FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION
OF HIGHER EDUCATION
ITMO UNIVERSITY

Report
on the practical task No. 1
“Algorithms for unconstrained nonlinear optimization. Direct methods”

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Goal

The use of direct methods (one-dimensional methods of exhaustive search, dichotomy, golden section search; multidimensional methods of exhaustive search, Gauss, Nelder-Mead) in the tasks of unconstrained nonlinear

Formulation of the problem

Considering few one-dimensional functions (some of them are convex). Necessary with given precision approximate these functions with simple methods. Besides, noisy linear function should be approximated with linear and rational functions using exhaustive search, Gauss and Nelder-Mead methods.

Brief theoretical part

There are some optimization methods that needs more iterations than others. For example, golden section method is improved dichotomy method. The exhaustive approach demands much more function calls to explore its values but sometimes it's necessary to get imagination of function.

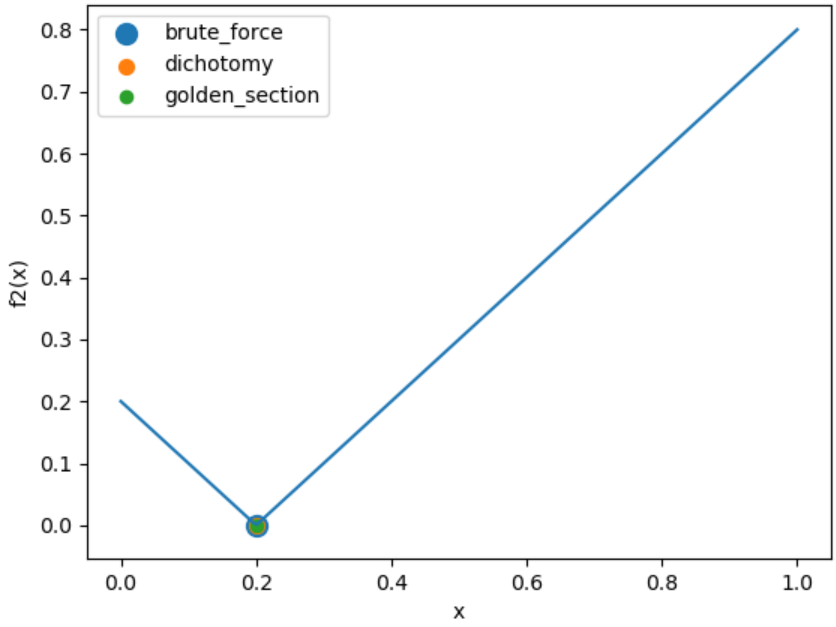
Dichotomy and golden section methods are good for convex functions. Otherwise, they may find ***local*** *minimum.*

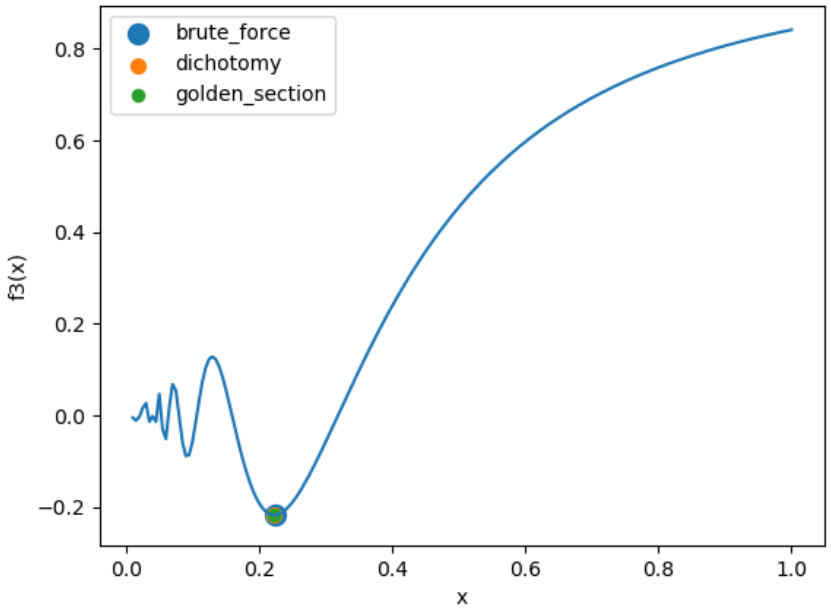
For multidimensional problems Gauss method may fail in case when extremum lines are parallel to axes. Nelder-Mead method can't guarantee finding ***global*** *extremum as well.*

