An introduction to GAM(M)s

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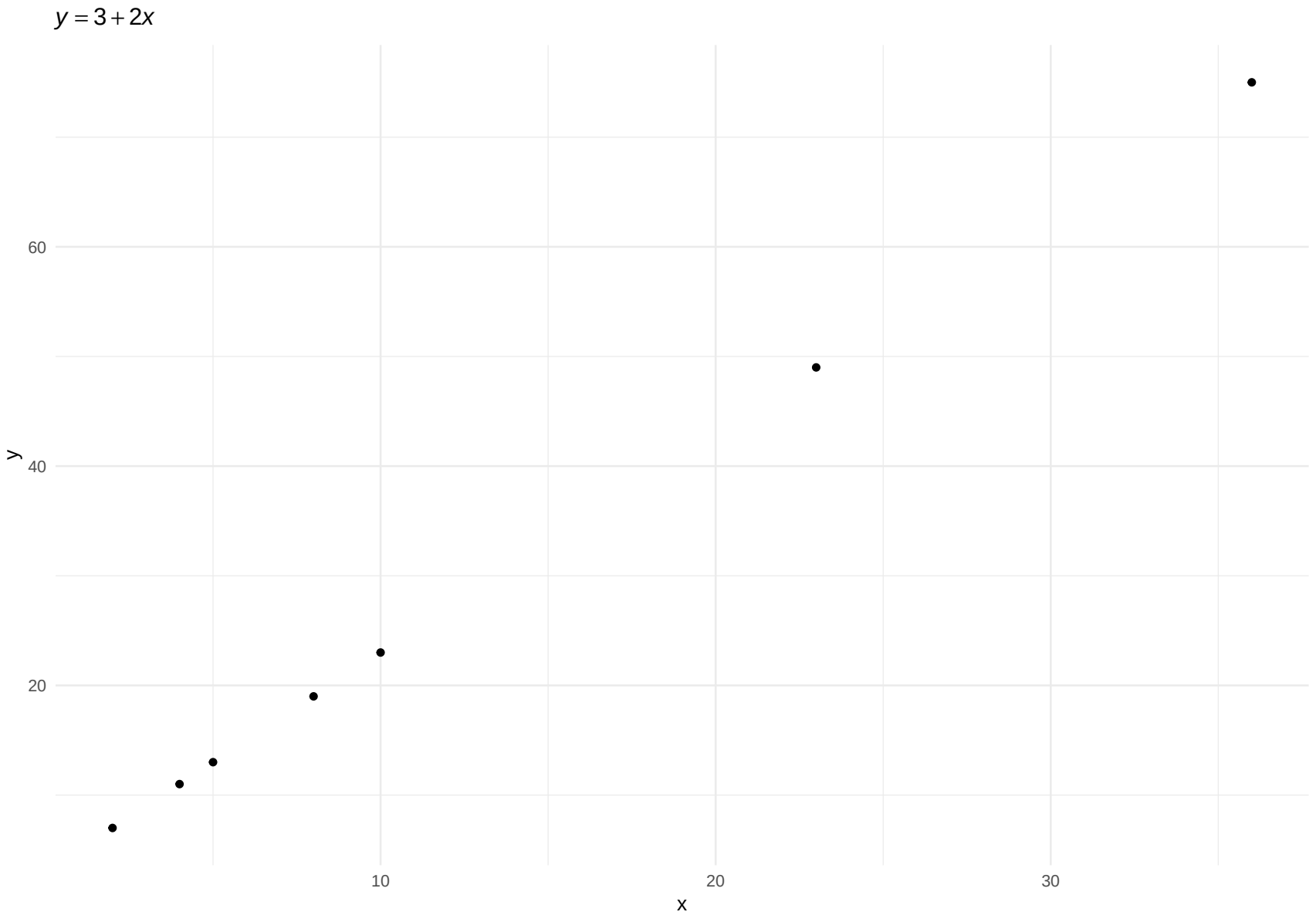
Time travel. . .

