# Unintentional Bias and AI-Enabled Medical Devices

## (Real World Domain Shift and Domain Adaptation Examples)


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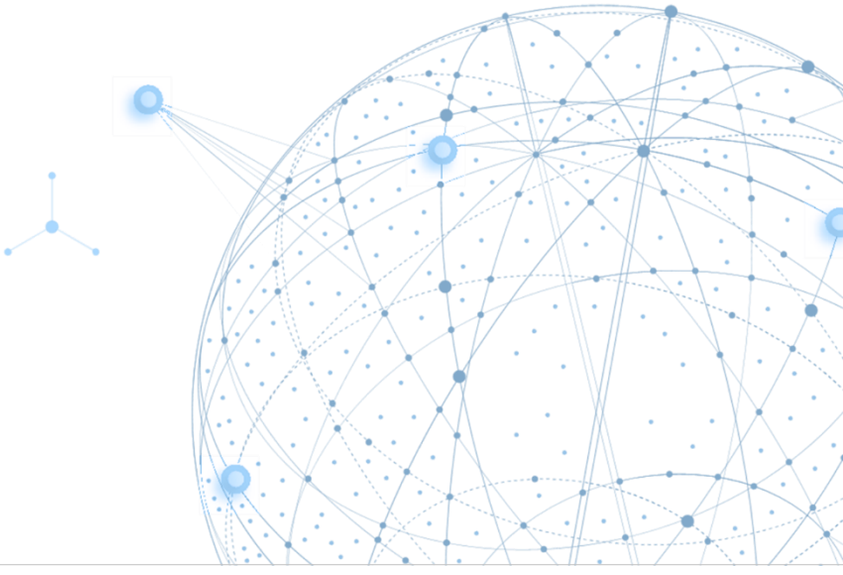
**CEO, JLK Inc.**



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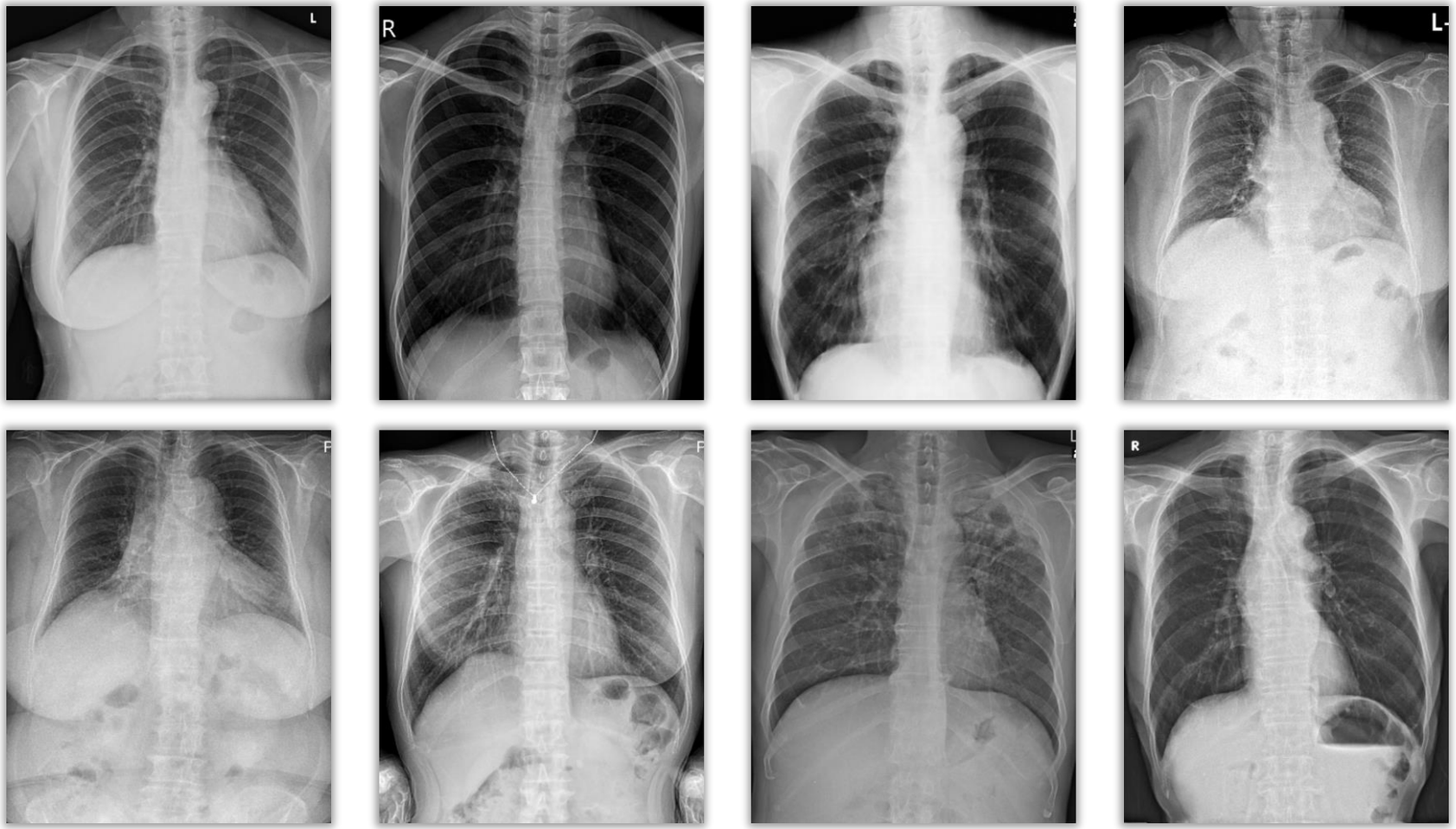
# Real World Problem