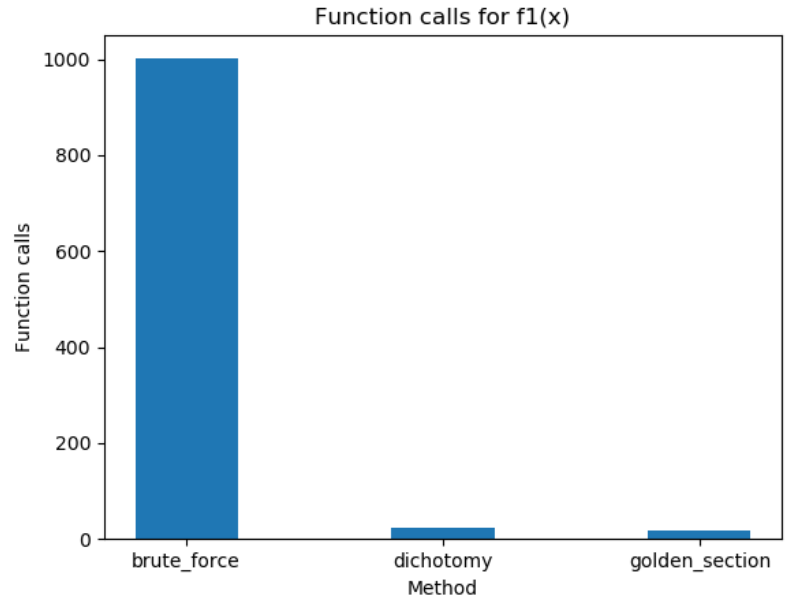
Results

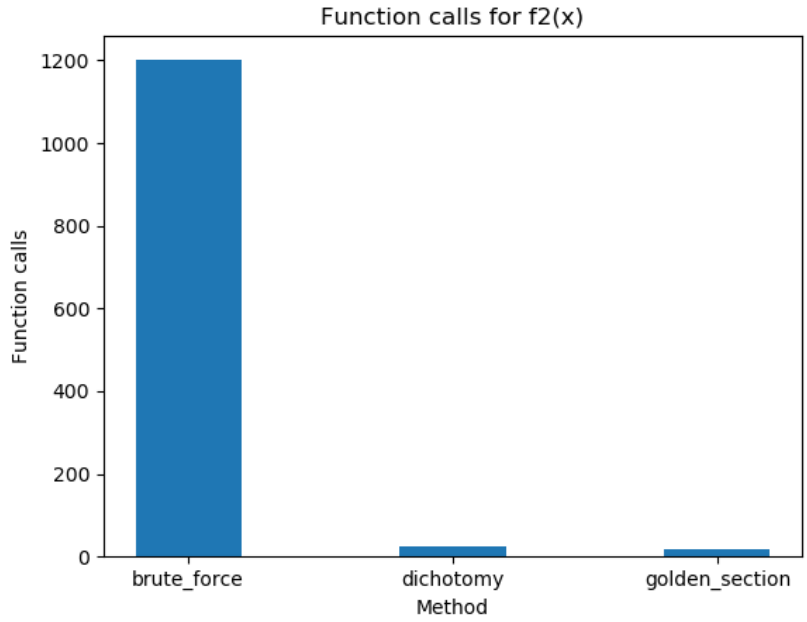
The figures of functions and solutions of different methods are demonstrated below. The bar plots show number of function calls for each optimization method.

