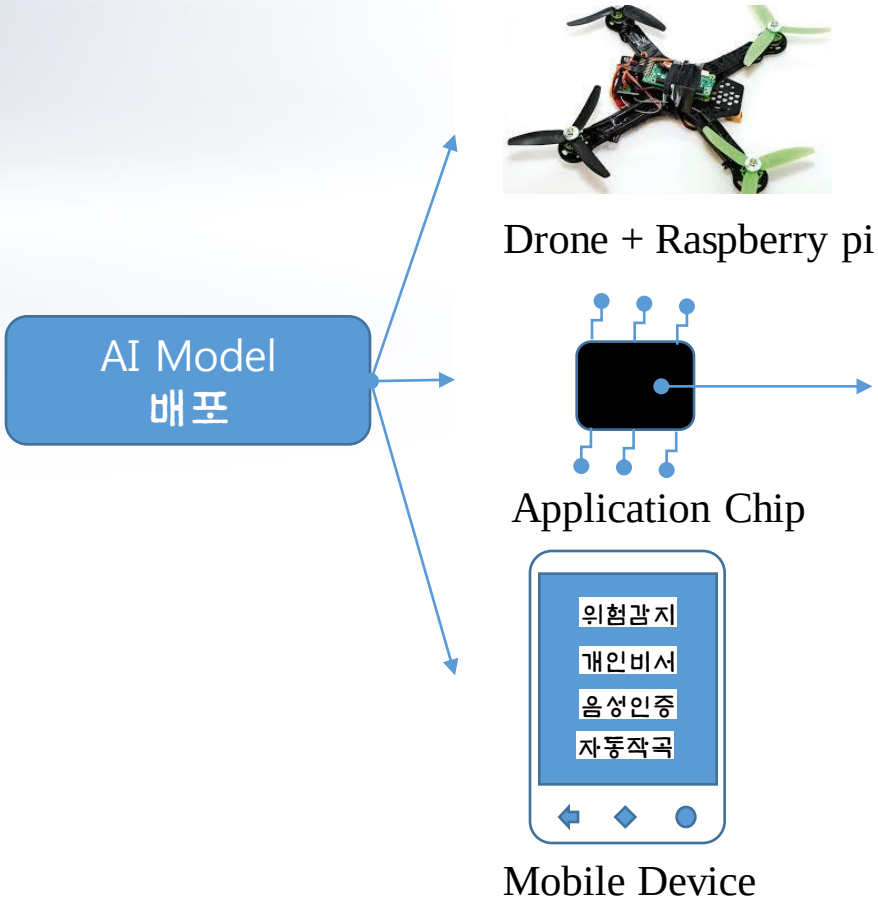


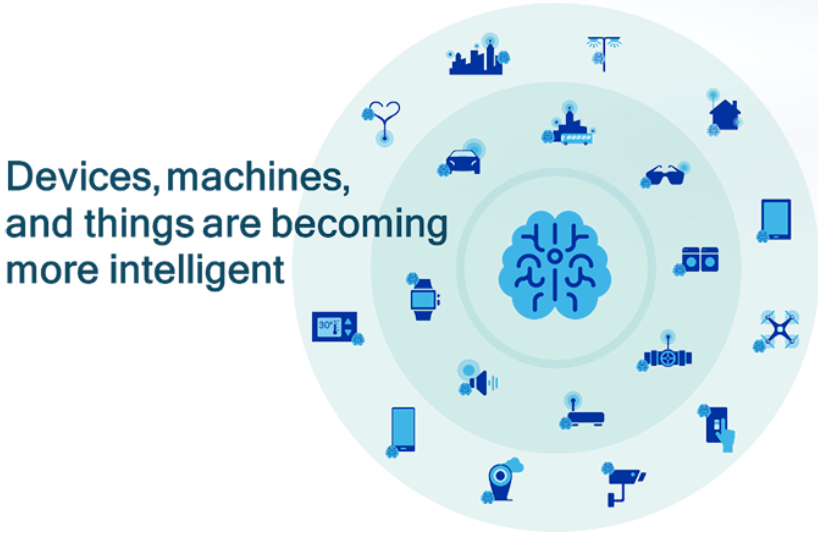
- 직전 상태를 고려한 다음의 최적 행동의 스스로 결정
- 자가 진단 및 조치
- 고객History와 Peer 집단의 성향을 고려한 음악, 영화 등 서비스의 추천
- Fraud Detection, Profiling
- 모방으로 부터의 창작 – 작곡, 작사, 작품(그림)
- 해석
  - Image to Text
  - Text to Image
  - Language to Language
  - Detail to Summary
  - Summary to Detail