Linear models

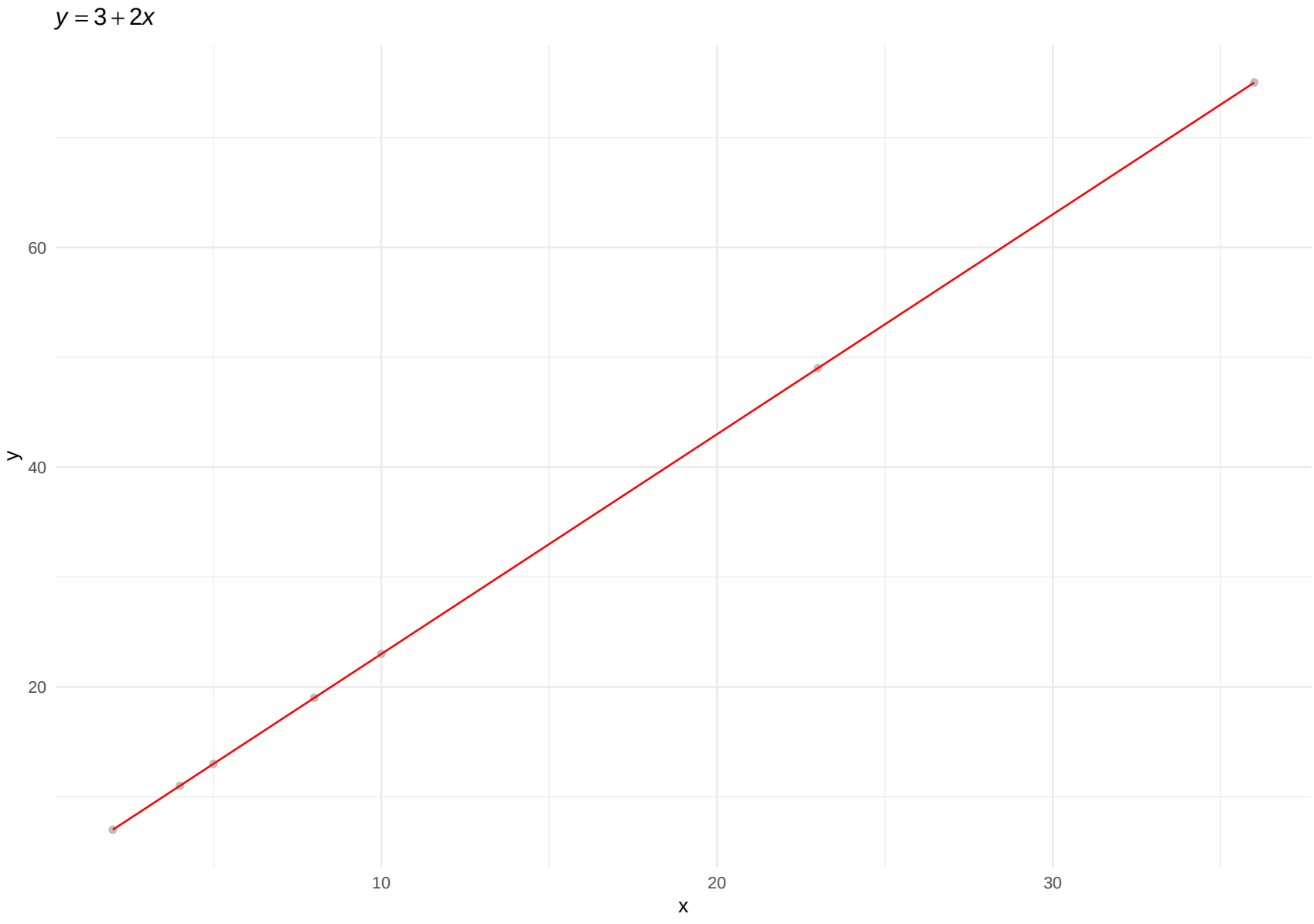
$$y = 3 + 2x$$

where $x = (2, 4, 5, 8, 10, 23, 36)$

Linear models



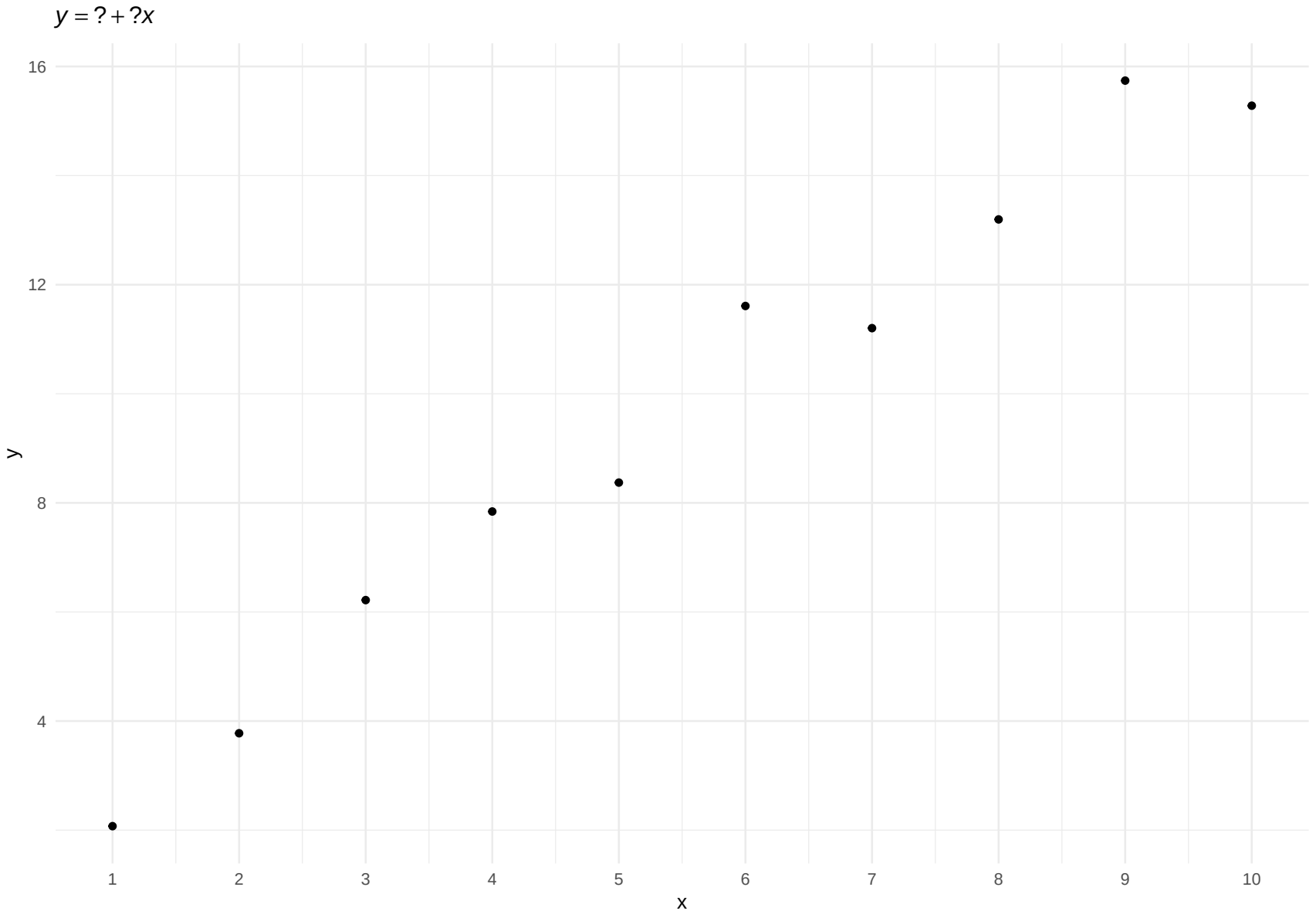
Linear models



Linear models

- In science, we have x and y...