**Undefined image texture differences and unexpected image conditions**

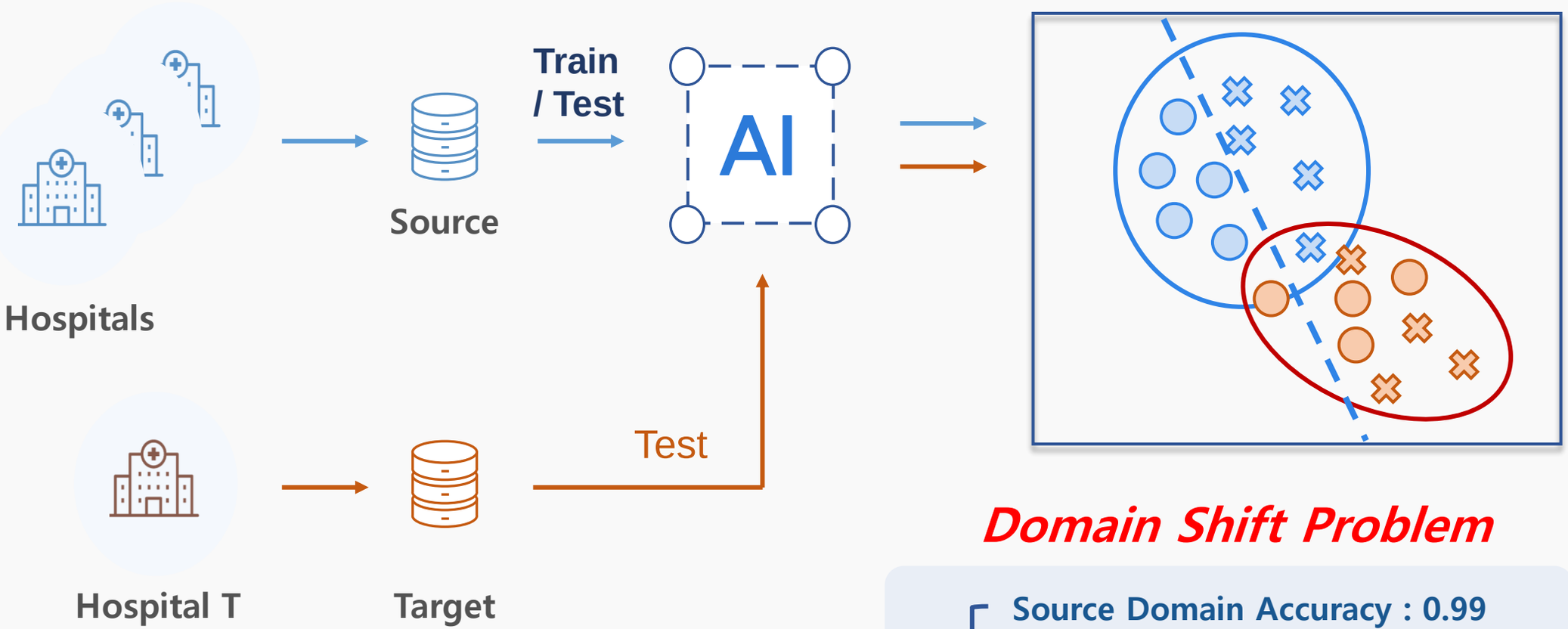
**because of various equipment vendors and clinical situations**

