Optimization algorithms

- Systematically try all combinations for β_0 and β_1 - Grid search algorithms
- Narrowing in - keep changing parameters in the direction that leads to lower SSQ - Descent algorithms
- Try random values for β_0 and β_1 - Monte Carlo algorithms
- Solve for parameters using math - Analytical or numerical algorithms

Optimization algorithms

- Systematically try all combinations for β_0 and β_1 - Grid search algorithms
- Narrowing in - keep changing parameters in the direction that leads to lower SSQ - Descent algorithms
- Try random values for β_0 and β_1 - Monte Carlo algorithms
- Solve for parameters using math - Analytical or numerical algorithms

Descent algorithms are ubiquitous and dependable

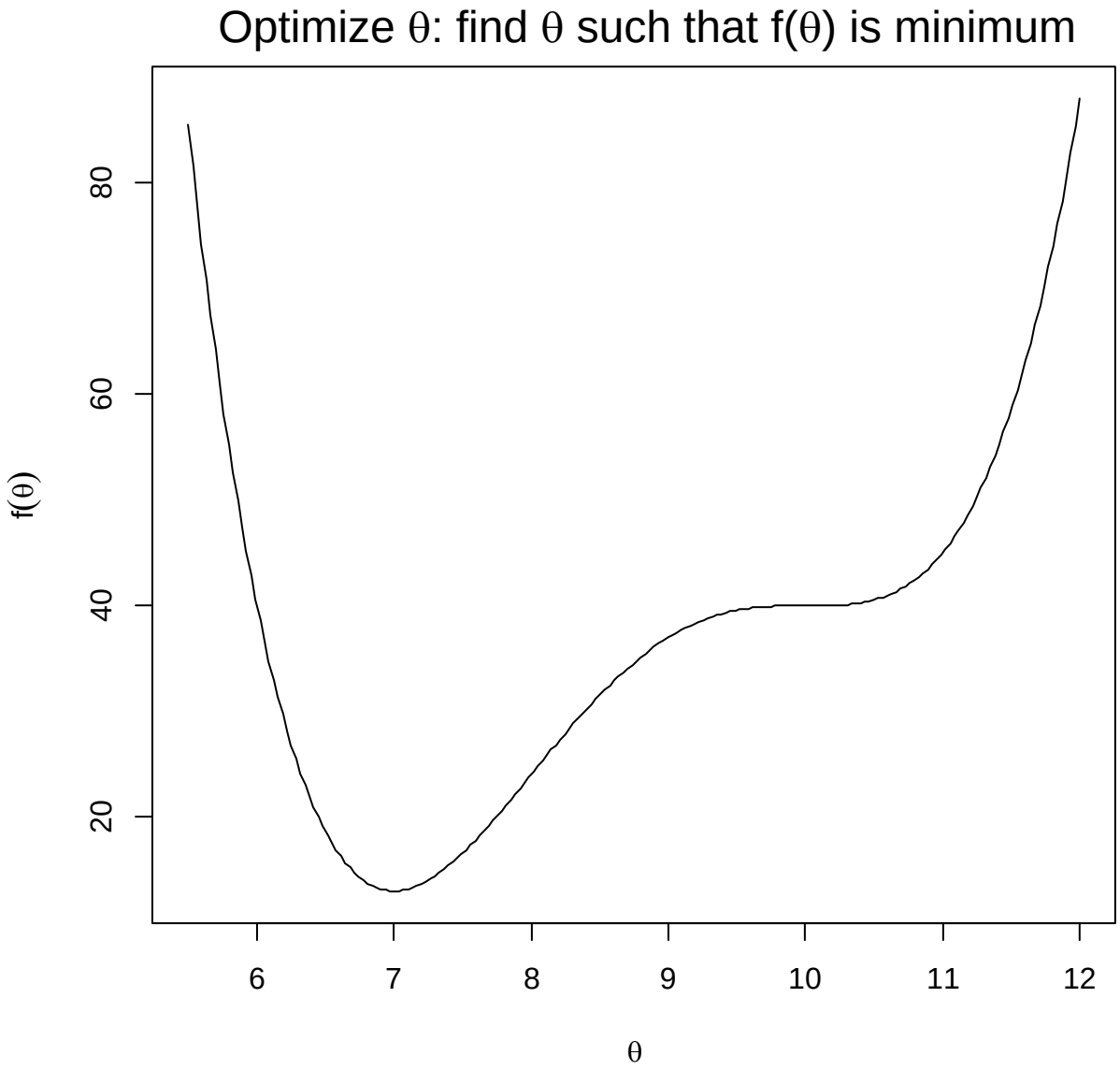
optim() ?optim for more info and references