- for example, vowel duration and VOT

Linear models

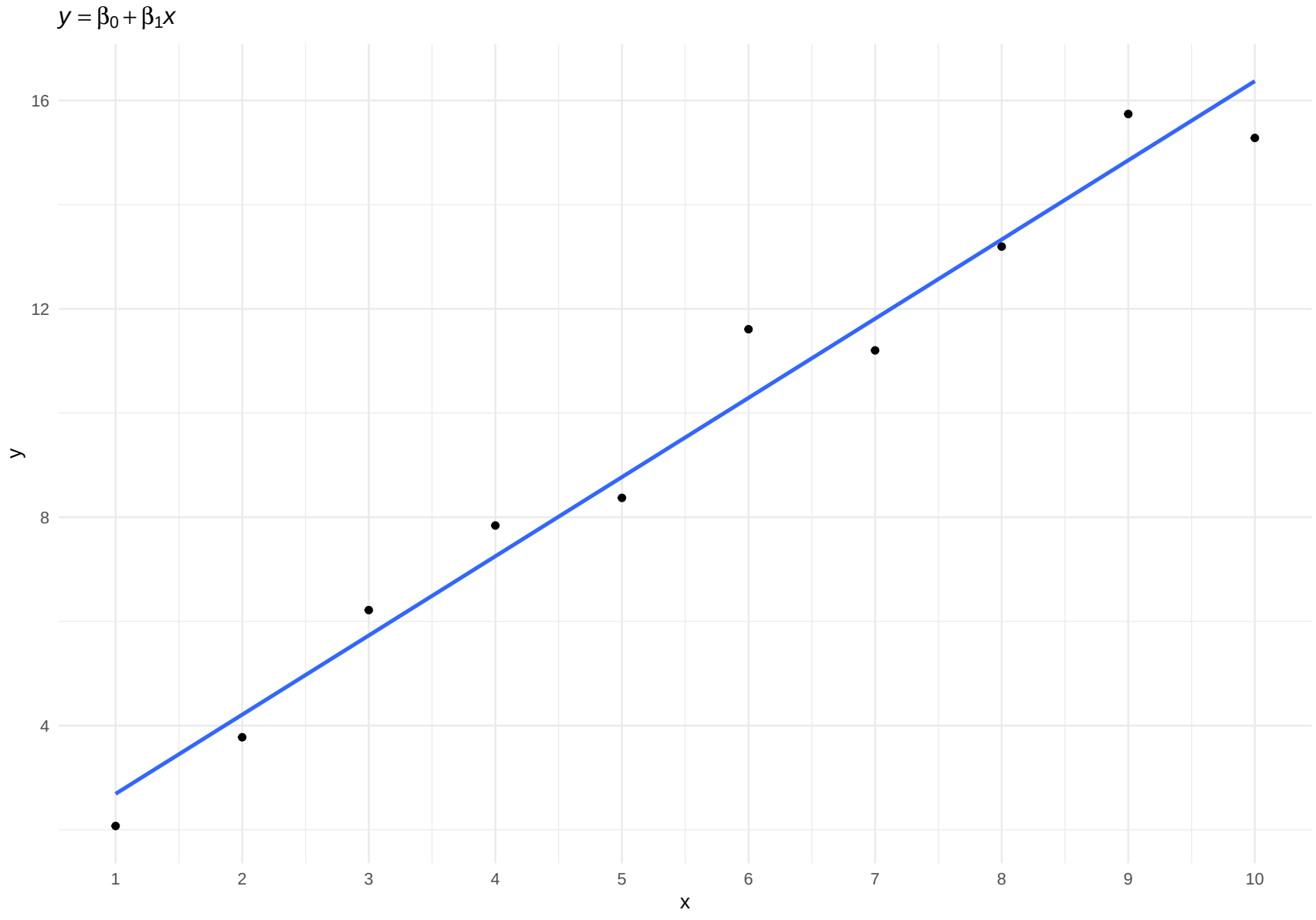


Linear models

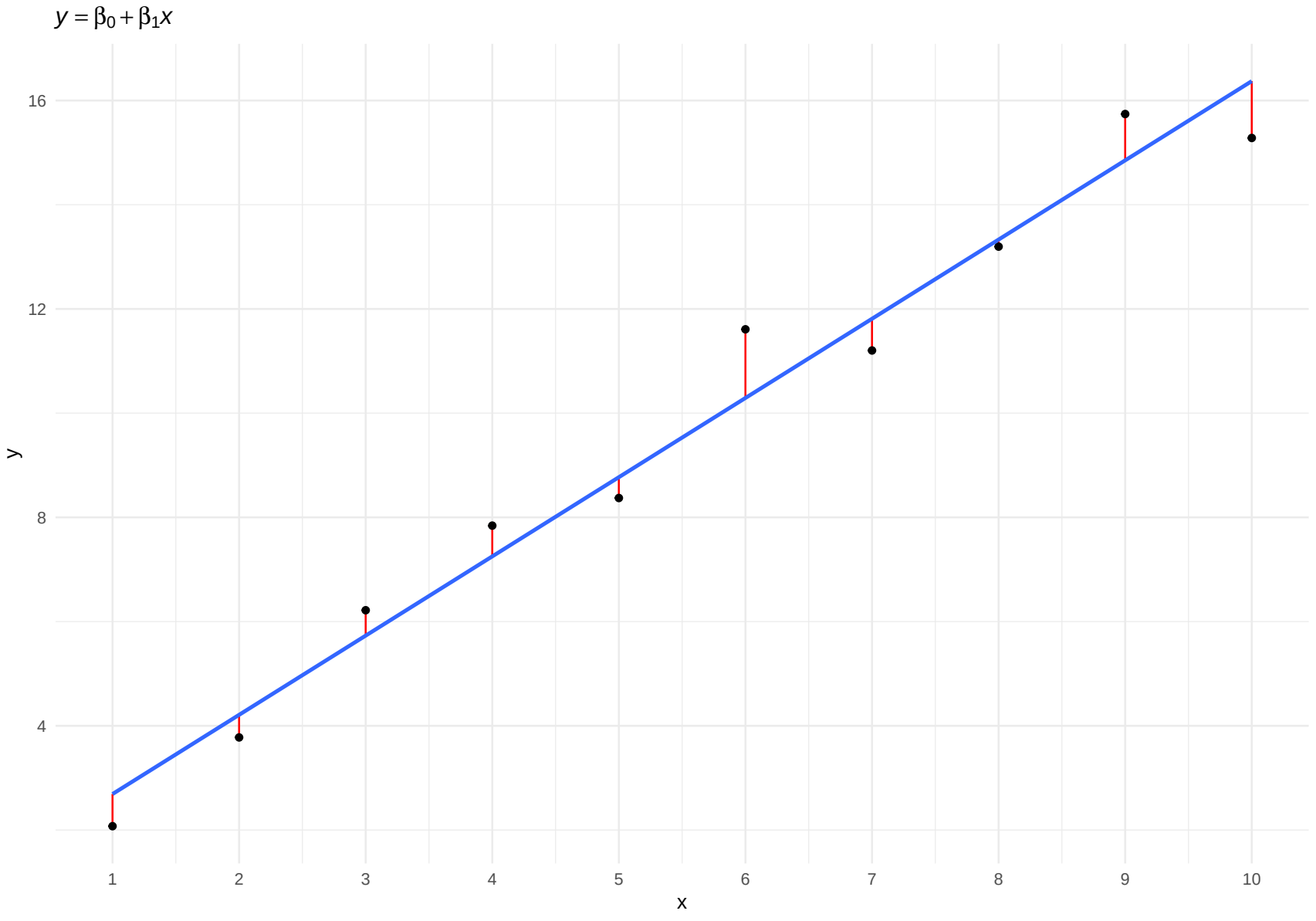
- The formula: $y = \beta_0 + \beta_1 x$
  - β_0 is the **intercept**
  - β_1 is the **slope**
- We know x and y
  - we need to estimate β_0, $\beta_1 = \hat{\beta}_0, \hat{\beta}_1$
- We can add more predictors
  - $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n$
- code in `R`

```
lm(y ~ x, data)
```