**Unexpected performance degradation of trained AI**



# Domain Shift Problem

- ✓ Caused by **dataset bias**, such as gender, age, race, equipment and so on.
- ✓ One of the main reasons that **degrade** robustness of the trained network.



# Real World Domain Shift Problem

**Texture difference** exists between source and target domain dataset resulted from different X-Ray equipment vendors

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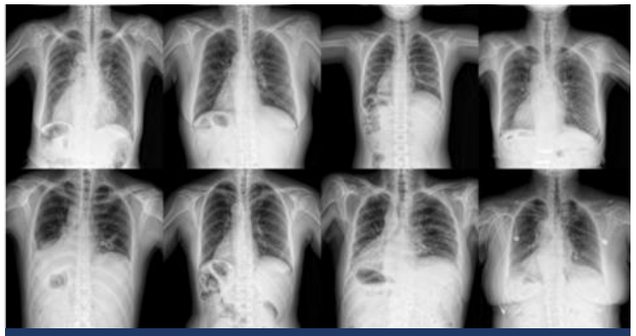
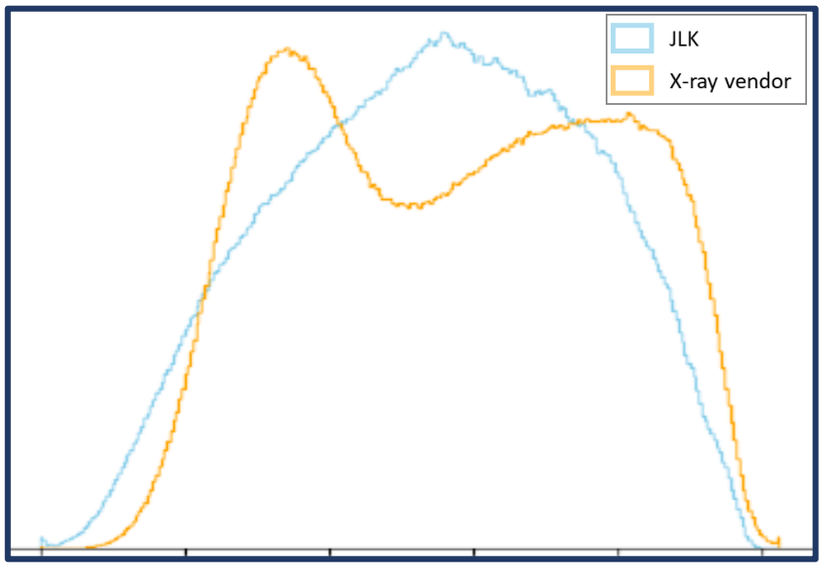
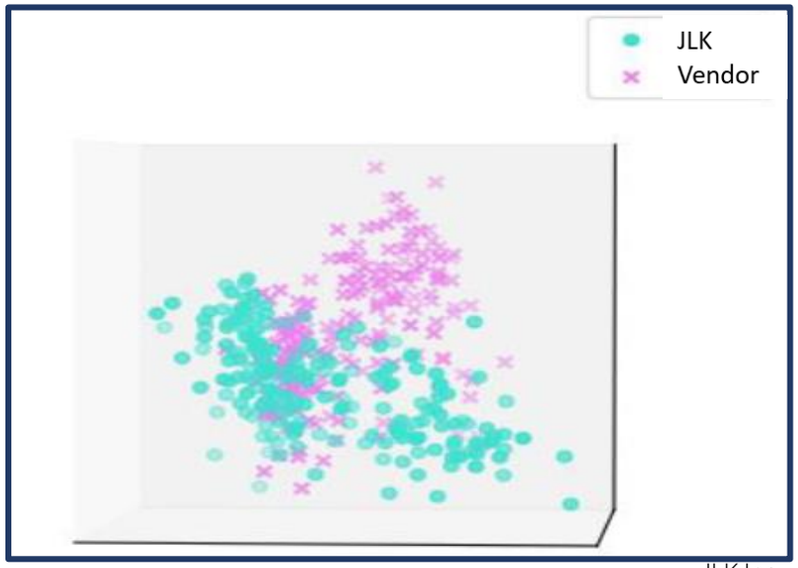