2. Process Step

6) AI Model Service

- AI in Device – Sensor, Operation, R2R, Abnormal Detection 등
- Embedded System : Linux/Windows, Raspberry pi, Application Chip



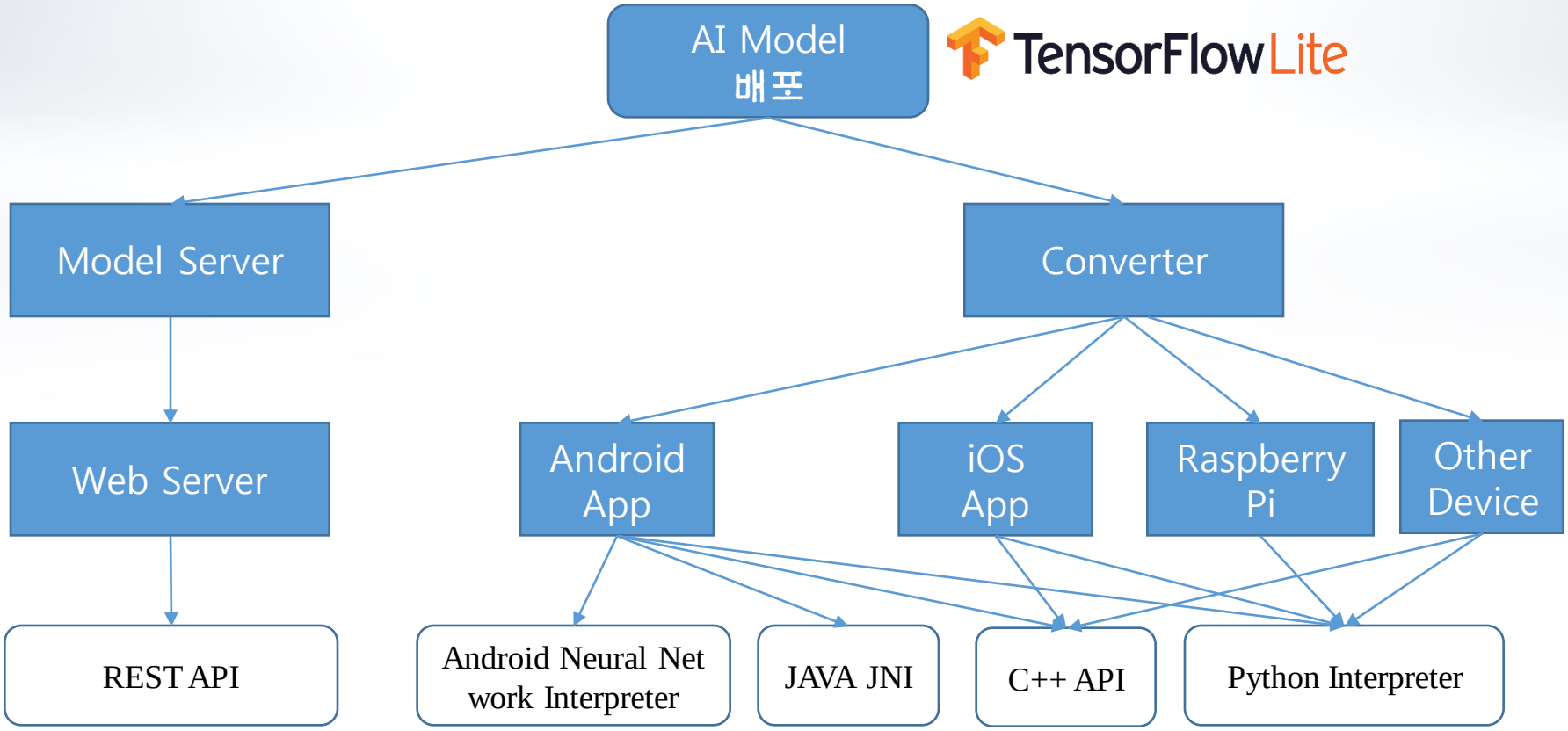


[source] https://www.qualcomm.com/news/onq/2017/08/16/we-are-making-device-ai-ubiquitous?cmpid=oofyus181544

