**Drift**

There are three basics types of drift: Covarite drift, Label drift, and Concept drift

Problem: We are predicting a target variable y given a set of input features X. For example, in our patient outcome prediction model, X could be a set of features of patients (e.g., HR, IBP), and y could be Hospital stay, ICU Stay..

## 1. Covariate/feature drift

Covariate drift or feature drift happens when p(X) changes but p(y|x) remains the same. The marginal distribution of the input features (HR, IBP) changes, but the conditional distribution of ICU stays/Hospital stays for given patient features stays the same.

## 2. Label drift

Label drift happens when p(y) changes but p(x|y) remains the same.

In the patient outcome prediction example, the ICU Stay/ hospital stay distribution p(y) could change after when the model was trained previously. For example, the Hospital stay has significantly increased during the pandemic, resulting in the Hospital Stay distribution shifting towards a higher value.

## 3. Concept drift

Concept drift happens when p(y|X) changes but p(X) remains the same.

In the Hospital Stay prediction example, the conditional probability of Hospital stay given patient features p(y|X) could change. For example the distribution of the HR, IBP does not change. The conditional probability of Hospital Stay given HR, IBP features could change, especially for older peoples.

**Drift detecting methods:**

**1.** **Monitor model performance**

The most common model performance metrics include confusion matrix, accuracy, recall, F1 score, ROC-AUC, MAE, MSE, and RMSE.

**2.** **Monitor descriptive statistics**

We can describe our datasets statistically with measurements like min, max, median, mean, uniqueness, correlation, and others.

**3.** **Monitor distribution changes**

There are several statistical tests or hypothesis tests that can be used to detect the distribution changes statistically such as Population Stability Index, Kolmogorov-Smirnov test, and Wasserstein distance metric.

1. Population Stability Index ([PSI](https://mwburke.github.io/data science/2018/04/29/population-stability-index.html)) measures “how much a population has shifted over time or between two different samples of a population in a single number”.

**a) When PSI<=0.1**

This means there is no change or shift in the distributions of both datasets.

**b) 0.1< PSI<0.2**

This indicates a slight change or shift has occurred.

**c) PSI>0.2**

This indicates a large shift in the distribution has occurred between both datasets.

PSI also reflects the relative "size" of the drift: the larger the PSI value, the more different the distributions are.

**2. Kolmogorov-Smirnov test** (or [KS test](https://en.wikipedia.org/wiki/Kolmogorov–Smirnov_test)) “quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution, or between the empirical distribution functions of two samples”.

It returns the p-value. If the p-value is less than 0.05, we can usually declare that there is strong evidence to reject the null hypothesis and consider the two samples different.

## 3. Wasserstein distance metric

The Wasserstein distance, also known as the Earth Mover’s distance, measures the distance between two probability distributions over a given region. The Wasserstein Distance is useful for statistics on non-overlapping numerical distribution moves and higher dimensional spaces,