X-ray Vendor

## Pixel-intensity analysis




Histogram




PCA

# Real World Domain Shift Problem

**Performance degradation in low-quality(normal) and early pneumonia images**

Normal

Normal, low quality

Early Pneumonia

Pneumonia

# Real World Domain Shift Problem

**Practical Example -** **Unexpected Cases for Pneumonia Analysis**

Grad : Mid, Probability : 40.66%

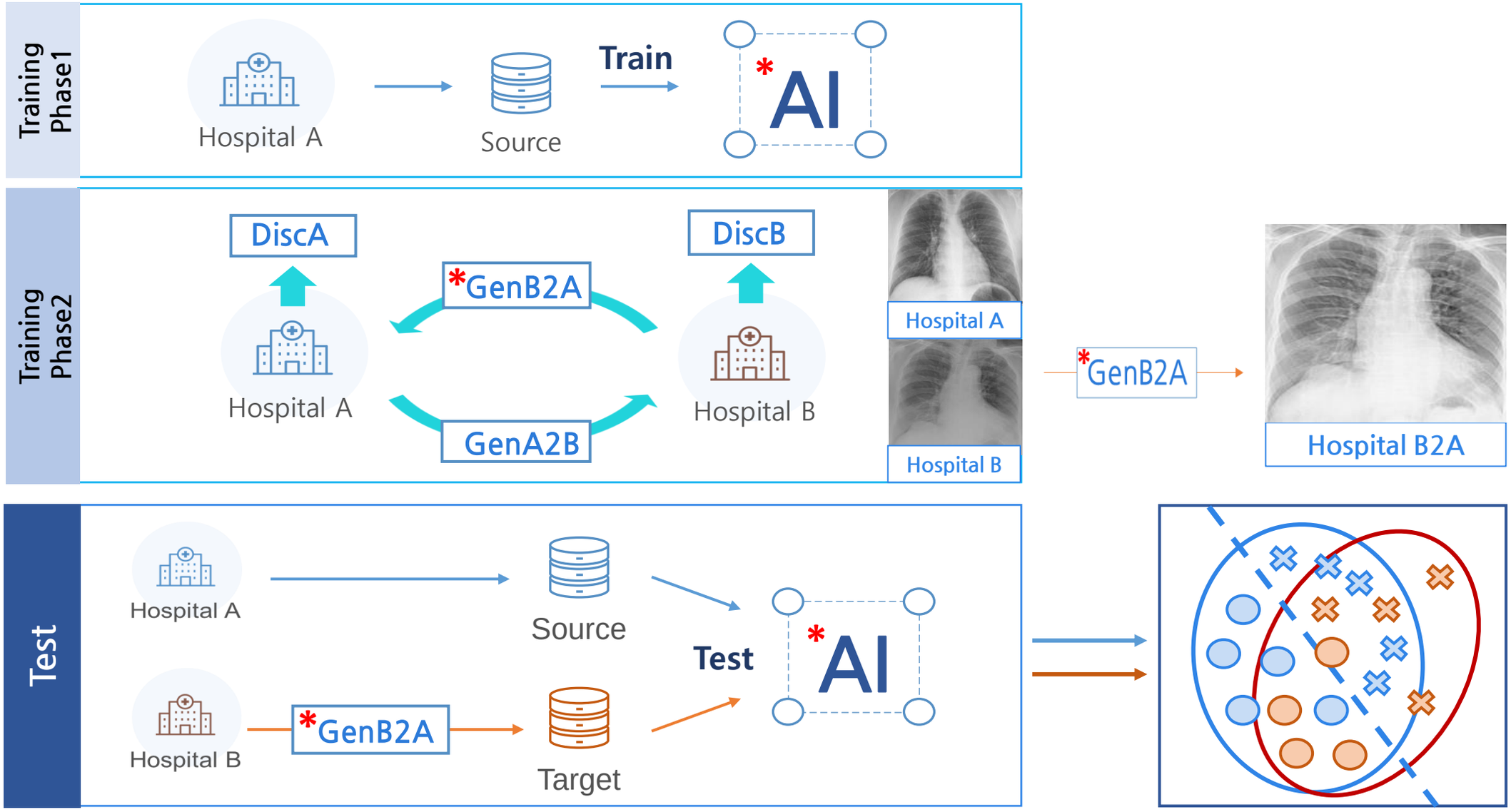
Grad : Mid, Probability : 59.46%

# 02 Domain Adaptation Examples

# Generalize vendor differences using a generative