2. Process Step

6) AI Model Service

- AI Server에서 학습되어 검증된 모델의 실세계 서비스 시스템/Device에 배포
- AI Model의 배포(Deploy) > TensorFlow Case

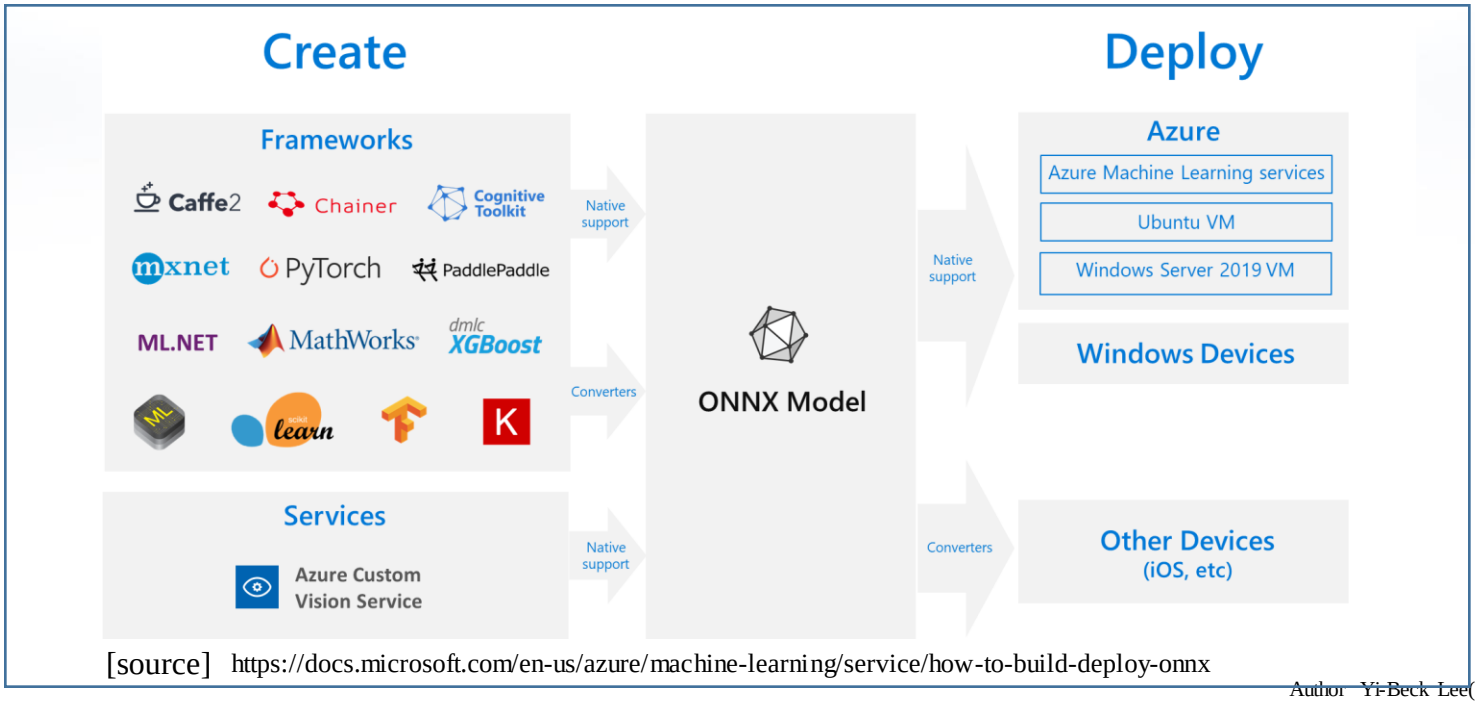


2. Process Step

6) AI Model Service

- AI Model의 배포(Deploy) > ONNX Case
  - ONNX : Open Neural Network eXchange
  - 모델의 상호 운용성
  - 서로다른 framework간의 Model Import & Export 기능
  - 서로 다른 서비스 Platform(Cloud, Device)에 대한 통합된 라이브러리