Nelder-Mead simplex algorithm

BFGS algorithm

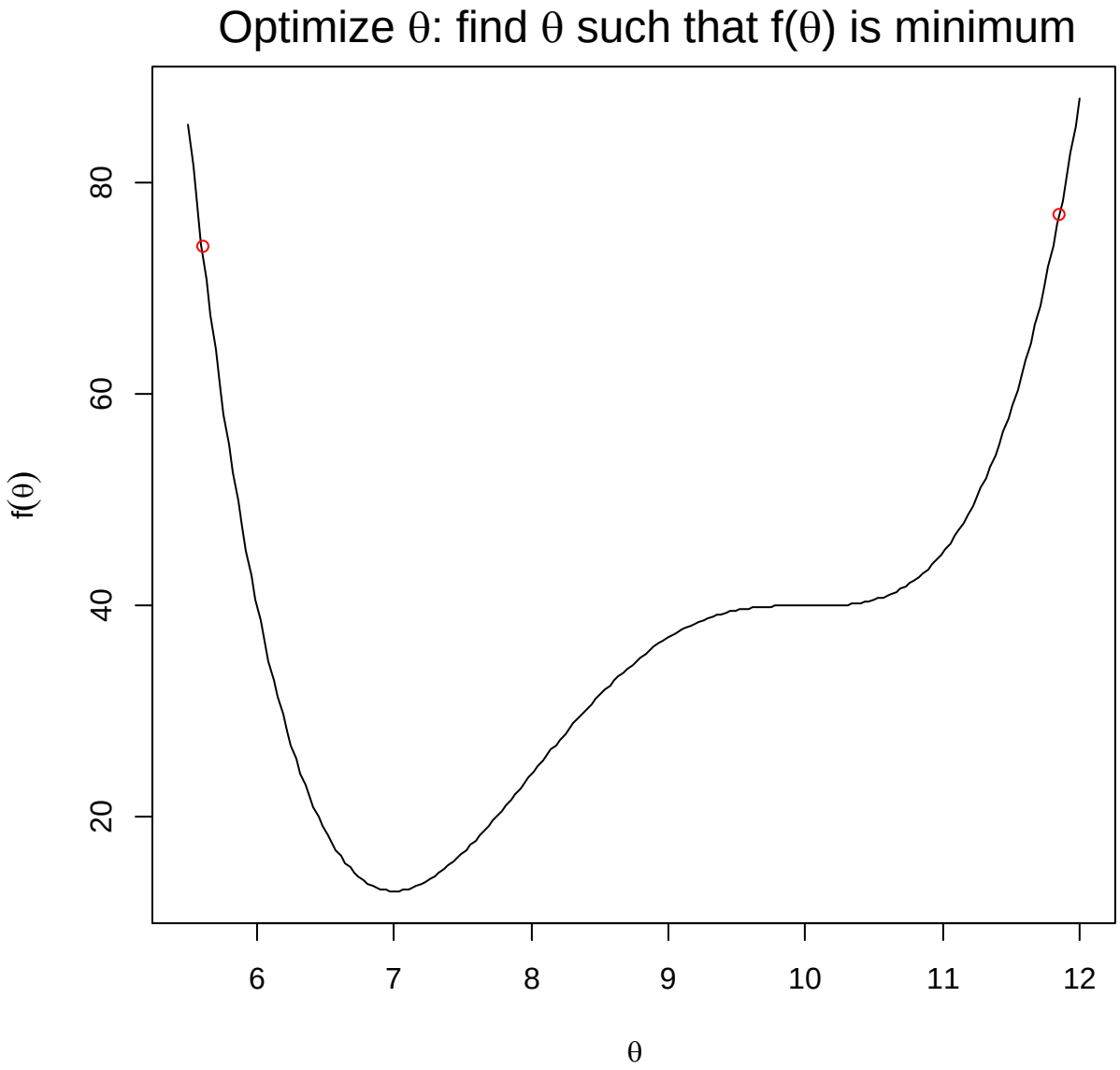
} e.g. lme4 (lmer, glmer)