neural network

✓ It is important to match image textures between source and target dataset

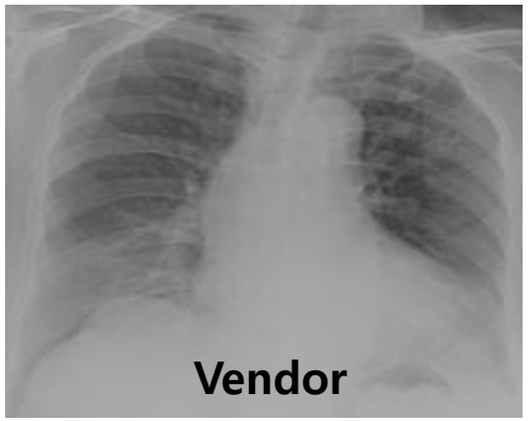
✓ Generator trained based on CycleGAN is used in preprocessing step to handle the domain shift problem



# Generalize vendor differences using a generative neural network

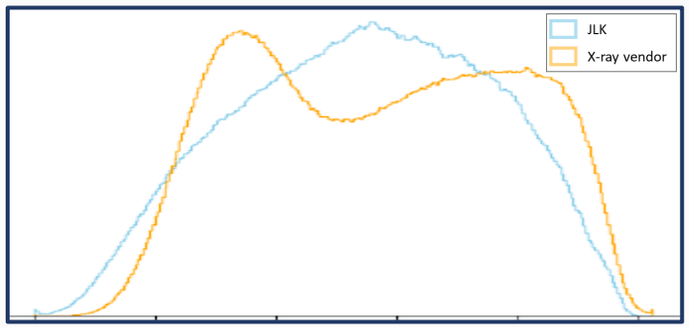
**Practical Example -**

- ✓ The Histogram of target dataset becomes similar to source dataset
- ✓ As a result of PCA, the distribution of the source and target becomes similar