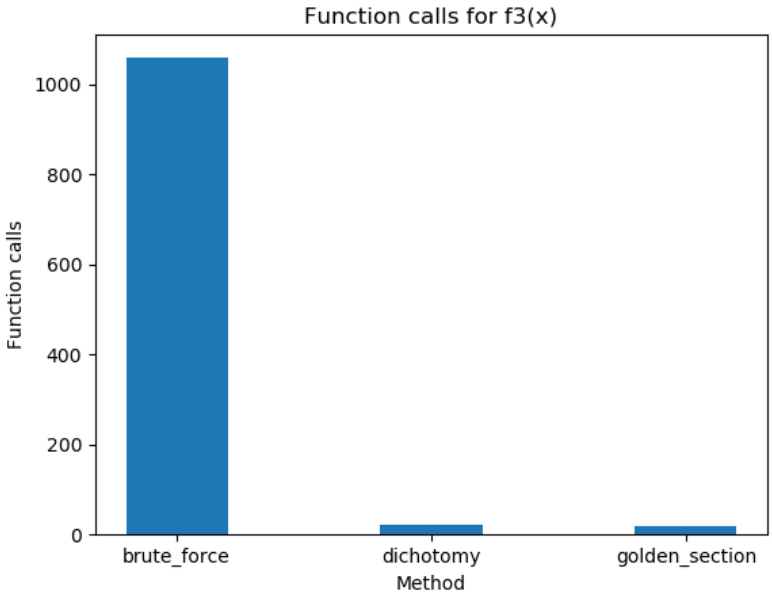
Part 1.

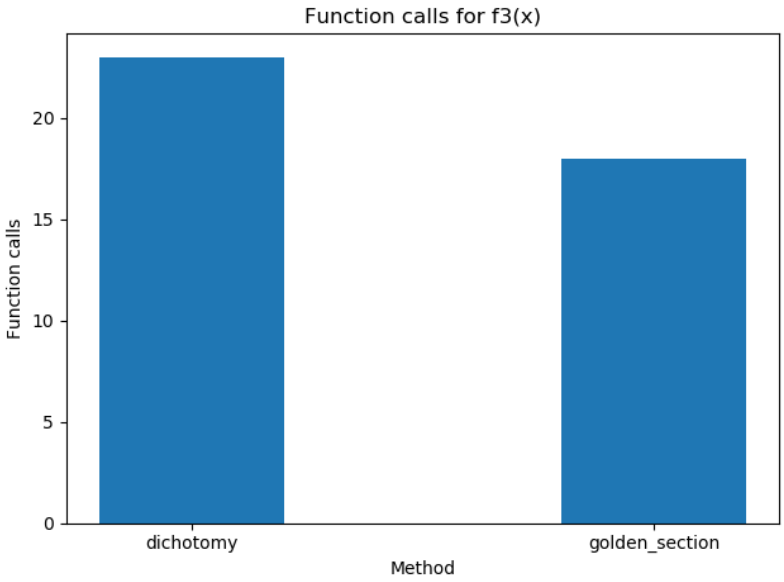

brute_force
dichotomy
golden_section
f2(x)
x
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.0
0.2
0.4
0.6
0.8
1.0


brute_force
dichotomy
golden_section
f3(x)
x
−0.2
0.0
0.2
0.4
0.6
0.8
0.0
0.2
0.4
0.6
0.8
1.0

