This is an example of a factorial design used to optimize the yield of a chemical reaction based on two independent variables: time and temperature. The example and data are from the book Design and Analysis of Experiments, Douglas C. Montgomery, and I do the code implementation on R and graph creation.

Problem description:

“A chemical engineer is interested in determining the operating conditions that maximize the yield of a process. Two controllable variables influence process yield: reaction time and reaction temperature. The engineer is currently operating the process with a reaction time of 35 minutes and a temperature of 155∘F, which results in yields of around 40 percent. Because it is unlikely that this region contains the optimum, she fits a first-order model and applies the steepest ascent method.”

1° step

checking the plausibility of quadratic fitting for the first trial experiment, fig 1A-B

2° step

Based on the angular coefficient of the line provided by the first trial experiment (using x1 and x2 coefficient of effect) I used the steepest ascent method to walk towards the optimum region. This coefficient provides the fastest direction where the yield grows. The technique showed step 10 (x1) as the highest yield, fig 2A.

3° step

In the region where the yield is maximized based on the steepest ascent of the trial experiment (step 10 fig 2A). It’s performed regression using interaction and quadratic terms on this vicinity. This analysis showed that we are near the optimum region, as the curvature of the contour graph demonstrated, fig 3A-B.