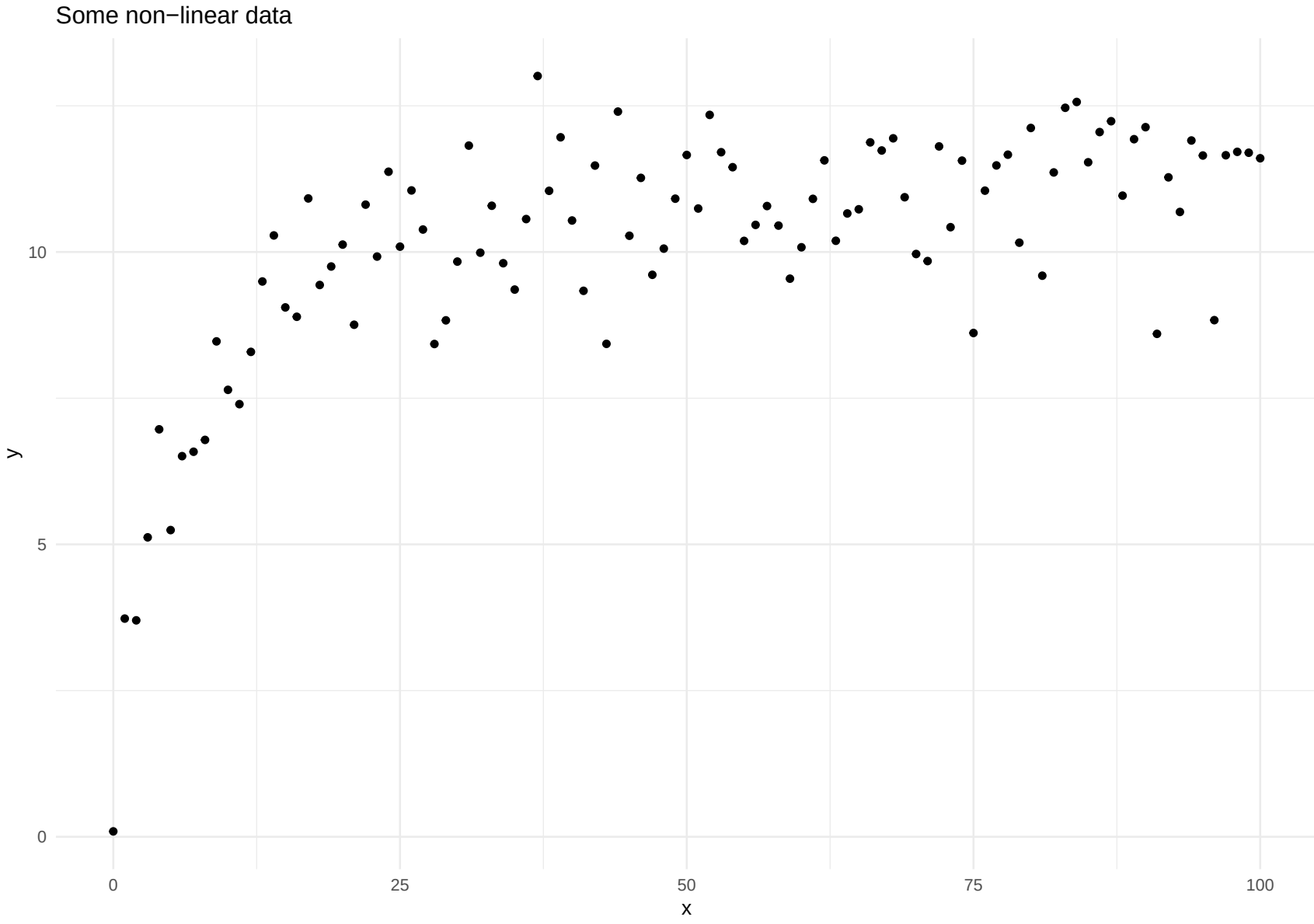
Linear models



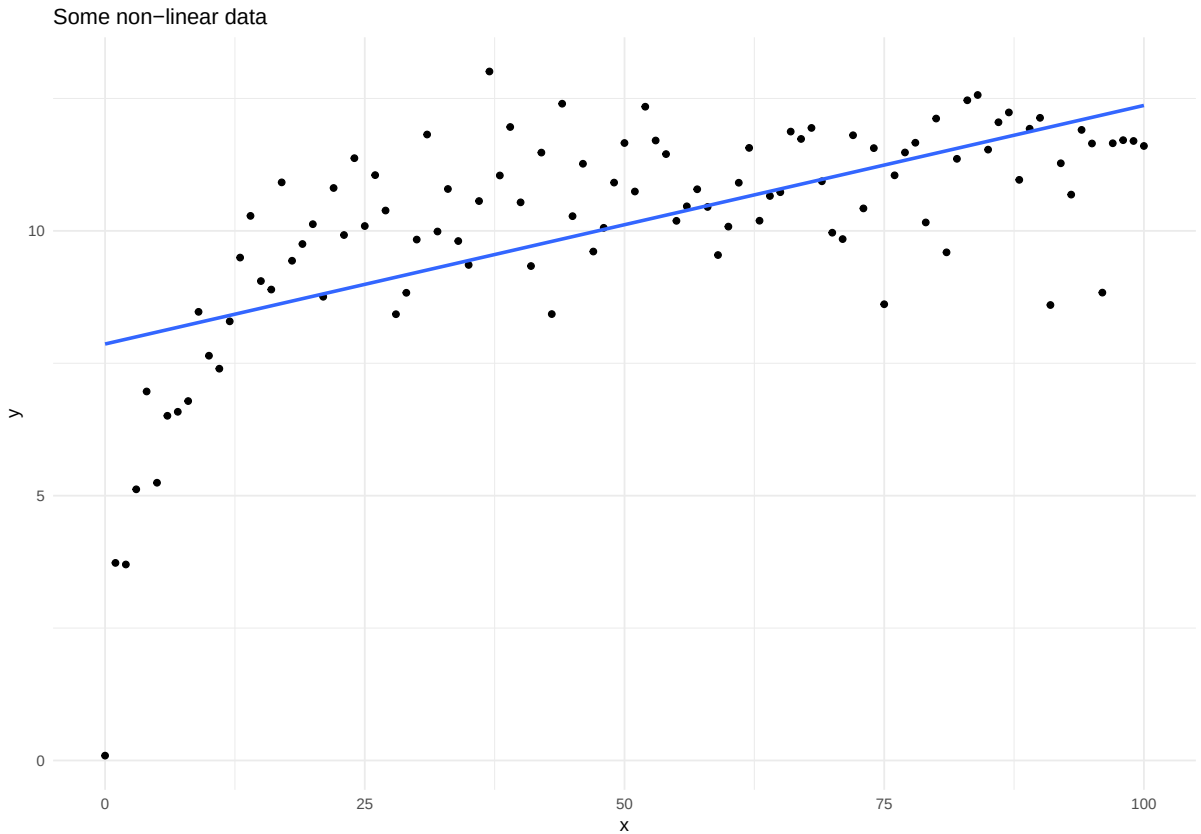
Linear models