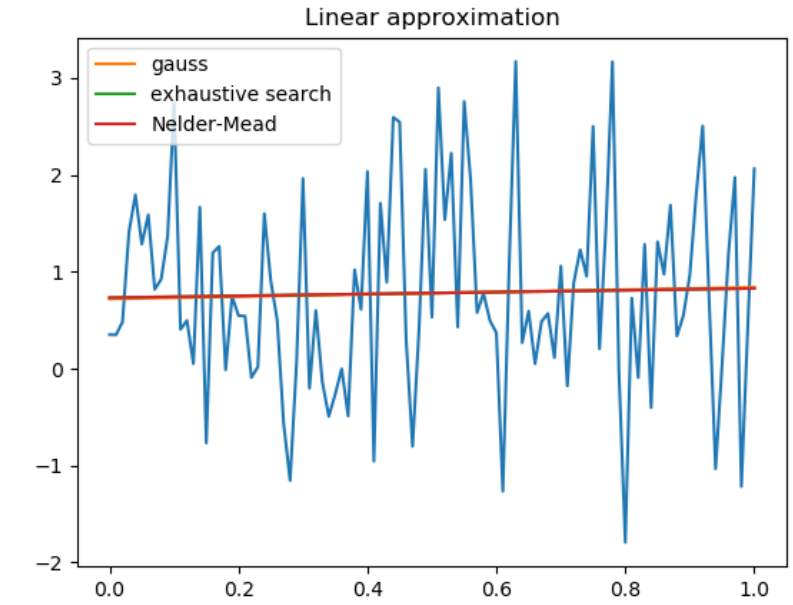

Function calls for f1(x)
Function calls
1000
800
600
400
200
0
brute_force
dichotomy
golden_section
Method

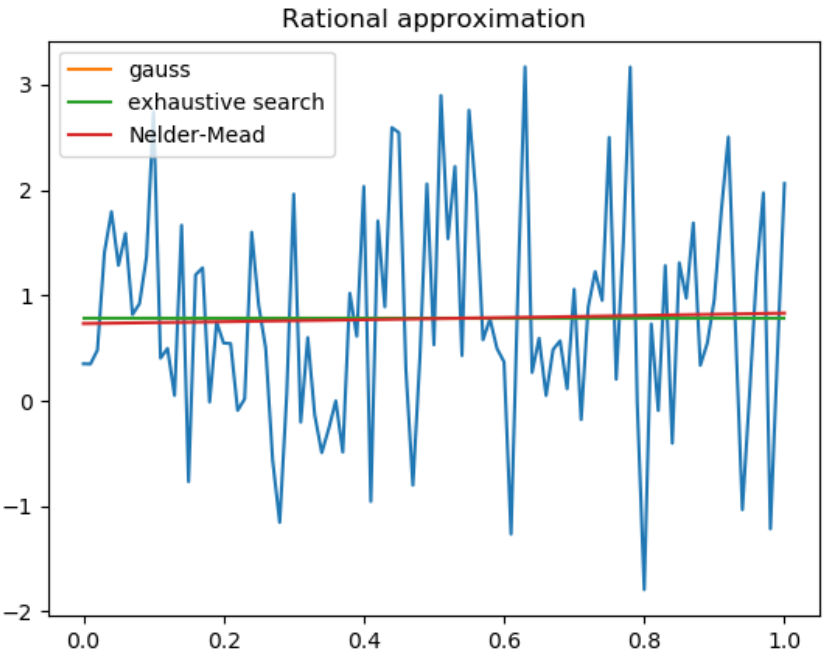

Function calls for f2(x)
Function calls
1200
1000
800
600
400
200
0
brute_force
dichotomy
golden_section
Method


Function calls for f3(x)
Function calls
1000
800
600
400
200
0
brute_force
dichotomy
golden_section
Method


Function calls for f3(x)
Function calls
20
15
10
5
0
dichotomy
golden_section
Method

Part 2.





Conclusions

Thus, we can see that exhaustive search is the slowest one but it gives appropriate solution. Golden section method needs less function calls that dichotomy one. All solutions are close to each other.

Appendix

Source code is available on

https://github.com/KostyaKrechetov/ITMO-Analysis-and-development-of-algorithms/tree/master/Task2