▣ Azure Cloud 환경에서의 ONNX 기반 Model 배포

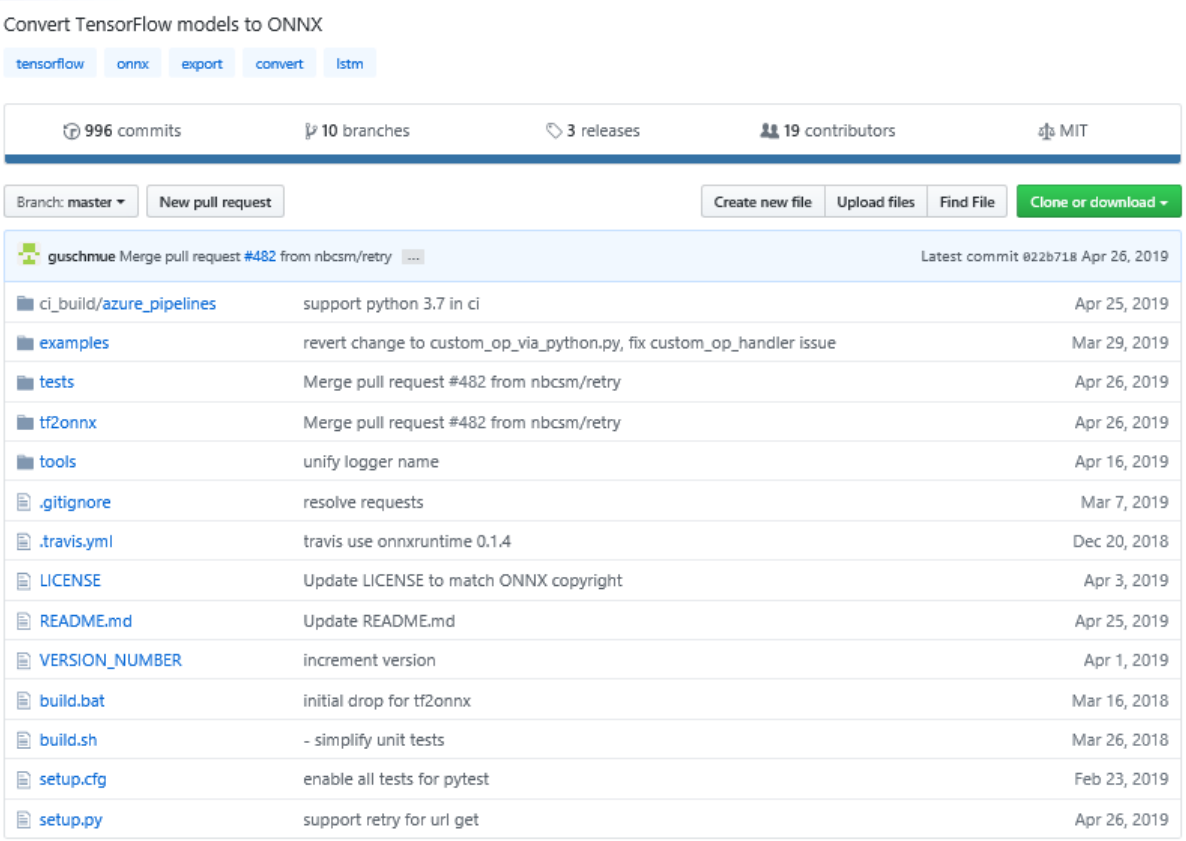


[source] https://docs.microsoft.com/en-us/azure/machine-learning/service/how-to-build-deploy-onnx