A feel for descent algorithms



Bisection algorithm

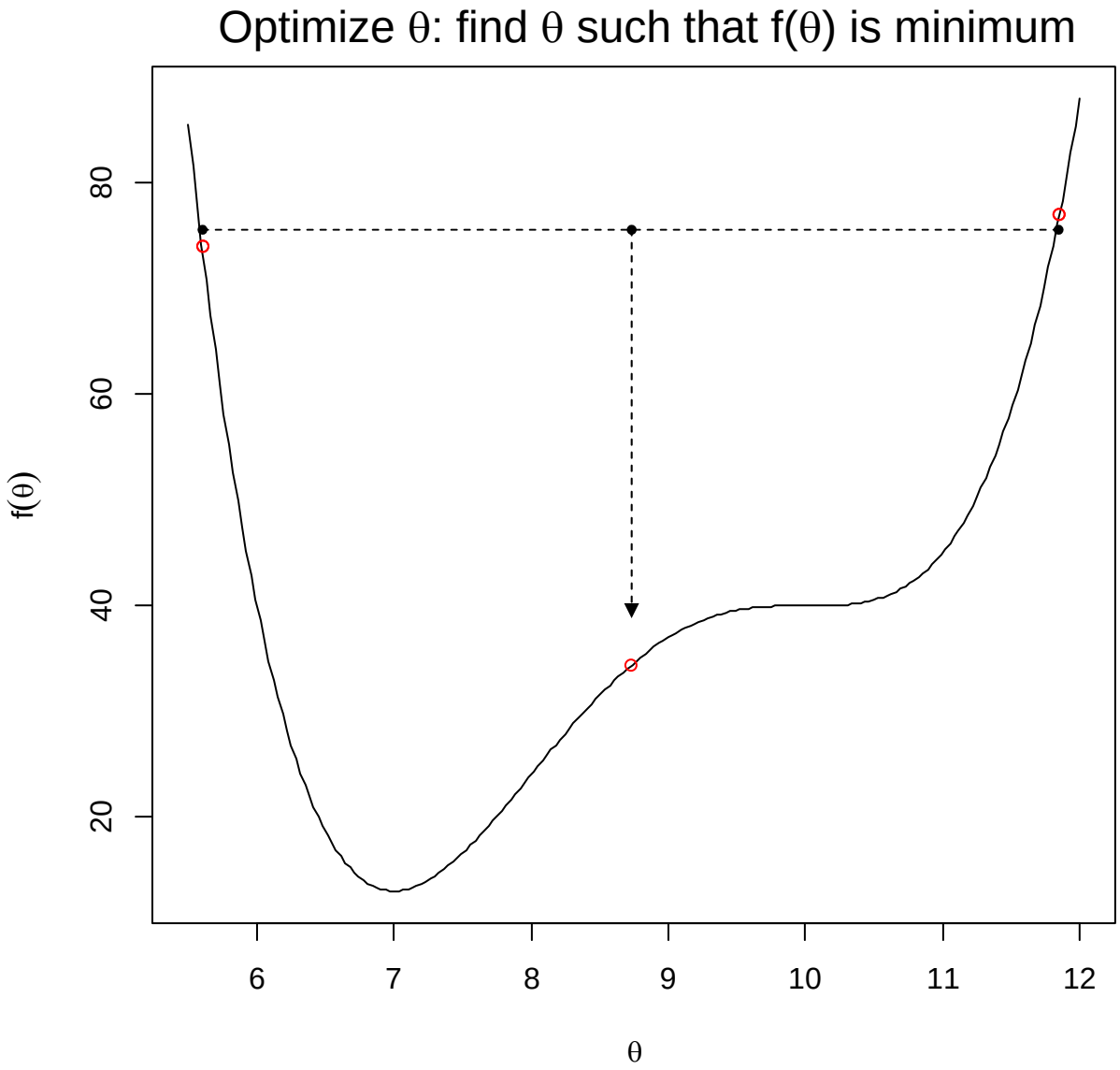
A feel for descent algorithms



Bisection algorithm

Start with 2 points

A feel for descent algorithms

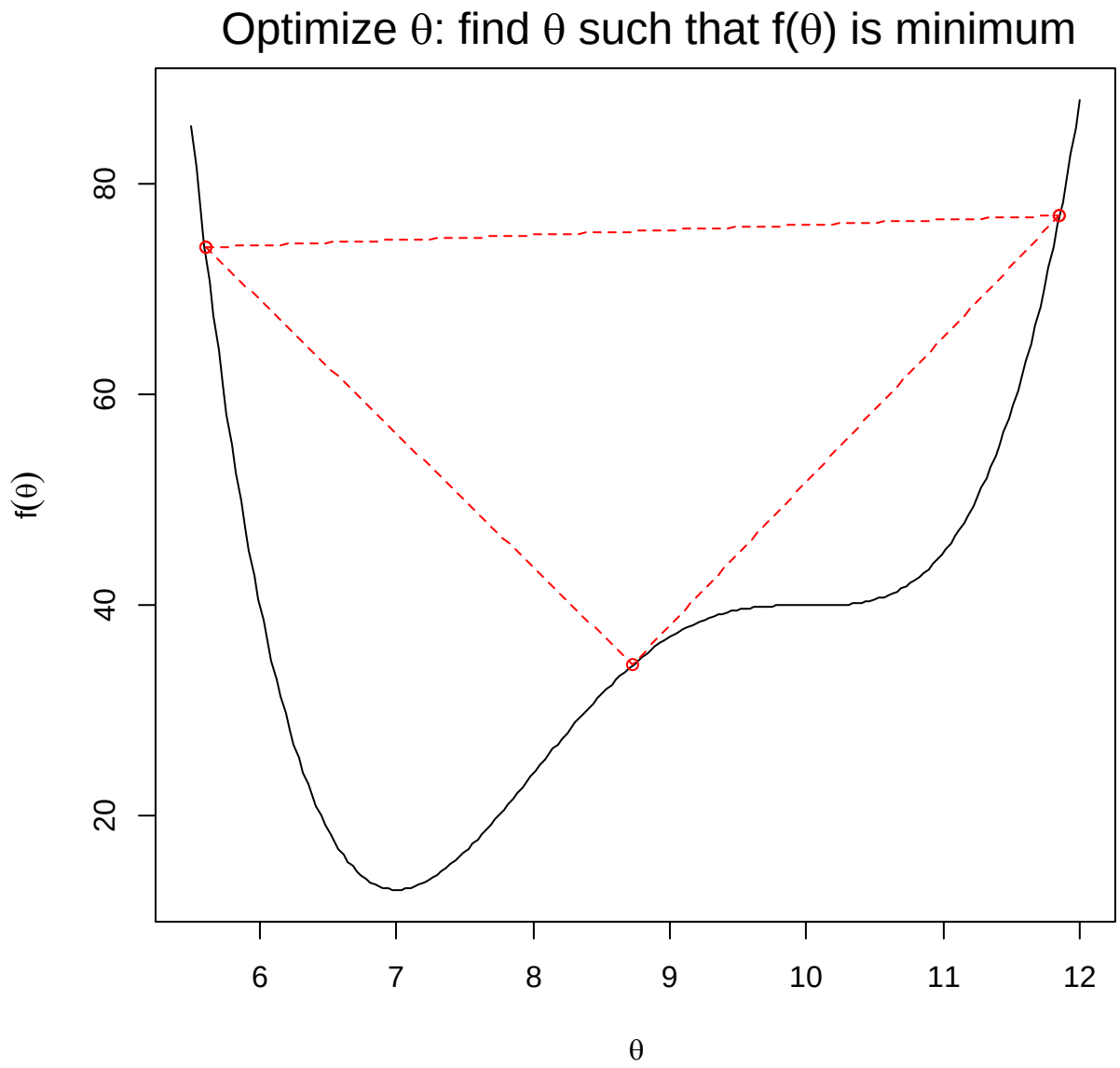


Bisection algorithm

Start with 2 points

Bisect

A feel for descent algorithms



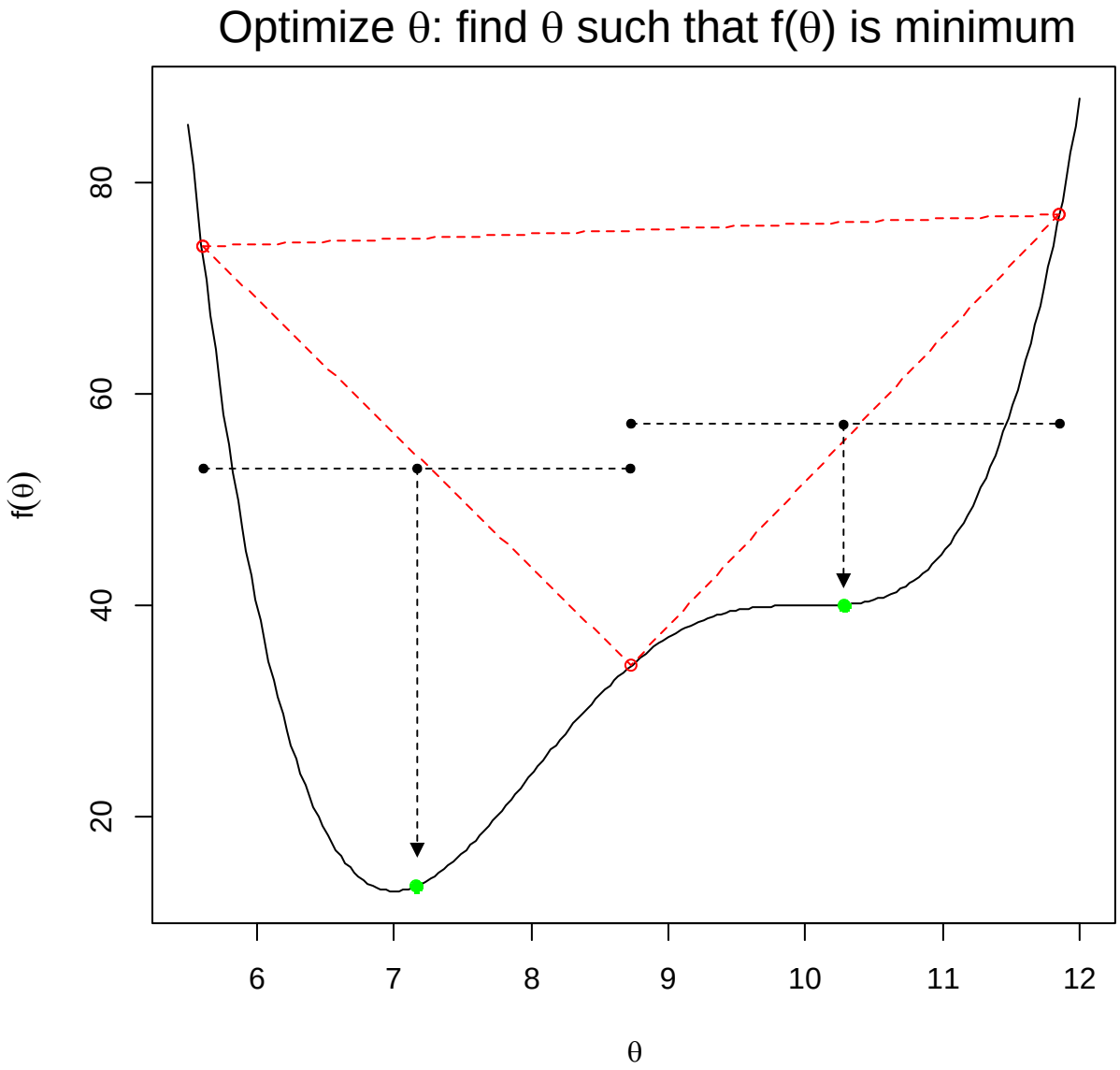
Bisection algorithm

Start with 2 points

Bisect

Make triangle

A feel for descent algorithms



Bisection algorithm

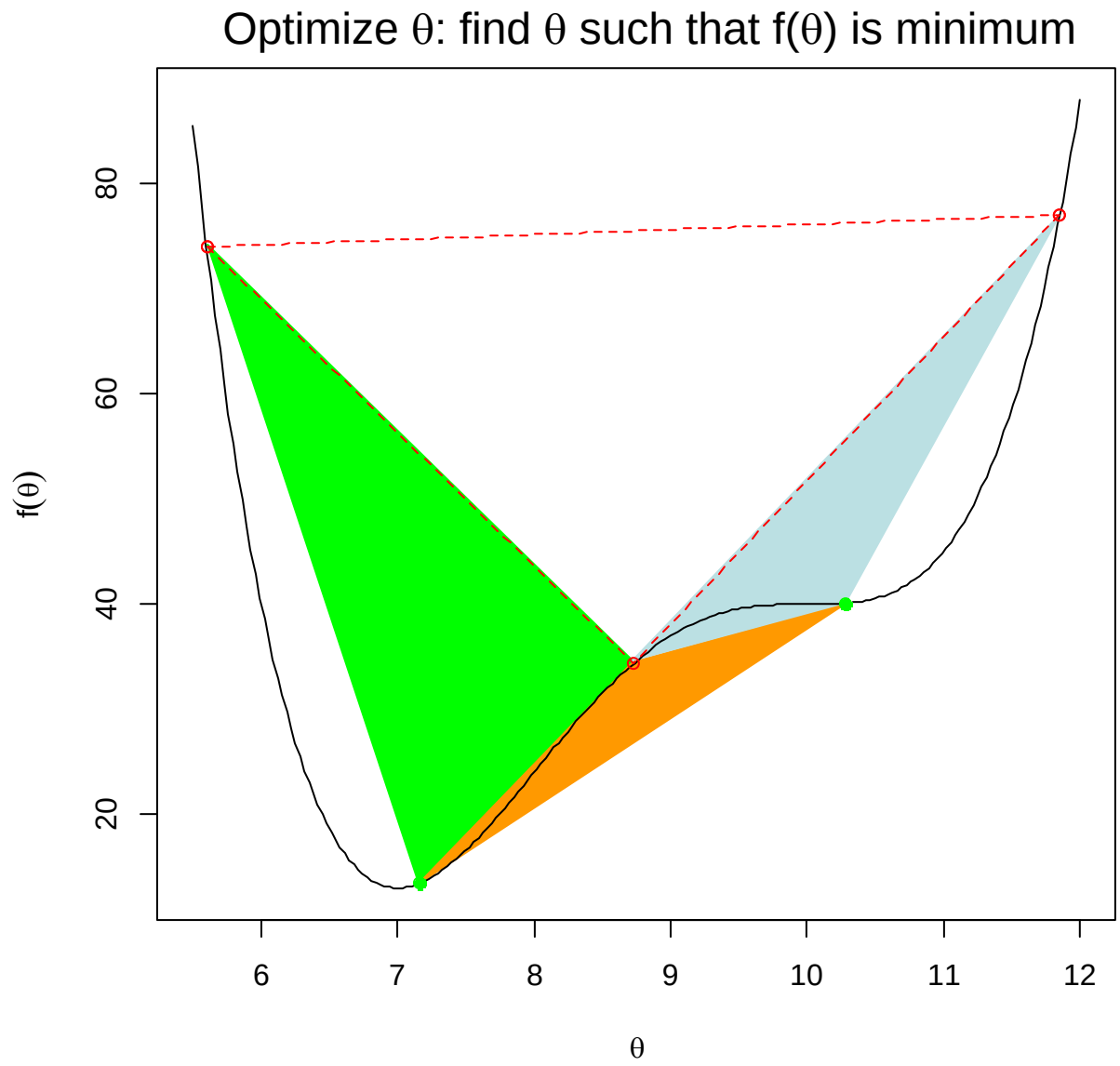