Linear models with non-linear data



Linear models with non-linear data

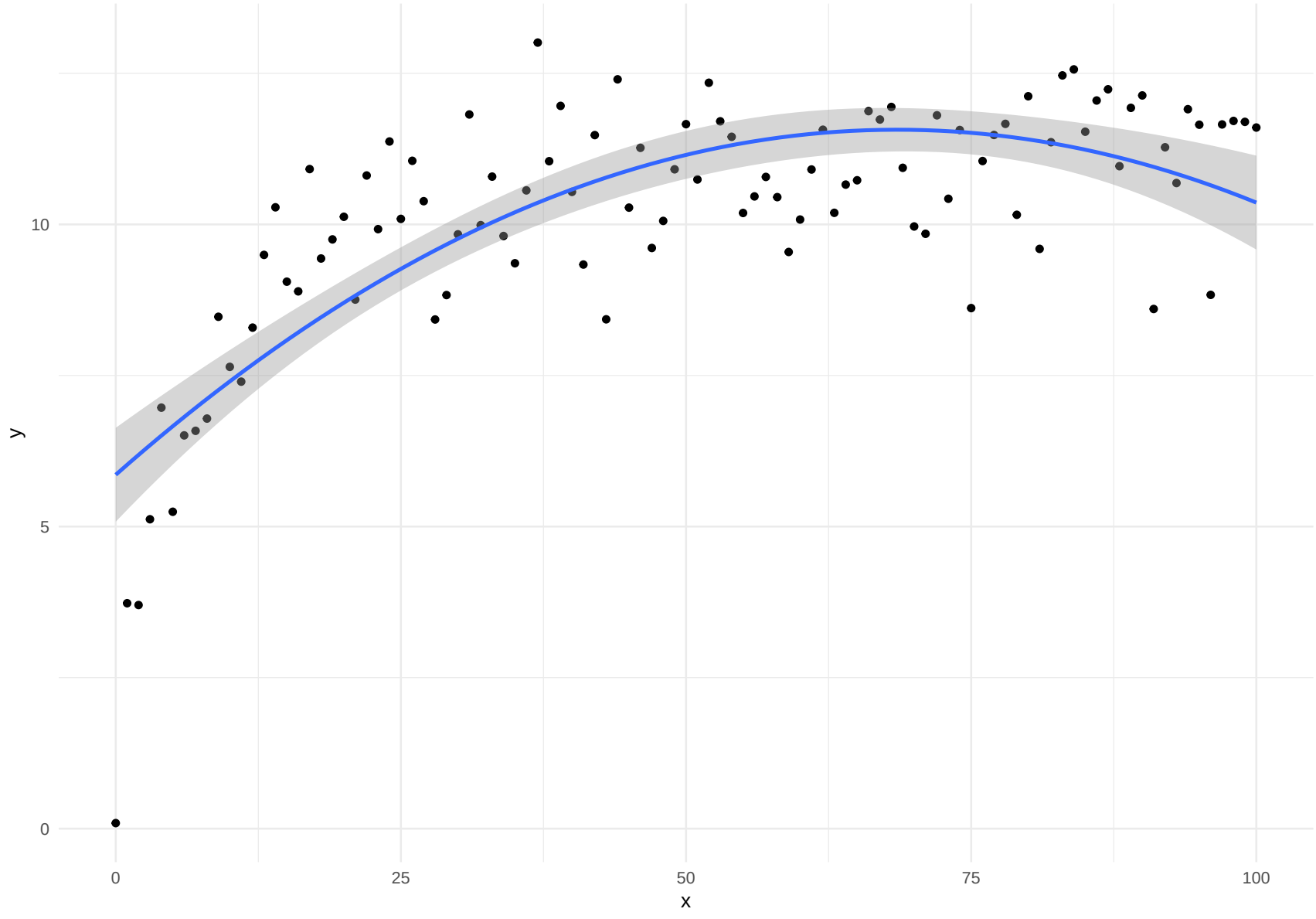


