

이상탐지서비스 알고리즘 소개 및 기업 적용 사례

이재훈 연구위원
LG전자 AI빅데이터담당
jae.h.lee@lge.com

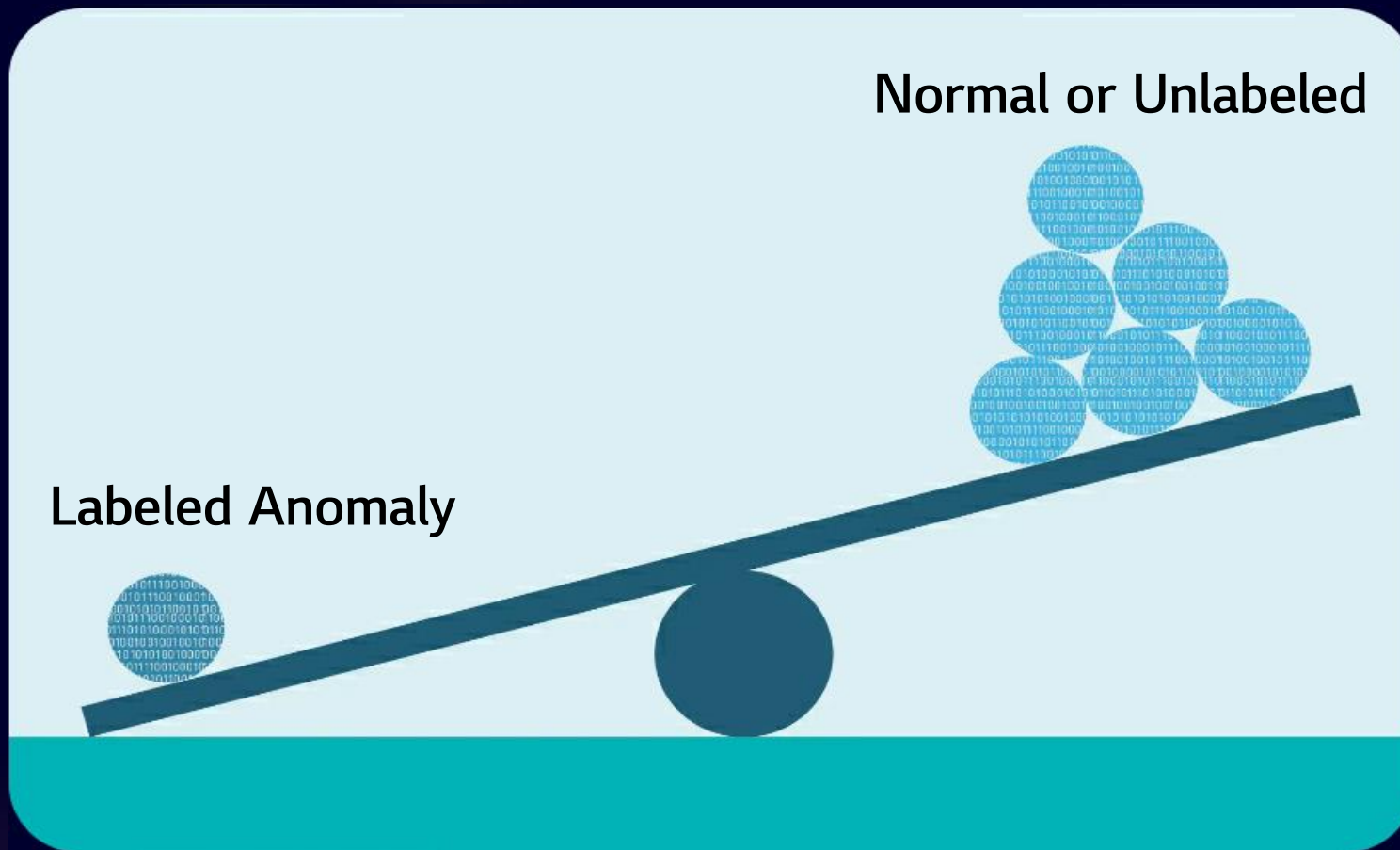
Time Series Anomaly Detection

- ✓ 서비스가 확산될수록 여러 지표를 동시에 모니터링할 필요성 증대
- ✓ 제조, 생산, SCM, 고객, 제품, 환경 등 수많은 영역에서 이상감지 활용



- 공장 설비 예지 보전
- 네트워크 침입 감지
- 부품 수급량 이상 감지
- VOC 이슈 비율 이상 감지
- 고객만족도지수 이상 감지
- 환경(온습도 등) 이상 감지

