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■ Search Q

Line search

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In optimization, the **line search** strategy is one of two basic iterative approaches to find a local minimum \mathbf{x}^* of an objective function $f: \mathbb{R}^n \to \mathbb{R}$. The other approach is trust region.

The line search approach first finds a descent direction along which the objective function f will be reduced and then computes a step size that determines how far \mathbf{x} should move along that direction. The descent direction can be computed by various methods, such as gradient descent, Newton's method and Quasi-Newton method. The step size can be determined either exactly or inexactly.

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Example use [edit]

Here is an example gradient method that uses a line search in step 4.

- 1. Set iteration counter $k \equiv 0$, and make an initial guess, \mathbf{x}_0 for the minimum
- 2. Repeat:
- 3. Compute a descent direction \mathbf{p}_k
- 4. Choose $lpha_k$ to 'loosely' minimize $h(lpha)=f(\mathbf{x}_k+lpha\mathbf{p}_k)$ over $lpha\in\mathbb{R}_+$
- 5. Update $\mathbf{x}_{k+1} = \mathbf{x}_k + \alpha_k \mathbf{p}_k$, and k = k+1
- 6. Until $\|\nabla f(\mathbf{x}_k)\|$ < tolerance

At the line search step (4) the algorithm might either *exactly* minimize h, by solving $h'(\alpha_k) = 0$, or *loosely*, by asking for a sufficient decrease in h. One example of the former is conjugate gradient method. The latter is called inexact line search and may be performed in a number of ways, such as a backtracking line search or using the Wolfe conditions.

Like other optimization methods, line search may be combined with simulated annealing to allow it to jump over some local minima.

Algorithms [edit]

Direct search methods [edit]

In this method, the minimum must first be bracketed, so the algorithm must identify points x_1 and x_2 such that the sought minimum lies between them. The interval is then divided by computing f(x) at two internal points, x_3 and x_4 , and rejecting whichever of the two outer points is not adjacent to that of x_3 and x_4 which has the lowest function value. In subsequent steps, only one extra internal point needs to be calculated. Of the various methods of dividing the interval, [1] golden section search is particularly simple and effective, as the interval proportions are preserved regardless of how the search proceeds:

$$\frac{1}{\phi}(x_2-x_1)=x_4-x_1=x_2-x_3=\phi(x_2-x_4)=\phi(x_3-x_1)=\phi^2(x_4-x_3) \text{ where } \\ \phi=\frac{1}{2}(1+\sqrt{5})\approx 1.618$$

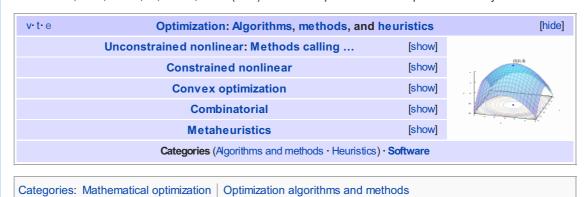
See also [edit]

- · Backtracking line search
- Secant method
- Newton-Raphson method

- Pattern search (optimization)
- Nelder-Mead method
- Golden section search

References [edit]

1. A Box, M. J.; Davies, D.; Swann, W. H. (1969). Non-Linear optimisation Techniques. Oliver & Boyd.



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