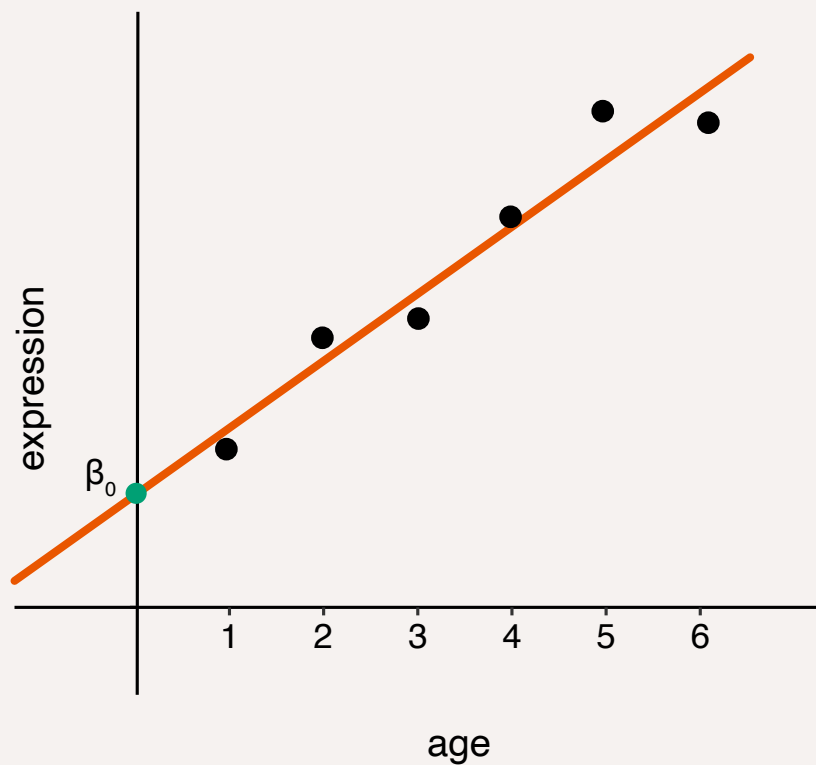**Covariates:** quantitative measurements (e.g. age)

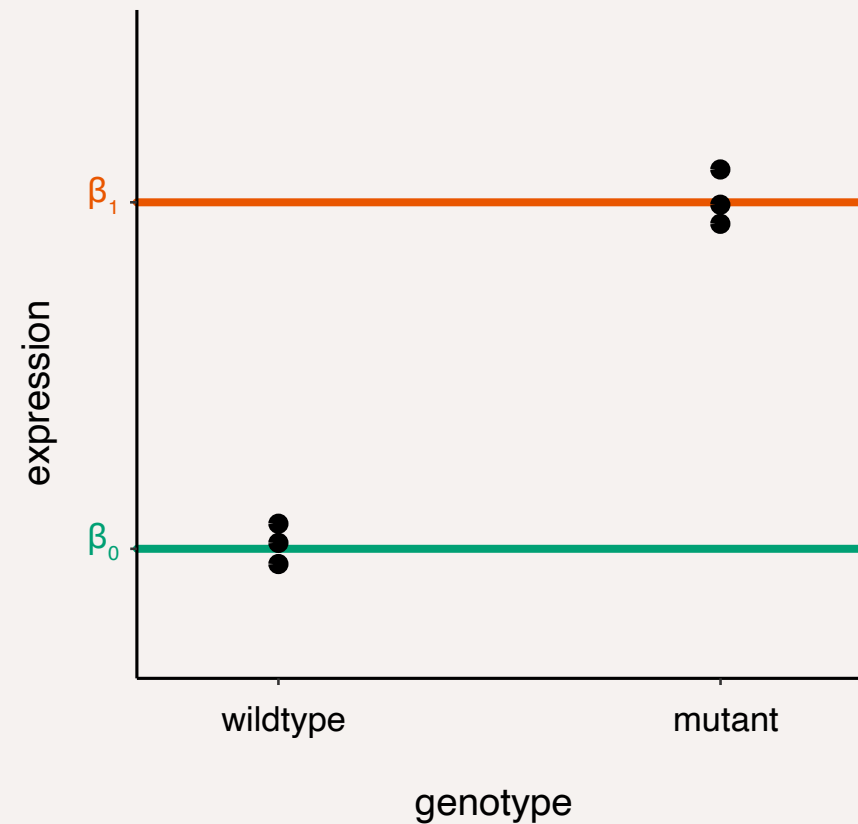**Factors:** categorical variables (e.g. genotype)

Regression model

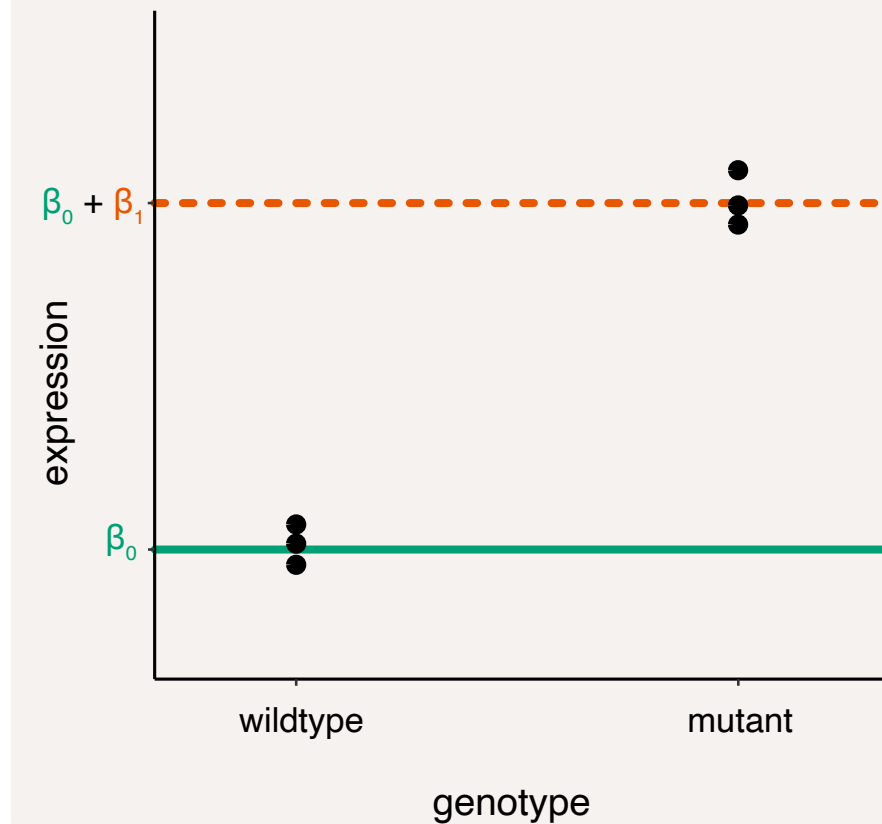$$\text{expression} = \beta_0 + \beta_1 \text{age}$$

Means model

$$\text{expression} = \beta_1 \text{wildtype} + \beta_2 \text{mutant}$$

Mean-reference model

$$\text{expression} = \beta_1 + \beta_2 \text{mutant}$$

Legend

- Original data points

Expected gene expression *(based on model)*

Expected gene expression *(of non-reference levels in mean-reference model)*