Challenge 1. Lack of Labels

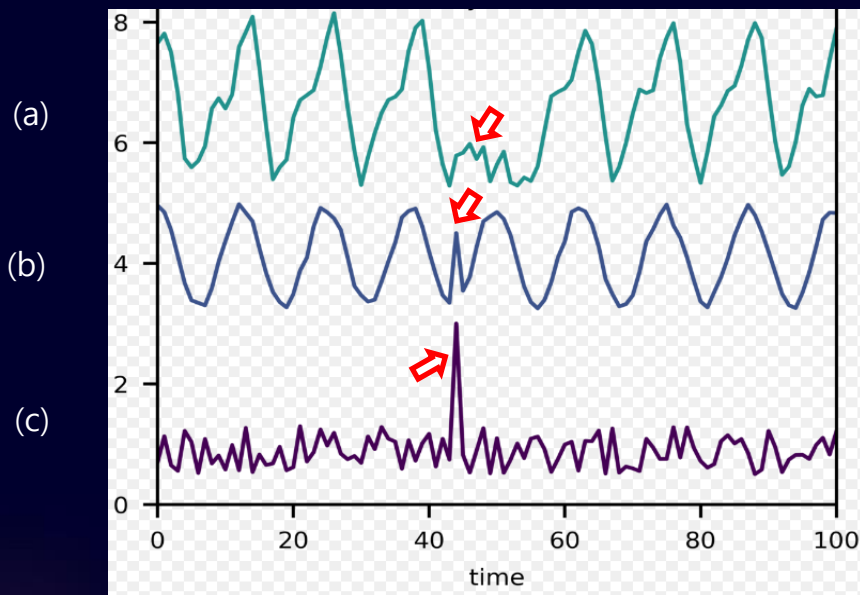


Challenge 1. Lack of Labels



Challenge 2. Diversity of Anomaly Types

✓ 도메인 특성과 필요에 따라 다양한 형태의 Anomaly 존재



Contextual Collective Anomaly

Contextual Point Anomaly

"Out-of-range" Point Anomaly

Multivariate Anomaly?

Challenge 2. Diversity of Anomaly Types

Point Anomaly Detection

- Local Outlier Factor (LOF)
- Dynamic Threshold
- Isolation Forest
- K-Nearest Neighbors (KNN)
- Robust Random Cut Forest
- One-Class SVM
- ...

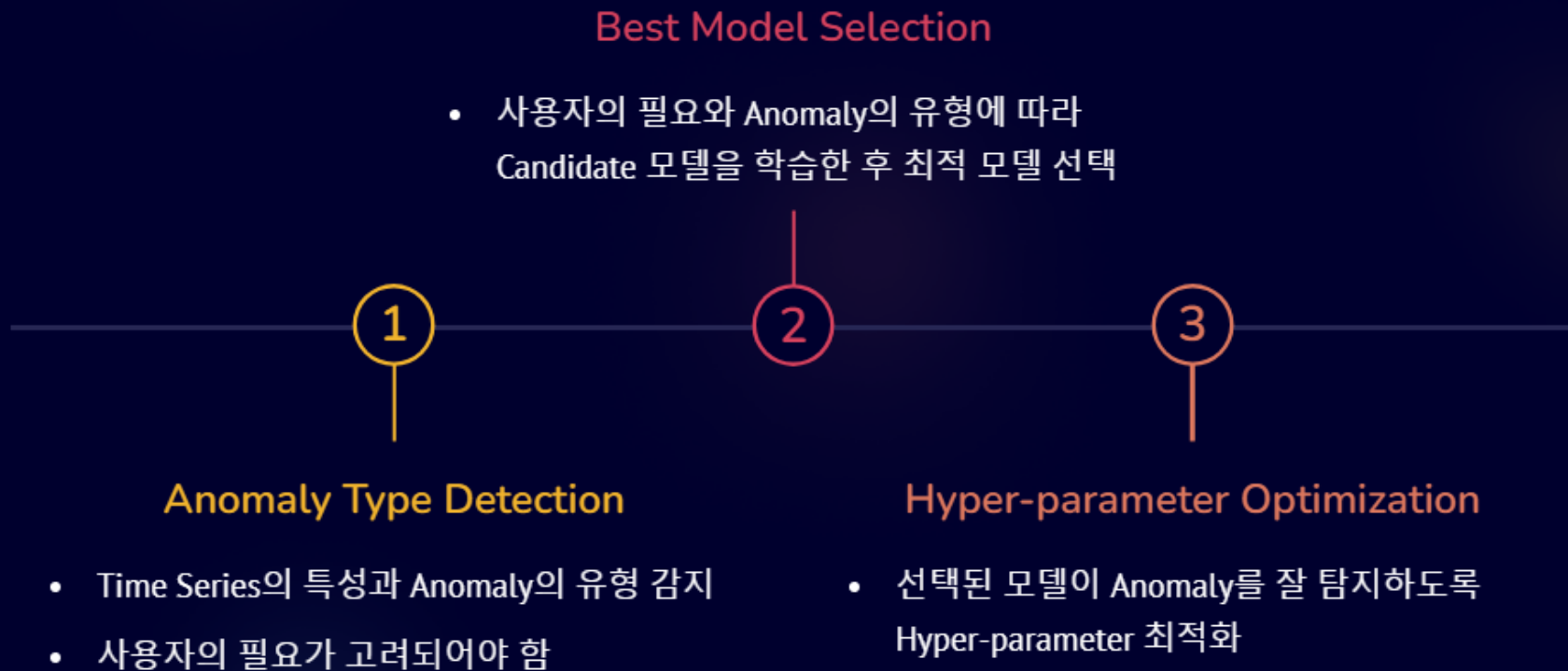
Contextual Anomaly Detection

- Robust Random Cut Forest
- Spectral Residuals
- Matrix Profile
- Hierarchical Temporal Memory
- DeepAnT
- LSTM AutoEncoder
- ...