Linear models with non-linear data

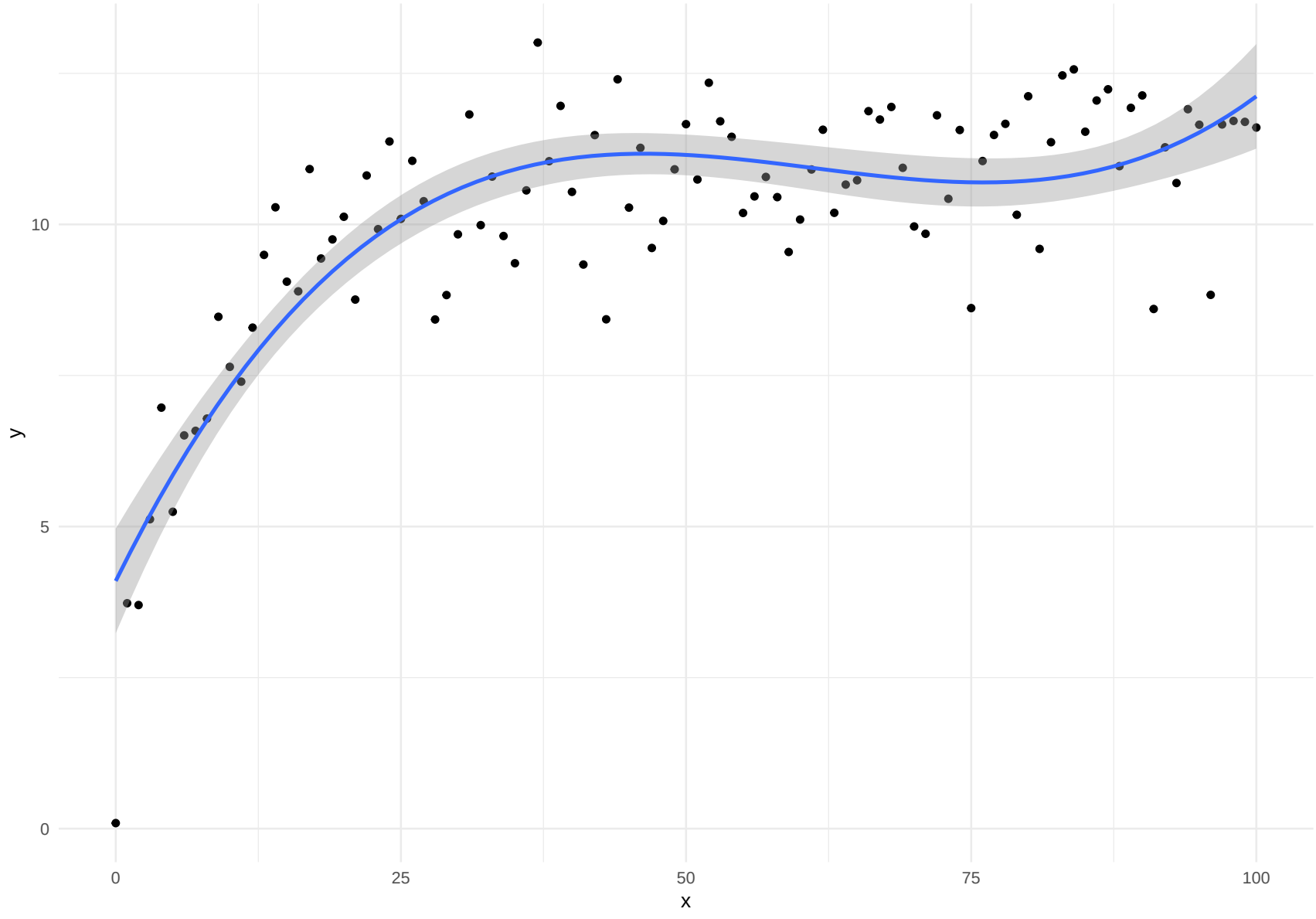
How to account for non-linearity in a linear model?