Start with 2 points

Bisect

Make triangle

Bisect lower sides

A feel for descent algorithms



Bisection algorithm

Start with 2 points

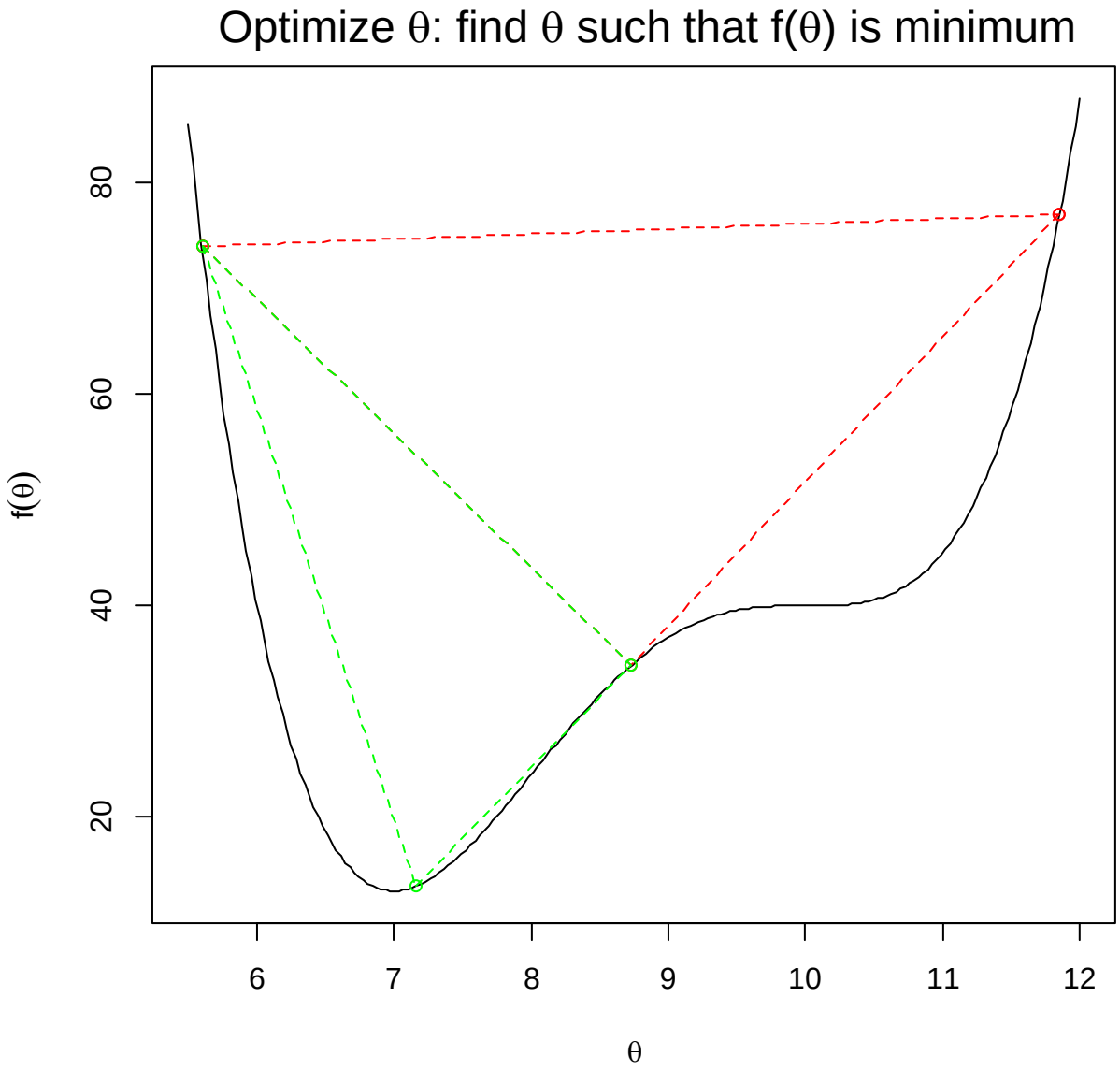
Bisect

Make triangle

Bisect lower sides

Make lowest triangle

A feel for descent algorithms



Bisection algorithm

Start with 2 points

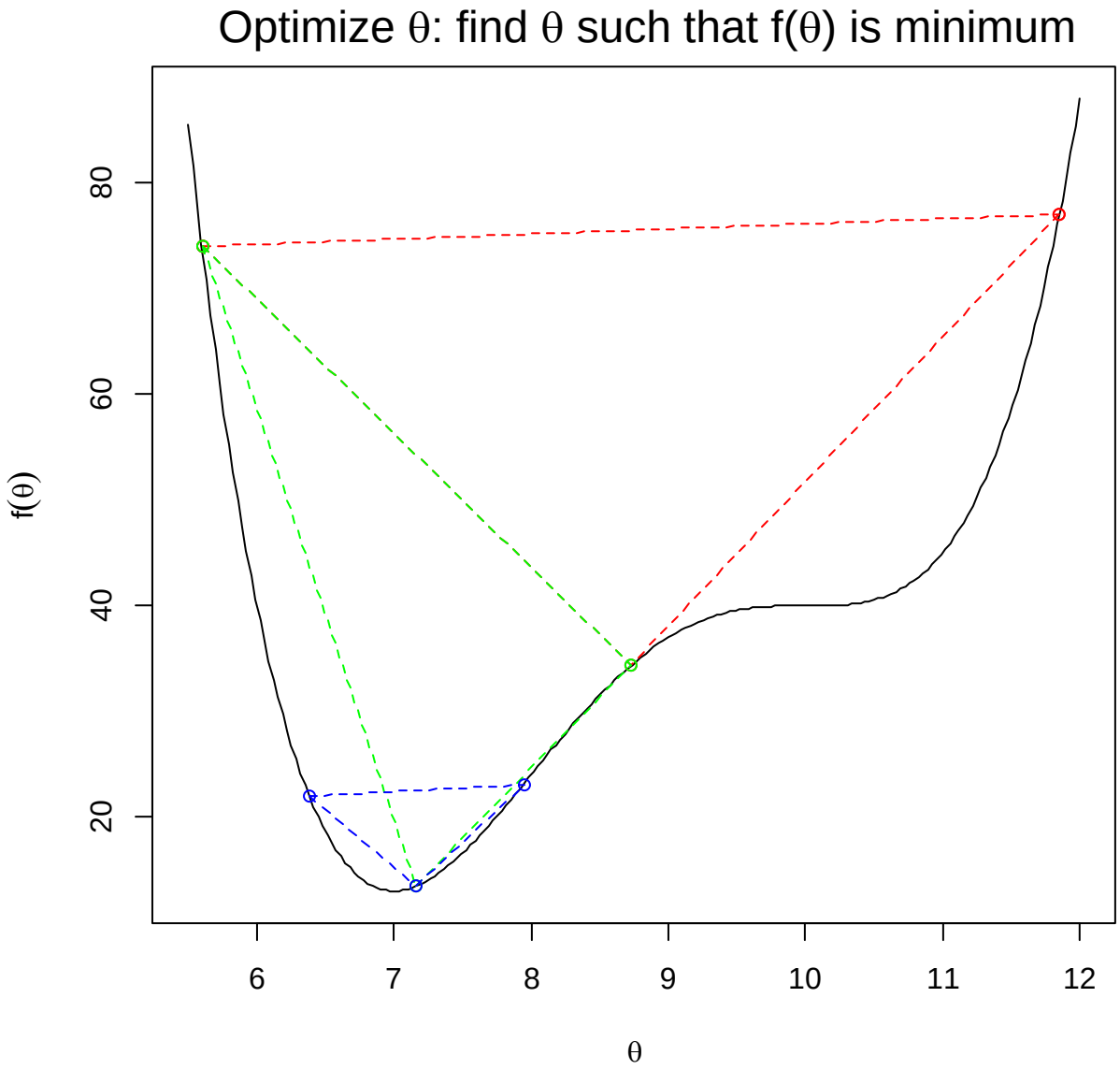
Bisect

Make triangle

Bisect lower sides

Make lowest triangle

A feel for descent algorithms



Bisection algorithm

Start with 2 points