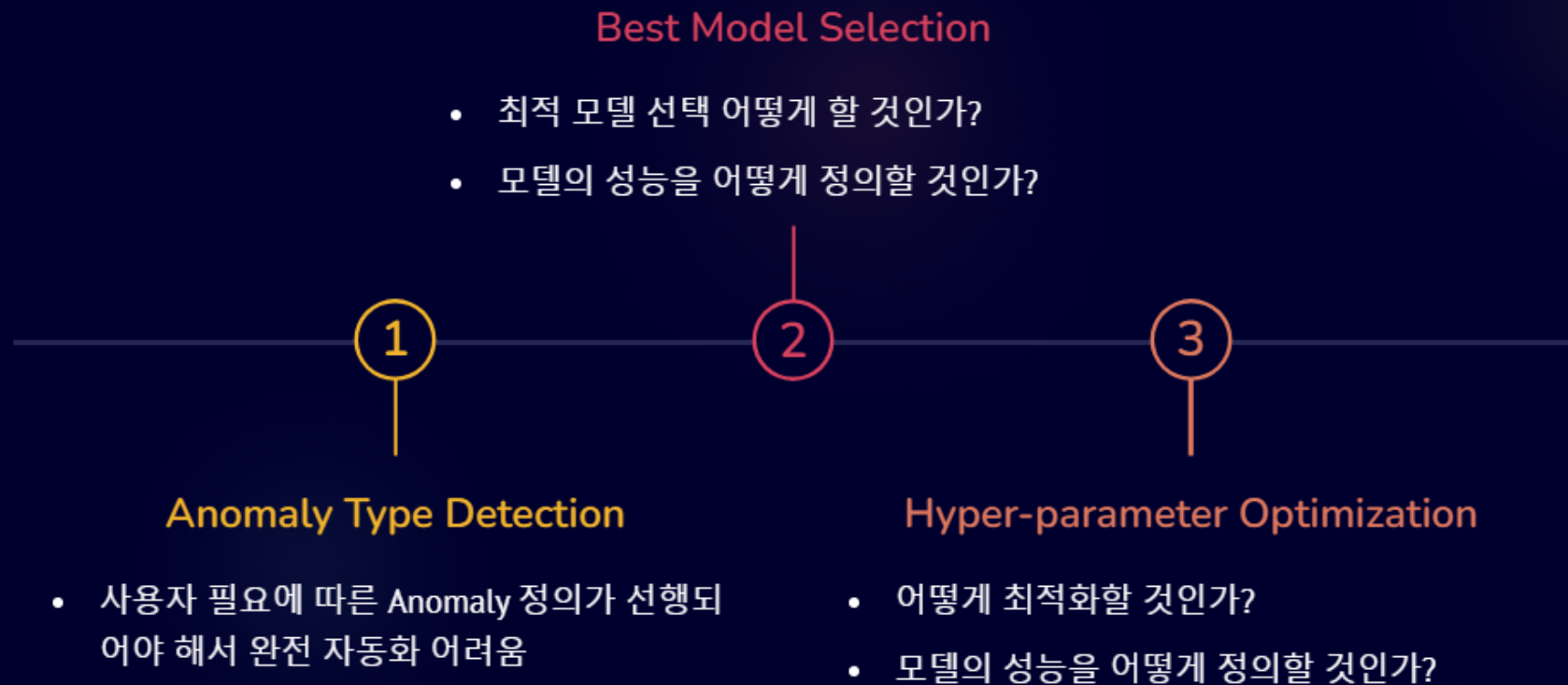
Multivariate Anomaly Detection

- AutoEncoder
- LSTM AutoEncoder
- USAD
- DBSCAN
- One-class SVM
- Robust Random Cut Forest
- TadGAN
- ...