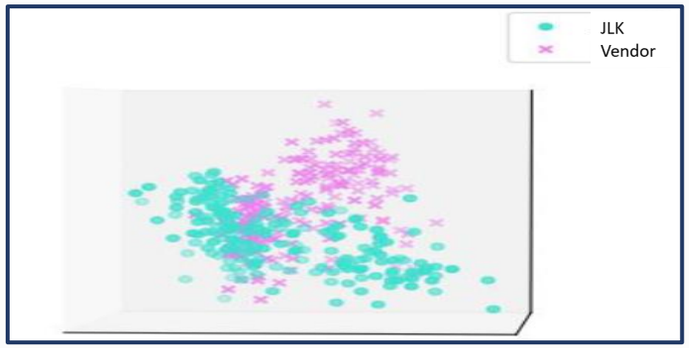



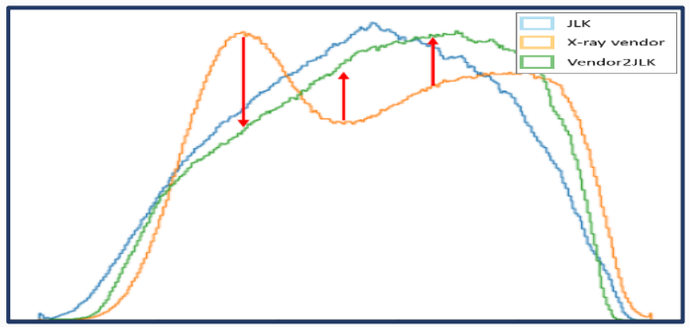


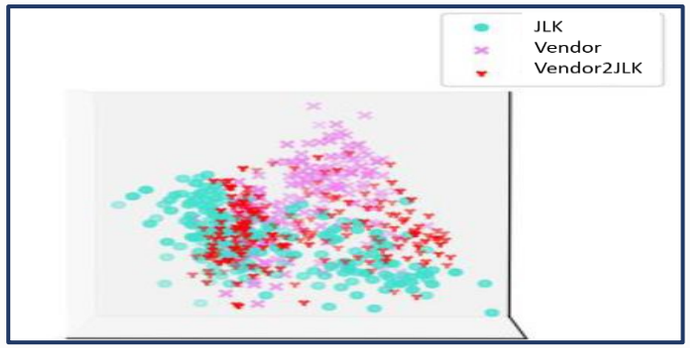
Histogram




PCA



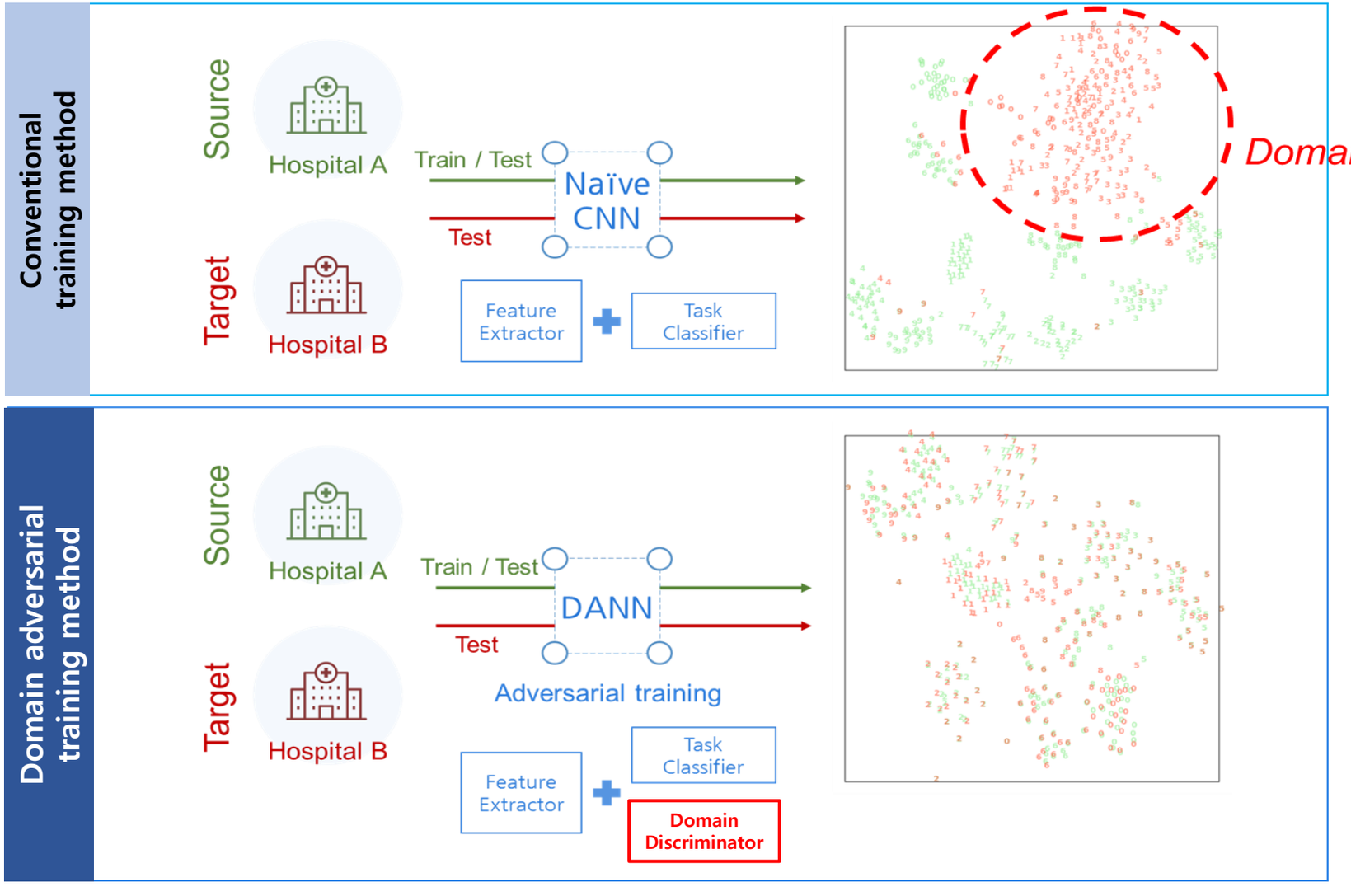



# Domain Adversarial Training

✓ Training a feature extractor to generate domain-independent features

✓ New network called **'domain discriminator'** is added to use both class information and domain information



# 03 Conclusion

# Conclusion

1. If we have distribution in real-world, we get unintended AI analysis results depending on race, type of equipment, clinic protocol, age and body type.

2. Ultimately, it is important to construct representative learning data which could predict these all exceptional cases and remove bias of learning data.

3. However, in an exceptional case such as this, relevant database does not exist and only a few of case studies are found in journals. Thus, it is difficult to make predictions on the situation.

4. Regulatory Affairs Guidelines stipulated by Korea's Ministry of Food and Drug Safety in 2019 include standards for performance enhancement through additional training dataset.

