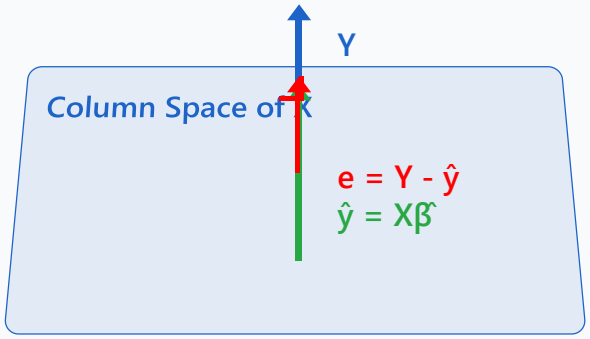
Geometric Interpretation

Projection onto Column Space



Column Space

All possible linear combinations of predictors

Prediction ŷ

Projection of Y onto column space of X

Residual e

Orthogonal to column space (perpendicular)

Projection Matrix

$$P = X(X^TX)^{-1}X^T$$

$$\hat{y} = PY$$

Residual Maker

$$M = I - P$$

$$e = MY$$

Orthogonality

$$\langle e, X_j \rangle = 0$$

for all predictors

$\hat{y}$ is the closest point in column space to Y

Unifies **Linear Algebra** and **Statistics**