Challenge 3. Automation & Optimization



Challenge 3. Automation & Optimization



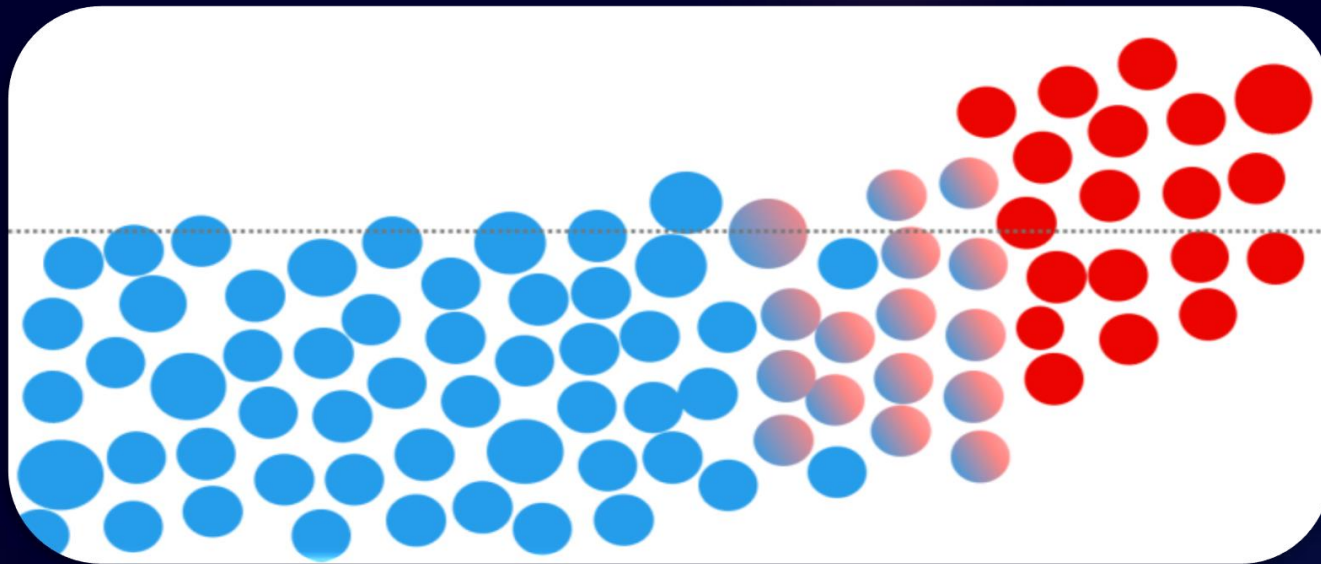
Challenge 4. Efficiency

- ✓ 실시간으로 많은 시계열 변수를 동시 관리해야 함
- ✓ 자동화된 Workflow 구축 필요
- ✓ 실시간 학습 및 추론 필요

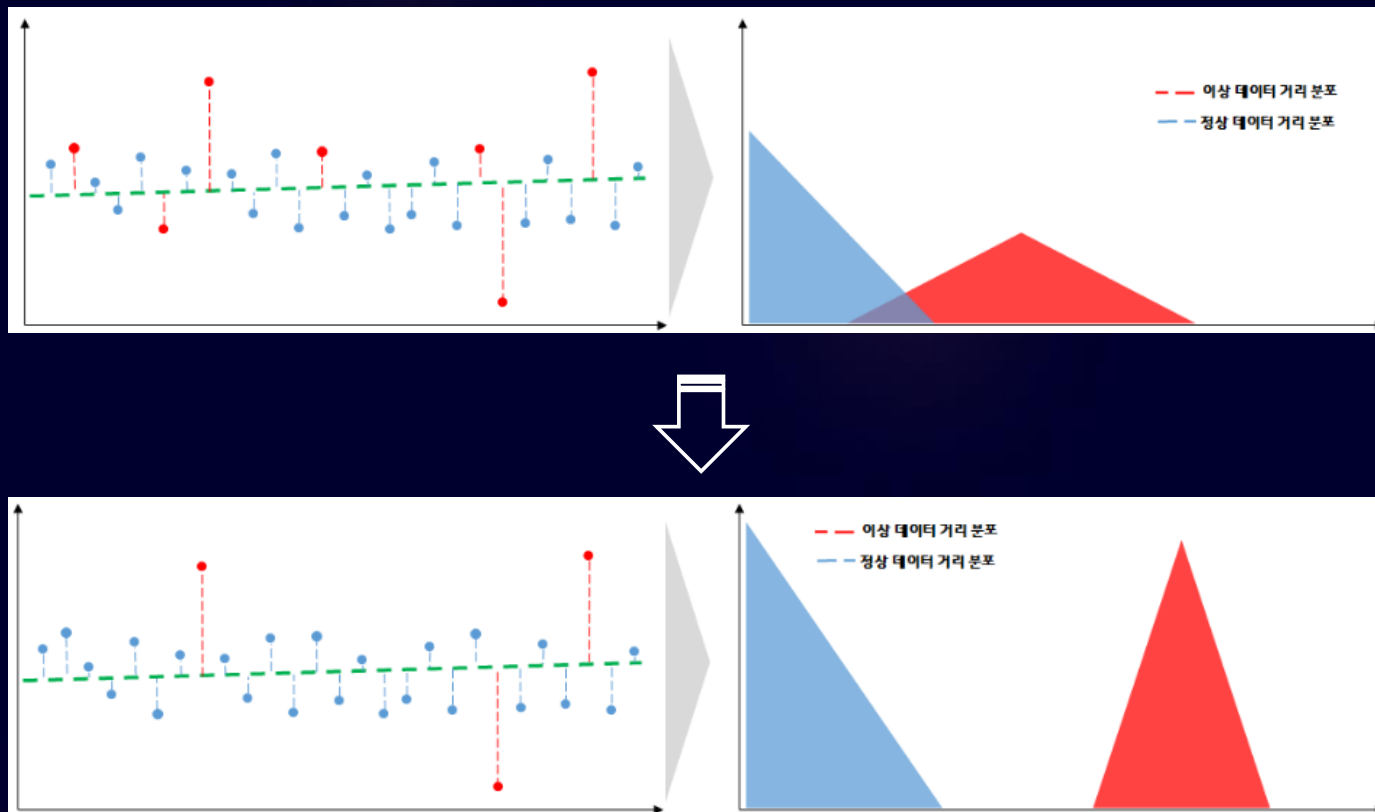


Challenge 5. Concept Drift

- ✓ 시간 또는 환경의 변화에 따라 데이터의 분포가 바뀜
 - ✓ 연속 학습 (Continual Learning) 필요
 - ✓ 또는 조건부 재학습 필요



Object Function Based Optimization



Object Function 정의

- ✓ How to select best model?
- ✓ How to optimize hyper-parameters?
- ✓ Anomaly 예측값과 Normal 예측값과의 거리가 클수록 Object Function 증가