Bisect

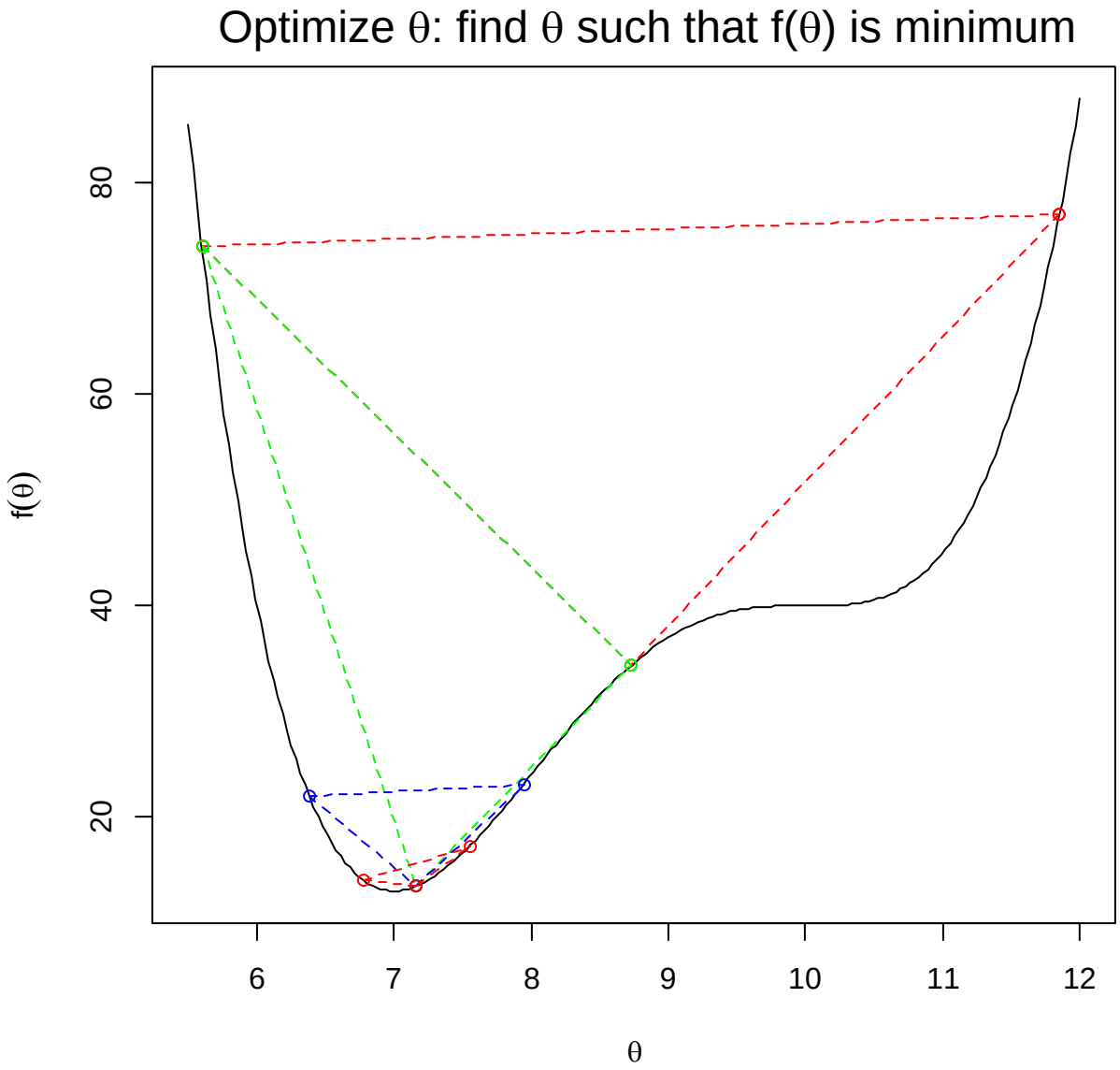
Make triangle

Bisect lower sides

Make lowest triangle

Keep repeating

A feel for descent algorithms



Bisection algorithm

Start with 2 points

Bisect

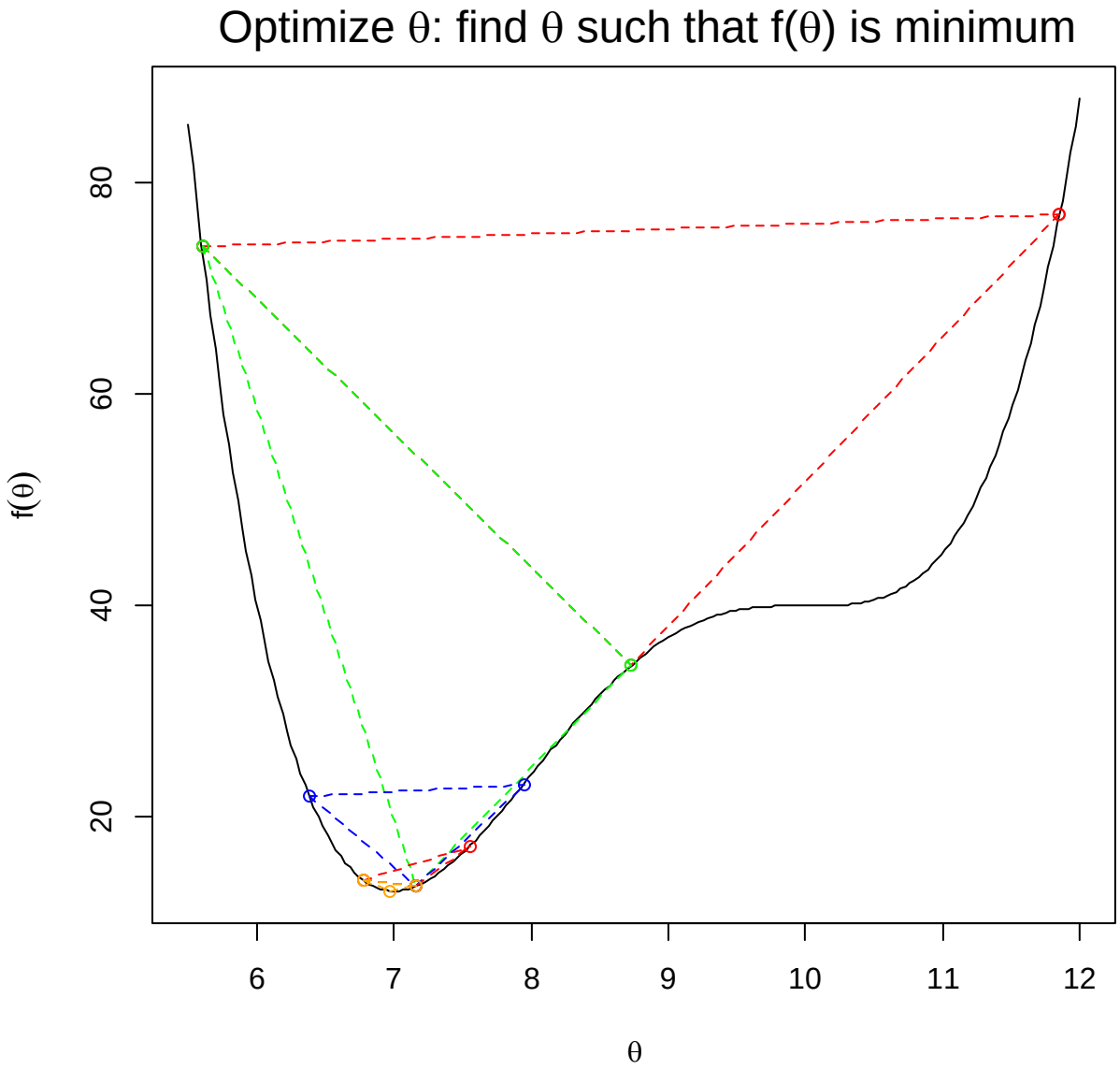
Make triangle

Bisect lower sides

Make lowest triangle

Keep repeating

A feel for descent algorithms



Bisection algorithm

Start with 2 points

Bisect

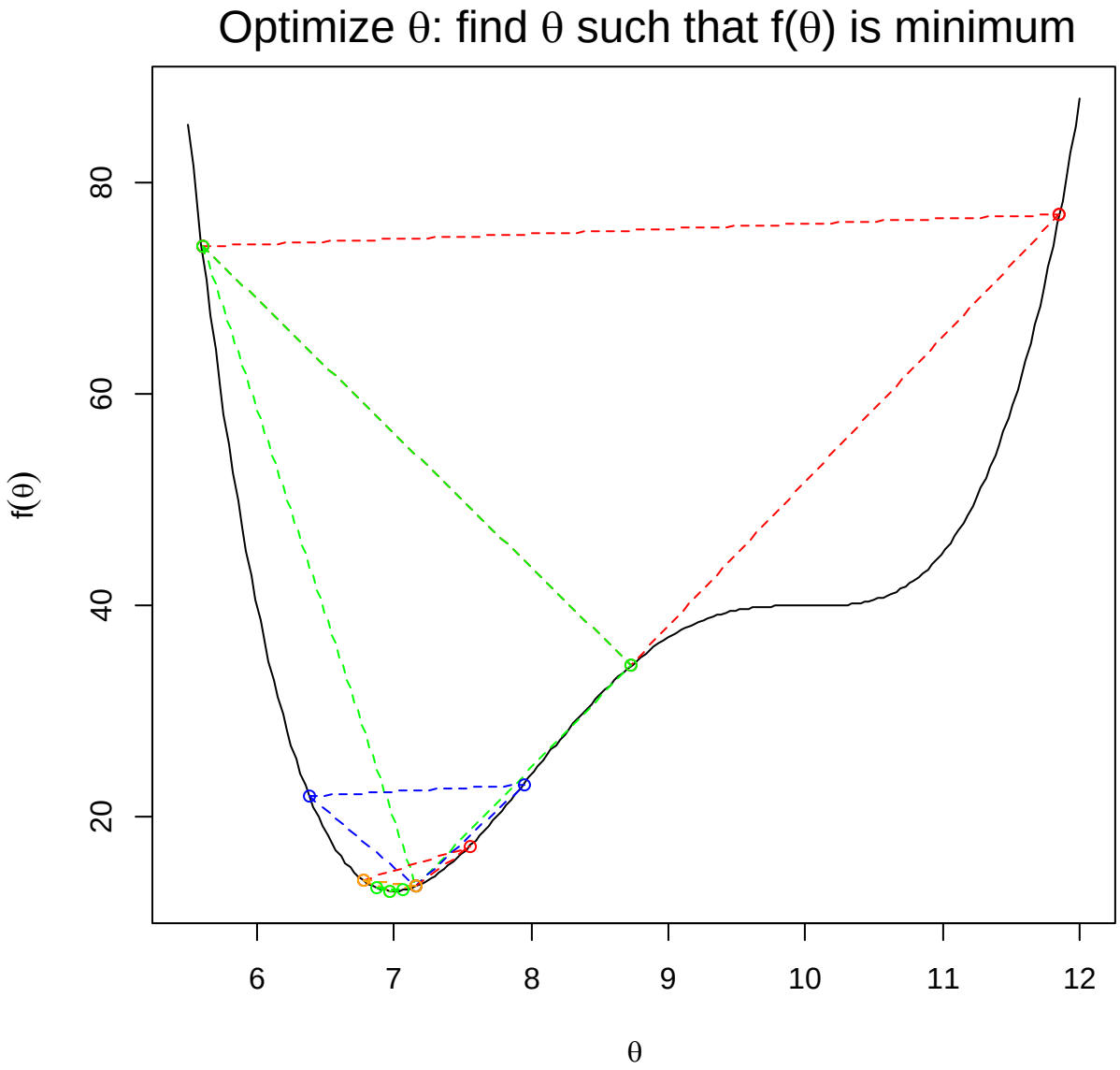
Make triangle

Bisect lower sides

Make lowest triangle

