Homework 1, Part 1

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Note: I have included the solutions to parts 2-5 here. Problem 6 will be in another document.

Problem 2

Comparison

For this simple function, the solutions and times are found in table 1 below.

When using the same number of pulls of the MC as points in the quadrature methods, the quadrature methods perform better. However, it would be very easy to increase the accuracy of the Monte Carlo method by upping the number of pulls without increasing the time very much. For more difficult functions with more inputs, the quadrature methods become more costly in terms of time as the function needs to be computed multiple times.

Problem 3

Comparison

The solutions and times are found in table 2 below.

While all 4 methods found the correct solution, conjugate descent proved to be the fastest in terms of time while Newton-Raphson required the smallest number of iterations. However, in calculating each of these, I was able to create a function to find the gradient and the hessian without needing to use any of the derivation methods. If there wasn't an analytical solution for the derivatives, it is likely that either BFGS or Newton-Raphson would be faster, as the number of numerical derivatives would be much smaller.

Problem 4

Using the fmincon function for 3 agents and 3 goods is fairly successful, although some values equaling zero can cause problems. Most of the time, it is able to find a solution. However, with 10 agents and 10 goods, using the same function, is far more sensitive. With deeply hetergeneous endowments, the algorithm can rarely find its way to the appropriate equal allocation (in the simplest case with equal weights and parameters).

Method	Solution	Time
Midpoint	-18.2095251513542	0.0057
Trapezoid	-18.2094487366169	0.0022
Simpson's Rule	-18.2095253999815	0.0029
Monte Carlo	-17.6166773287535	0.2523

Table 1: Caption

Method	Solution	Iterations	Time
Steepest Descent	(1,1)	50000	0.0799
Conjugate Descent	(1,1)	2917	0.0056
Newton-Raphson	(1,1)	6	0.1766
BFGS	(1,1)	35	0.0082

Table 2: Caption