**Isotonic Regression**

Isotonic regression is a type of regression model that predicts continuous target values using a monotonic function of the independent variables. It also preserves the order of the dependent variable values. It is a piecewise linear function.

**Isotonic data**

Isotonic data is data that continually decreases. Let Y and X be features of the data set. As X increases, the values for Y either repeatedly increase or stay the same, but never decrease then increase. Alternatively, the values of Y can repeatedly decrease or stay the same, but never increase then decrease.

**Model Building**

* We aim for homoscedasticity in models. A linear model may have bias towards the front or end or middle.
* A lack of homoscedasticity may suggest that the regression model may need to include additional predictor variables to explain the performance of the dependent variable.
* Can we estimate a linear model between each threshold such that we minimise the error wrt the training data. Now the model is parameterized by a set of predictions at the thresholds.

**Applications:**

* You have already seen the full range of input variables
* Linear model is too inflexible
* Imputation
* Multivariate data (alternative to RF)

**Assumptions:**

* **Monotonicity:** The target variable values must increase or decrease monotonically with the independent variables.
* **No ties:** There should not be any ties in the target variable values for any given set of independent variables. (DOMINIC WHAT IS A TIE)
* **No noise:** The target variable values should be continuous and without much noise.

**Characteristics:**

* **Monotonic function:** Isotonic regression models fit a monotonic function, which preserves the order of the target variable values.
* **Non-parametric:** Isotonic regression models are non-parametric, meaning they do not make assumptions about the underlying relationship between the independent and dependent variables.
* **Robust to outliers:** Isotonic regression models are robust to outliers, as they are not affected by extreme values in the target variable.

**Benefits of Isotonic Model:**

* It is not constrained by any functional form, such as linearity imposed by linear regression. Therefore it is useful wherever a particular ordering is expected.
* Useful in ML since the model probability is a true representation of the actual likelihood of the event - good for developing cost functions

**Disadvantages of Isotonic Model**:

* More prone to overfit, so only works well on large data sets