$$C(Y_A, Y_N, N_P) = D(Y_A, Y_N) - C_P(N_P)$$

Y_A : Anomaly로 예측한 데이터

Y_N : Normal로 예측한 데이터

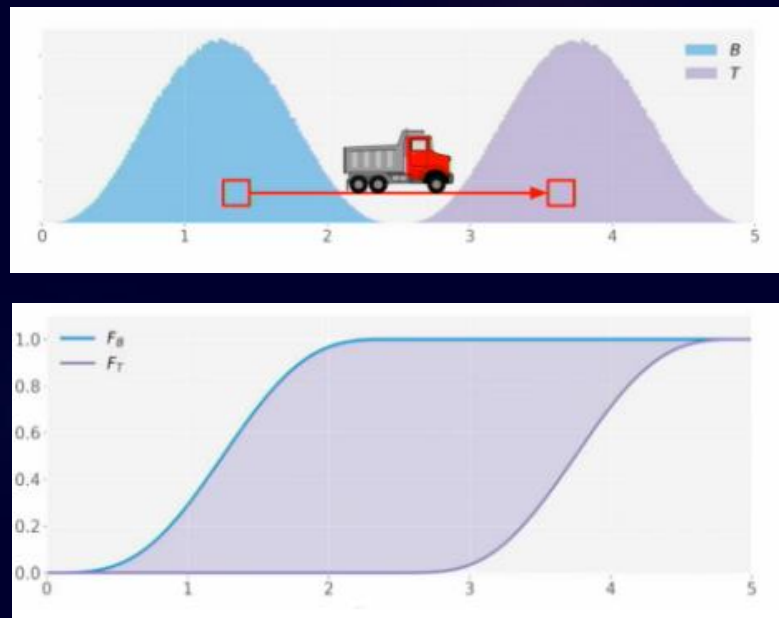
N_P : 특정 거리 조건을 만족하는 Anomaly 데이터 수

C : Distance Cost 함수

C_P : Penalty Cost 함수

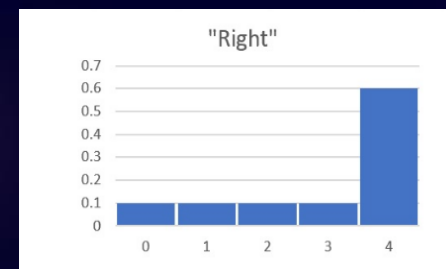
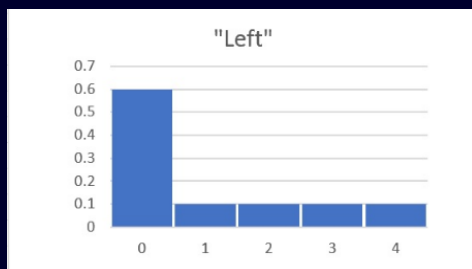
Earth Mover Distance

- ✓ 두 분포의 차이를 나타내는 거리 함수
- ✓ 이 산을 저 산으로 옮기는 데 필요한 일의 양을 거리로 계산



Earth Mover Distance

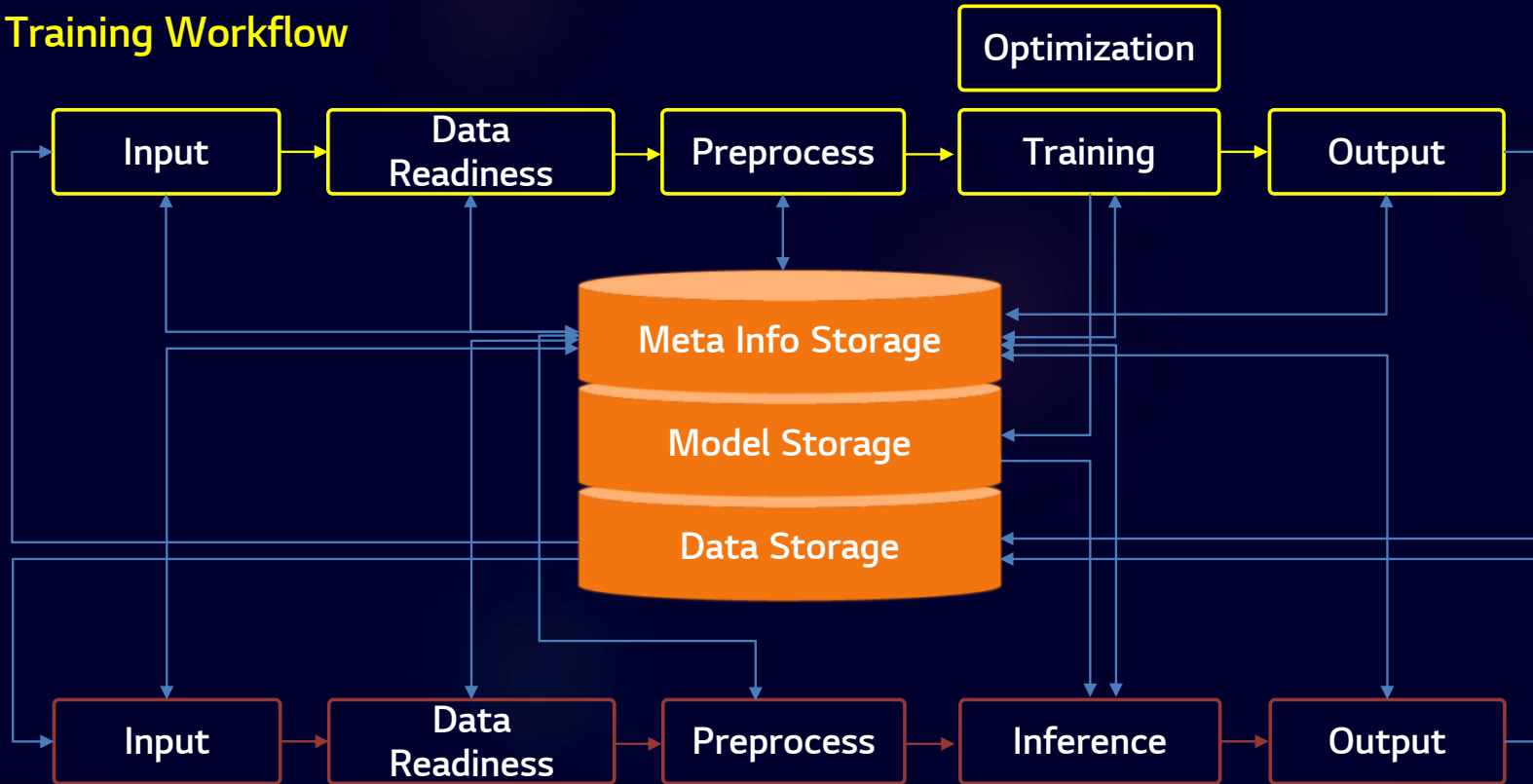
✓ 두 분포 간의 겹치는 영역이 작은 경우 Earth Mover Distance가 합리적