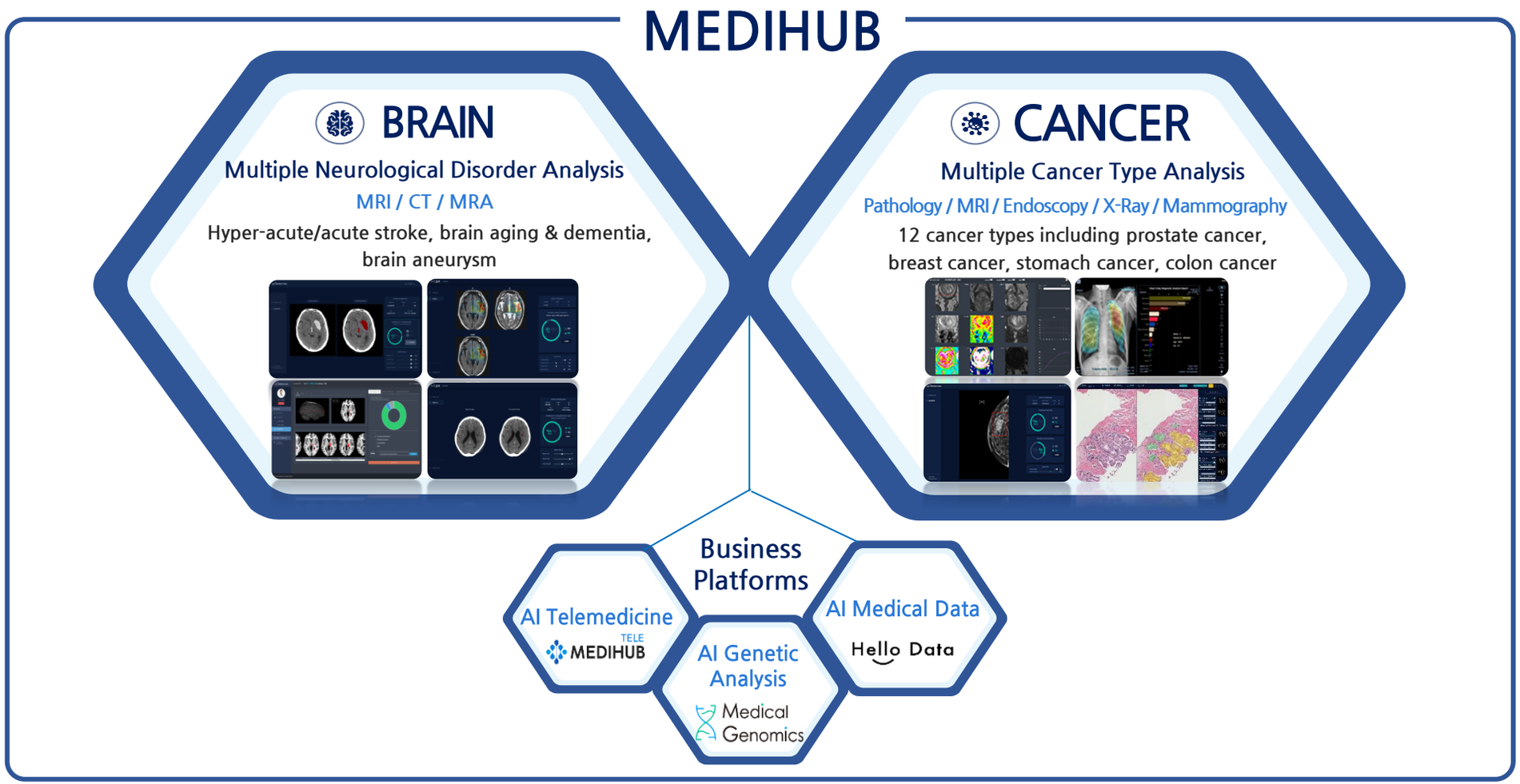
5. If we were to take aforementioned such traits as Active Implantable Medical Device's inevitable characteristic, and say that unexpected degradation in performance was found on the approved AIMD articles, the manufacturer will proceed with an update and report details to build a database for unexpected circumstances, further reinforcement on the Regulatory Affairs for Medical Devices will take place.

# 04 Appendix

# Company Overview (Medical AI Solution Coverage)

## JLK Inc - Leading the AI Medical Industry with Innovative Technology

| | | | |
|---|---|---|---|
| CEO | Dongmin Kim | IPO | IPO in Dec. 2019 |
| Foundation | Feb 2014 | Locations | South Korea, US, Japan |
| Employees | 88 (as of September, 2022) | Website | www.jlkgroup.com |




# Thank You