- Use **higher-degree polynomials**
  - quadratic: $y = \beta_0 + \beta_1 x + \beta_2 x^2$
  - cubic: $y = \beta_0 + \beta_1 x + \beta_2 x^2 + \beta_3 x^3$
  - nth: $y = \beta_0 + \beta_1 x + \beta_2 x^2 + \beta_3 x^3 + ... + \beta_n x^n$

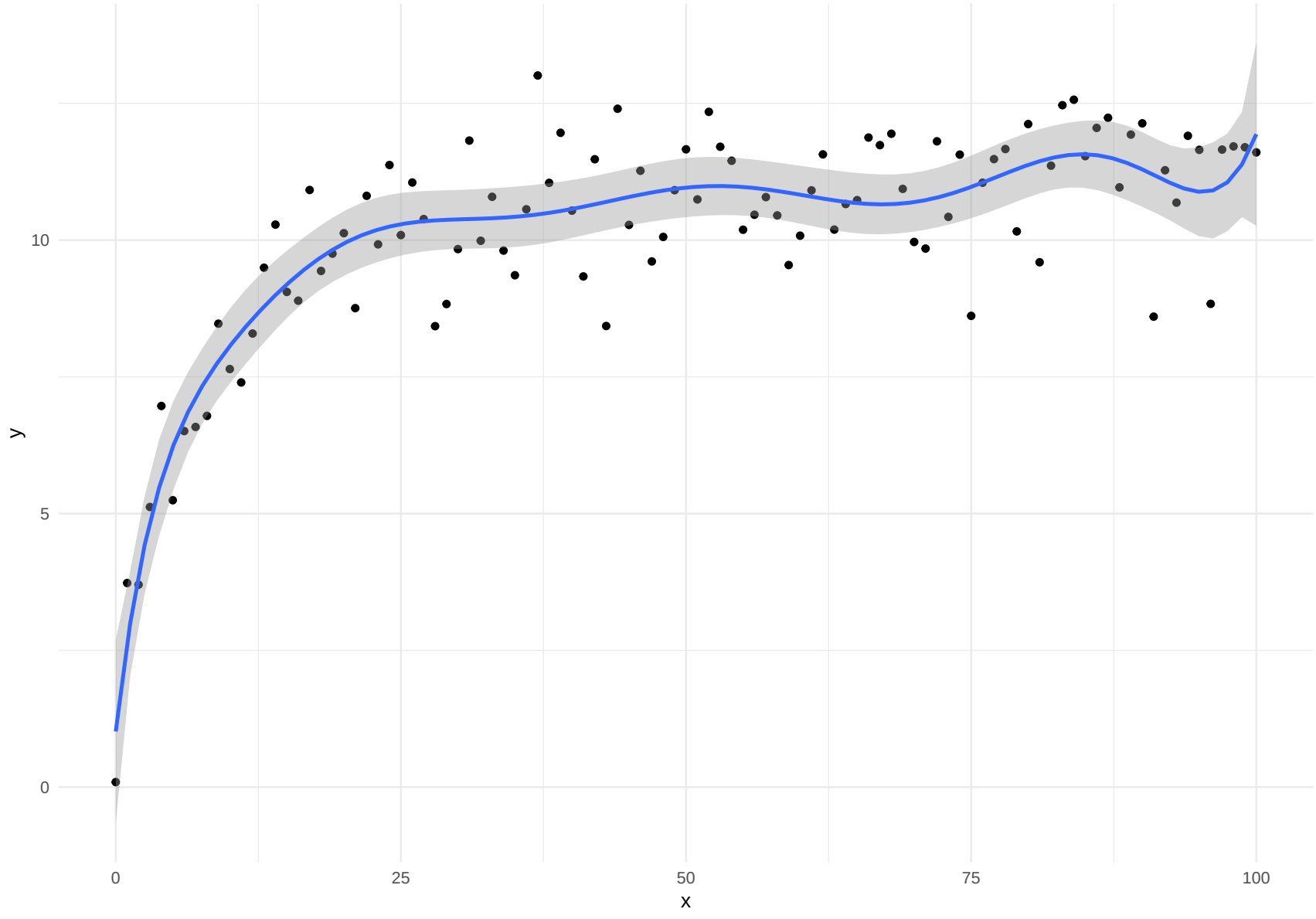
Linear models with non-linear data



Linear models with non-linear data



Linear models with non-linear data



Linear models with non-linear data

- $y = f(x) + \epsilon$
- $f(x) =$ some function of x

Basis functions

- polynomials are a type of basis functions
  - linear regression is the simplest polynomial (degree 1)
- **splines** are another type
  - there are several kinds of splines
  - each with their own basis functions

Generalised additive models

- LMs have parametric terms
  - like βx
- GAMs add smooth terms (or smooths)
  - $\texttt{s}() = f(x)$