Distribution Comparison	Kullback-Leibler	Jensen-Shannon	Earth Mover
Left vs Center	1.79	0.45	1.0
Center vs Right	1.79	0.45	1.0
Left vs Right	1.79	0.45	✓ 2.0

Modeling Workflows For Stream Data

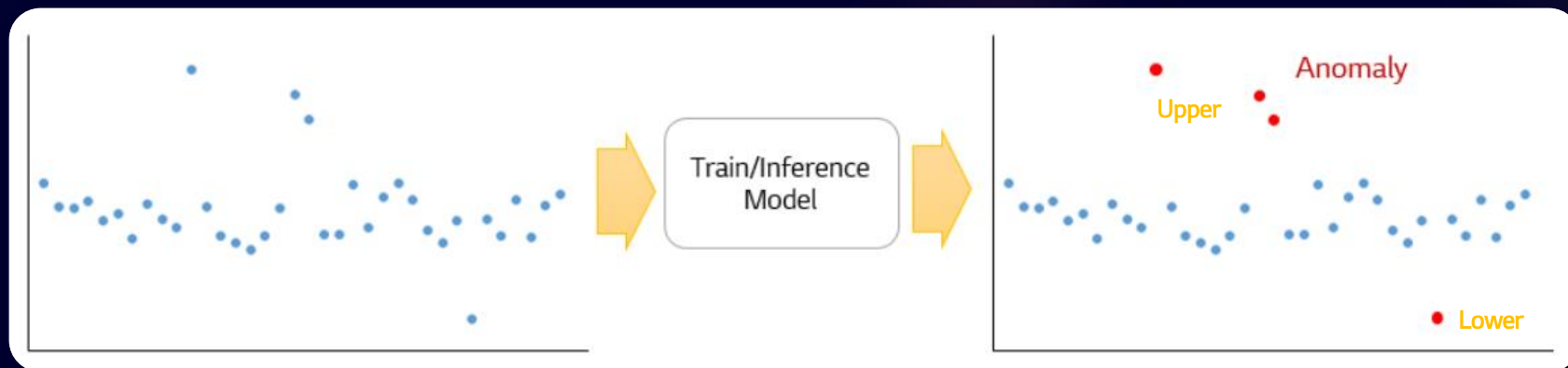
Training Workflow



Inference Workflow

Our Point Anomaly Detection Algorithm

- ✓ 실시간 스트리밍 point 데이터가 정상/ 이상인지 탐지하는 알고리즘
- ✓ Univariate Time Series Data을 대상으로 함



Our **Point** Anomaly Detection Algorithm

Automatic HPO

- Anomaly threshold 포함하여 모든 파라미터 자동화
- Bayesian-based 하이퍼파라미터 최적화

Diverse Candidate Models

- 통계적 방법론: Exponential Smoothing, Dynamic Threshold
- 머신러닝 방법론: Spectral Residual, Robust Random Cut Forest

Best Model selection

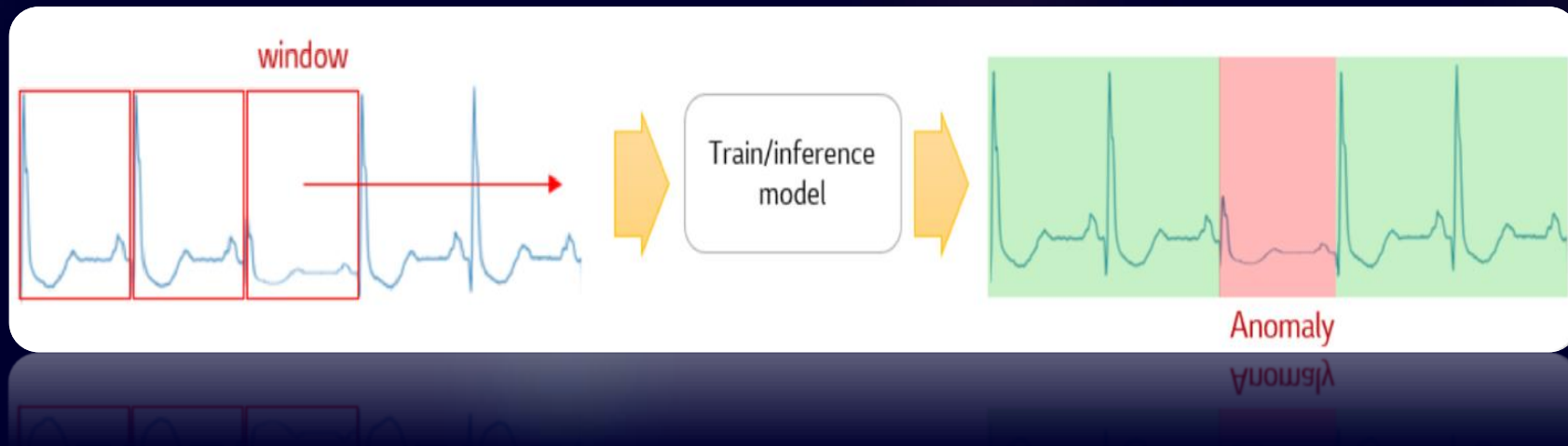
- 자체 목적함수 (Object function) 기반으로 최적 모델을 자동으로 선택
- 수동으로 candidate 모델 제한 가능