Keep repeating

A feel for descent algorithms



Bisection algorithm

Start with 2 points

Bisect

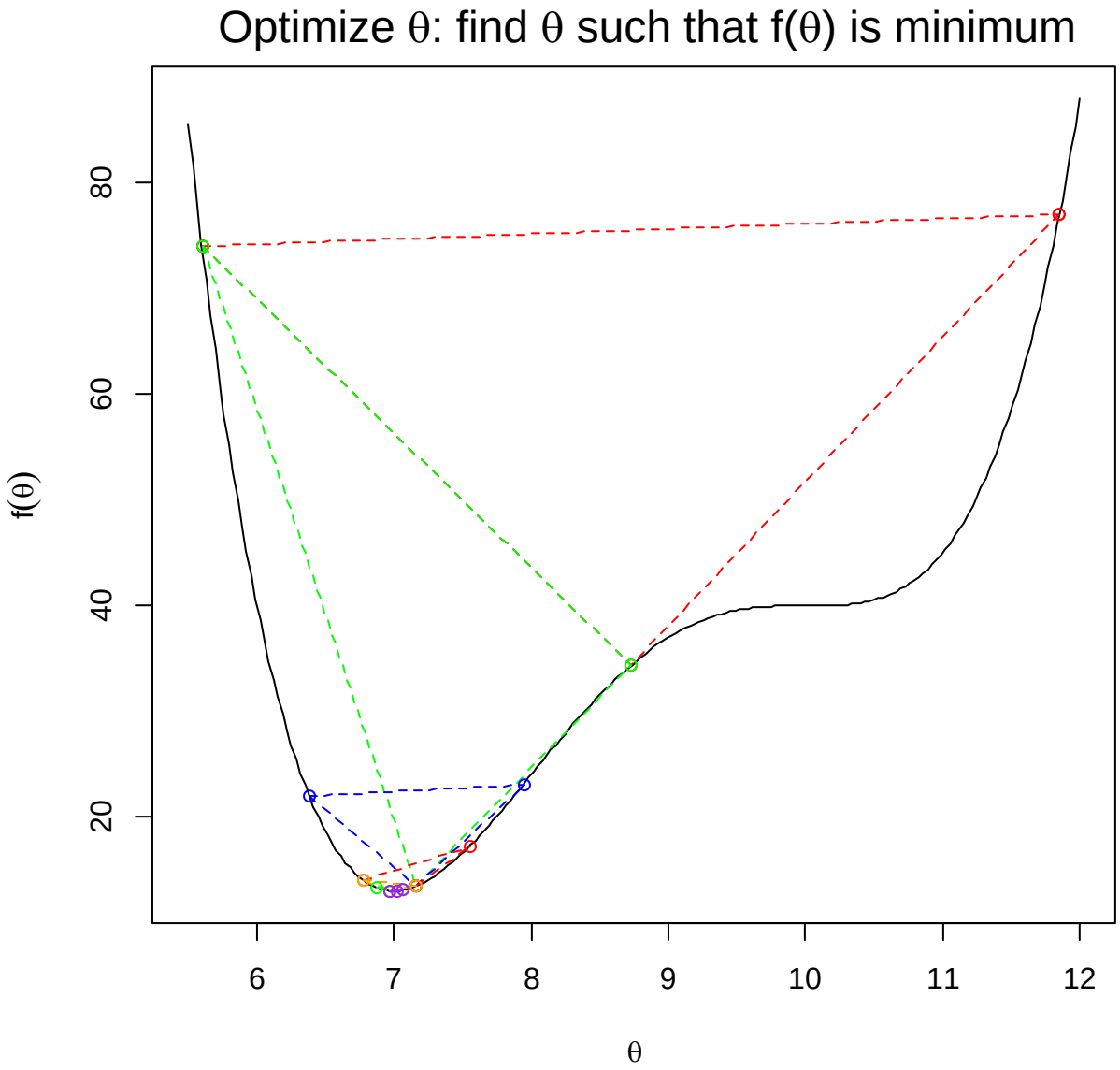
Make triangle

Bisect lower sides

Make lowest triangle

Keep repeating

A feel for descent algorithms



Bisection algorithm

Start with 2 points

Bisect

Make triangle

Bisect lower sides

Make lowest triangle

Keep repeating

Nelder-Mead algorithm

- Has a similar flavor to the bisection algorithm
- Instead of triangles, has a generalized shape called a simplex that tumbles down into the basin
- Quite robust. Good option to try first in many optimization problems.

Descent algorithms

- Not guaranteed to find the global optimum (might find a local optimum)
- Might not converge (might not get all the way to the optimum)

Optimization algorithms

- Systematically try all combinations for β_0 and β_1 - Grid search algorithms
- Narrowing in - keep changing parameters in the direction that leads to lower SSQ - Descent algorithms
- Try random values for β_0 and β_1 - Monte Carlo algorithms
- Solve for parameters using math - Analytical or numerical algorithms

What does R do for linear regression?
lm(y~x) solves a system of linear equations using linear algebra
Mathematical theory shows what to do (QR decomposition)
Numerical algorithm is needed to do it (householder algorithm)
Fast, guaranteed to find the minimum SSQ
Only works for SSQ: limited to ordinary linear regression

Optimization methods

- Bolker (2008). Ecological Models and Data in R. Princeton University Press.
- Chapter 7