2. Process Step

6) AI Model Service

- AI Model의 배포(Deploy) > ONNX Case
  - convert TensorFlow models to ONNX models

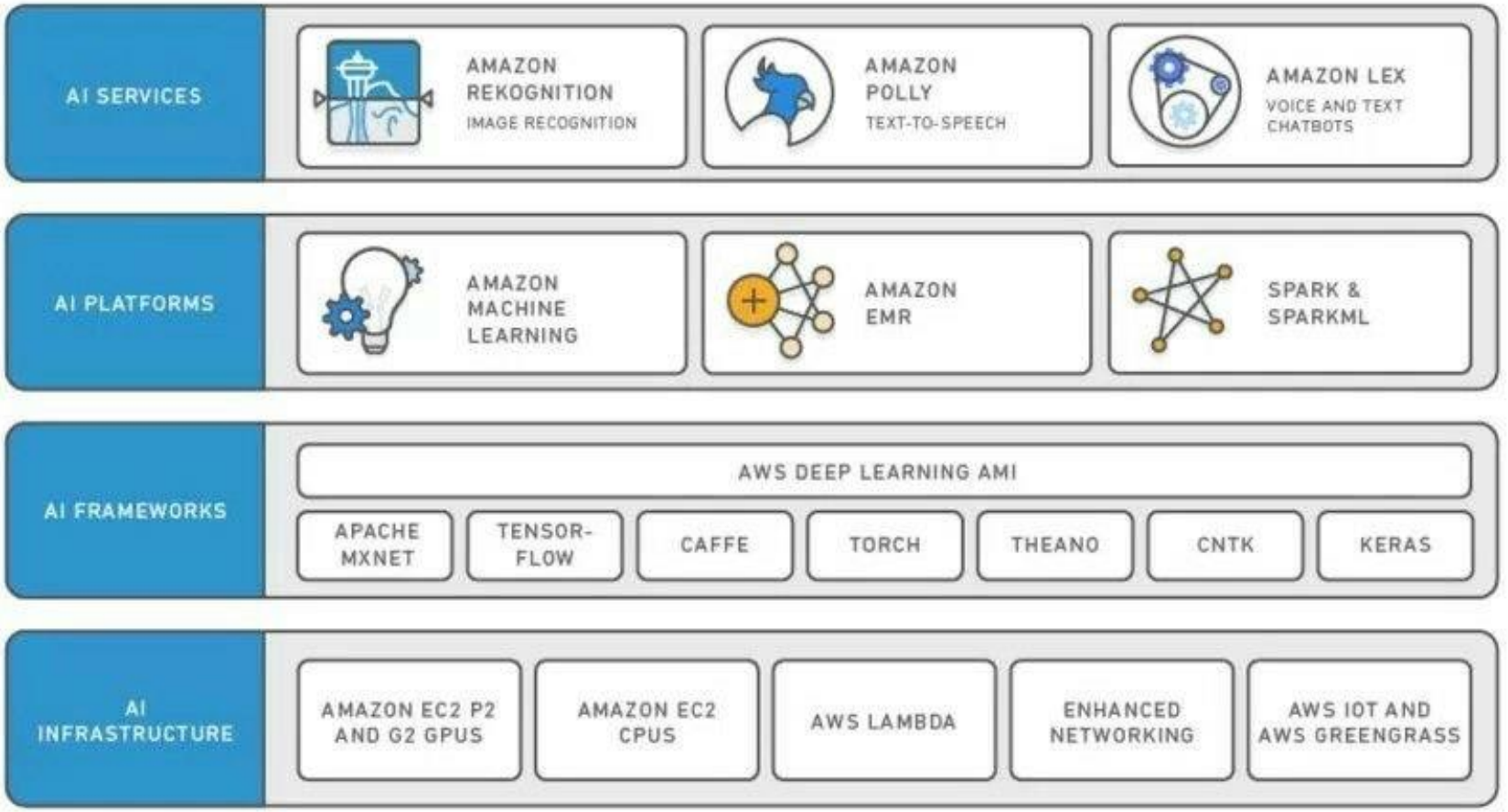


[source] https://github.com/onnx/tensorflow-onnx

2. Process Step

6) AI Model Service

- AI-a-a-S : Artificial Intelligence as a Service
  - AWS Case

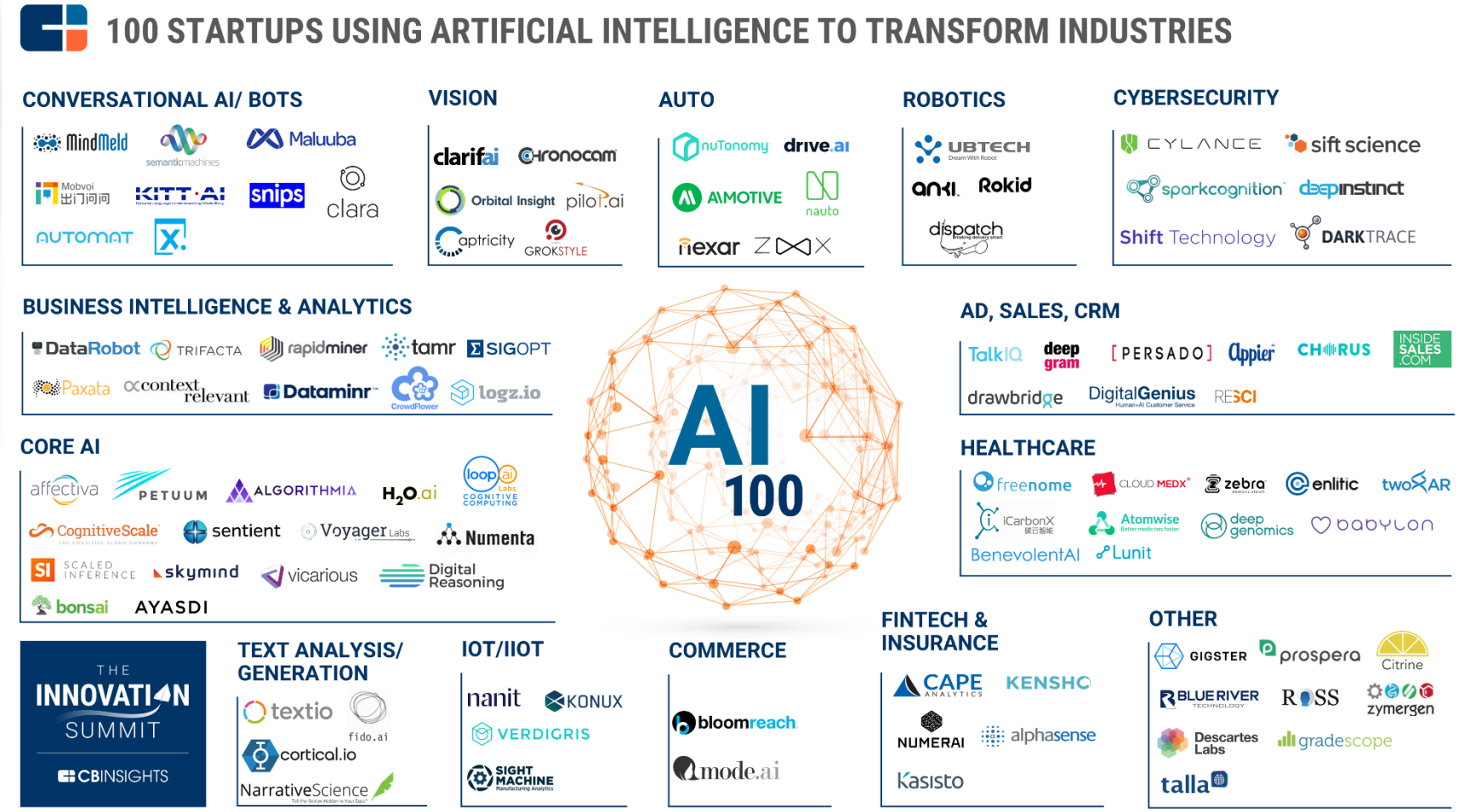


[source] https://www.nanalyze.com/2017/05/artificial-intelligence-service-core-ai/
https://i.pinimg.com/originals/00/17/25/001725085850742f185e5e28f5ef9115.jpg

2. Process Step

6) AI Model Service

- Top 100 AI Startups



[source] https://www.nanalyze.com/2017/05/artificial-intelligence-service-core-ai/

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Korea Association for ICT Promotion