Customizable detection

- Anomaly 방향 설정 가능 (Upper / Lower / Both)
- 특정 파라미터 수동 설정 가능

Our **Contextual** Anomaly Detection Algorithm

- ✓ 실시간 스트리밍 데이터가 구간별 정상/이상인지 판별
- ✓ Time Series 정상 패턴을 학습하고 이에서 벗어난 이상 패턴을 탐지



Our **Contextual** Anomaly Detection Algorithm

Automatic HPO

- 모든 파라미터 자동화
- Anomaly Score 분포 활용
- Bayesian -based 하이퍼파라미터 최적화

Continual Learning

- 초기 Training 이후 점진적으로 연속학습
- Concept Drift 대응 가능

Tumbling / Sliding window

- Tumbling Window: Overlapping 없이 이상 패턴 구간 탐지 가능
- Sliding Window: 한 point씩 구간 Sliding하여 이상 탐지 가능

Adaptive Threshold / Window

- Anomaly Score 분포에 기반한 최적의 threshold 제공
- 효율적인 정상 분포 학습을 위해 매번 모델 업데이트마다 Window 조정

Our Multivariate Anomaly Detection Algorithm

- ✓ 여러 변수를 모니터링하면서 이상 또는 불량을 조기 검출
- ✓ Time Series 정상 패턴을 학습하고 이에서 벗어난 이상 패턴을 탐지



Our Multivariate Anomaly Detection Algorithm

Automatic HPO

- 모든 파라미터 자동화
- Semi-supervised 학습 기반 최적화
- Bayesian-based 하이퍼파라미터 최적화

LSTM Autoencoder

- Long-term Dependency 시계열 특성 활용
- 조기 이상진단 (Early Sensing) 가능

Neural Architecture Optimization

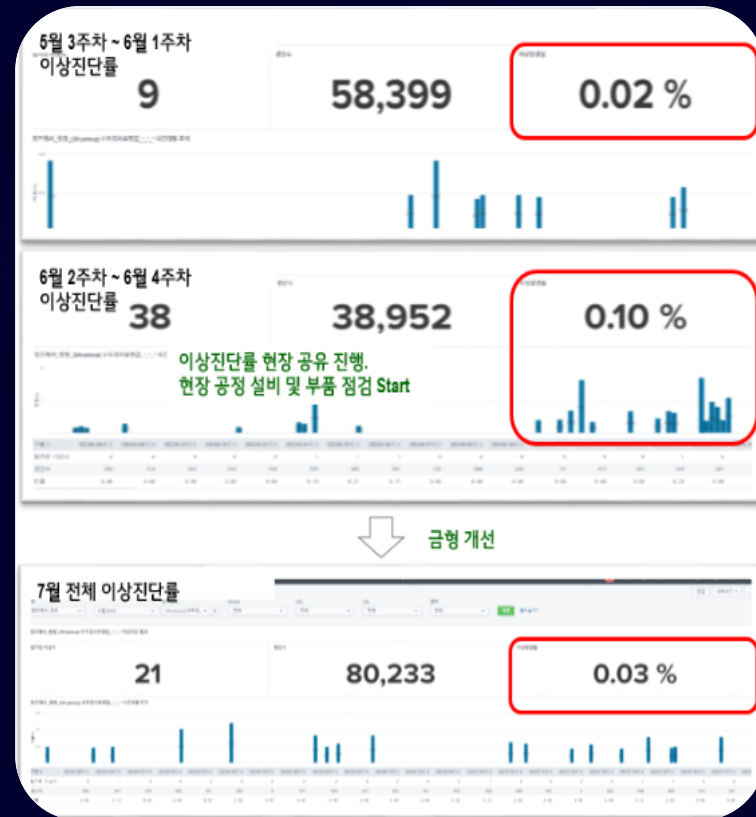
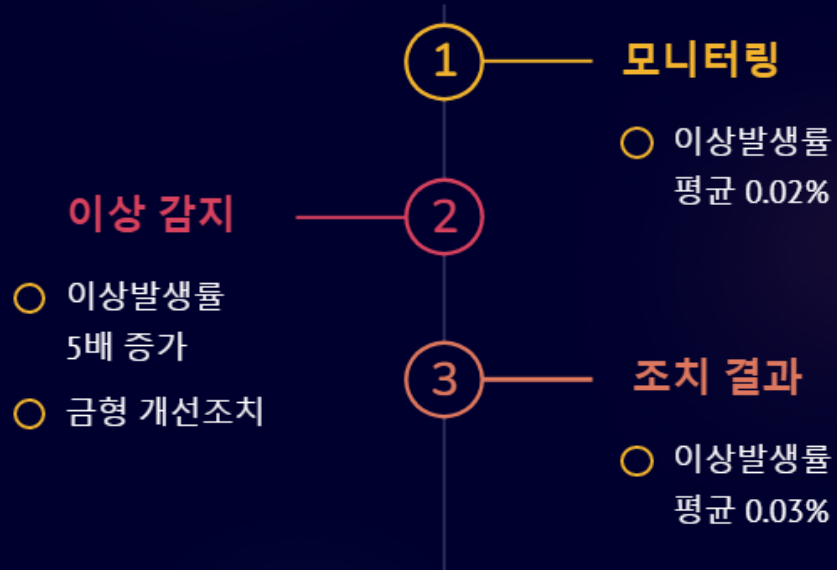
- 데이터에 따라 최적화된 네트워크 구조를 통해 Overfitting / Underfitting 방지
- X인자 갯수 및 Window size 고려

Adaptive Threshold / Window

- Look Back Window Size 자동 조정
- Anomaly Score기반의 자동 Threshold 설정

이상진단 서비스 적용 사례

✓ Oil Pickup 유량 검사 공정



이상진단 서비스 적용 사례

✓ Harness 압입 공정 개선

이상 감지

- 규격 선 내 이상 감지 (압입력 증가)
- 신규 금형 제작

1

모니터링

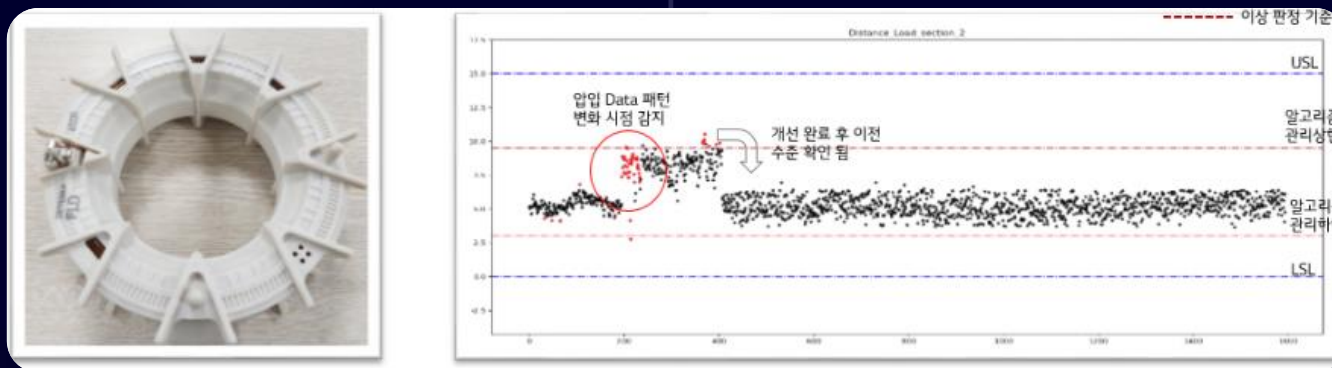
- 압입력 데이터 모니터링

2

3

조치 결과

- 압입력 수준 회복



AWS Marketplace 출시

The screenshot displays the AWS Marketplace website with the search term 'AI-Advisor'. The interface includes a navigation bar with links like 'About', 'Categories', 'Delivery Methods', 'Solutions', 'AWS IQ', 'Resources', and 'Your Saved List'. A search bar at the top right shows 'AI-Advisor' with a clear button. Below the navigation bar, there's a 'Refine results' section on the left with filters for Categories (Business Applications, Infrastructure Software, Machine Learning, Professional Services, Data Products, Industries), Delivery methods (SaaS, Professional Services, Data Exchange, SageMaker Algorithm), Publisher (eGain, MeerkAT, FHI Insight, inGenious AI, Atos science + computing, Paragon Cloud Services, Ironside, IBM Security), Pricing model (Upfront Commitment, Free), and Pricing unit (Custom Units, Hosts). The main content area shows 17 results for 'AI-Advisor', sorted by Relevance. Three results are visible, each marked with a red checkmark: 'AI-Advisor Point Anomaly Detection', 'AI-Advisor Contextual Anomaly Detection', and 'AI-Advisor:Early Sensing(Multivariate)'. Each result includes the publisher 'MeerkAT', version 'v.1.1.4', and a brief description of the technology.

aws marketplace ×

About ▾ Categories ▾ Delivery Methods ▾ Solutions ▾ AWS IQ ▾ Resources ▾ Your Saved List Become a Channel Partner

Refine results

Categories

- Business Applications (7)
- Infrastructure Software (4)
- Machine Learning (4)
- Professional Services (4)
- Data Products (3)
- Industries (1)

▼ Delivery methods

- ☐ SaaS (7)
- ☐ Professional Services (4)
- ☐ Data Exchange (3)
- ☐ SageMaker Algorithm (3)

▼ Publisher

- ☐ eGain (4)
- ☐ MeerkAT (3)
- ☐ FHI Insight (3)
- ☐ inGenious AI (2)
- ☐ Atos science + computing (2)
- ☐ Paragon Cloud Services (1)
- ☐ Ironside (1)
- ☐ IBM Security (1)

▼ Pricing model

- ☐ Upfront Commitment (13)
- ☐ Free (4)

▼ Pricing unit

- ☐ Custom Units (10)
- ☐ Hosts (3)

1 search filter has been cleared ×
You selected the following filter in your last search: Apply previous filter

AI-Advisor (17 results) showing 1 - 17 Sort By: Relevance ▾

MeerkAT ✓ **AI-Advisor Point Anomaly Detection**
By **MeerkAT** | Ver v.1.1.4
This algorithm is a technique for detecting unusual patterns that differ from common patterns in a data set, and considers individual data points as outliers when they differ significantly from surrounding data. Various machine learning algorithms can find outliers that match the algorithm's...

MeerkAT ✓ **AI-Advisor Contextual Anomaly Detection**
By **MeerkAT** | Ver v.1.1.4
CAD (Contextual Anomaly Detection) is a technology that monitors and learns normal patterns for time-series data with specific patterns and detects abnormal patterns that deviate from the normal pattern. Unlike Point Anomaly Detection, it can identify anomaly patterns in time-series data even if...

MeerkAT ✓ **AI-Advisor:Early Sensing(Multivariate)**
By **MeerkAT** | Ver v.1.1.4
MAD stands for Multivariate Anomaly Detection, which is a technology that learns and monitors normal patterns for time-series data with specific patterns and can detect abnormal patterns that deviate from the normal pattern. Unlike Point Anomaly Detection, it identifies anomaly patterns in the...