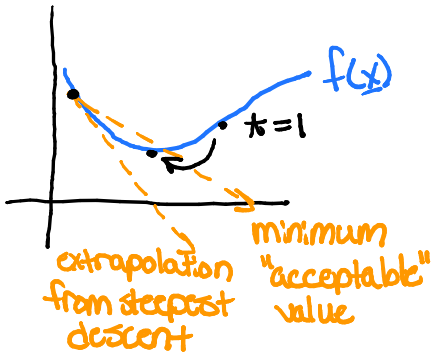
PHYS 177
winter 2019

## lecture 16 : line search

learning goals
- apply simple line search heuristics

steepest descent can suggest a direction, but how far to go? with steepest descent no natural scale for $t$

### backtracking line search




choose parameters $\alpha \in (0, 1/2)$, $\beta \in (0,1)$

initialize $t = 1$

while $f(\underline{x} + t\underline{s}) > f(\underline{x}) + \alpha t \nabla f(\underline{x})^T \underline{s}$

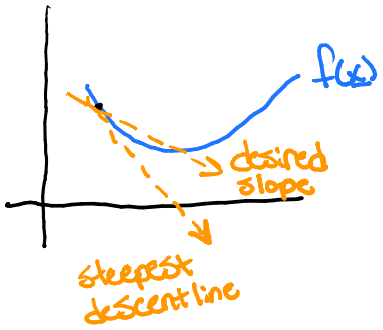
$t = \beta t$

start w/ "large" step, step back until decrease of function is acceptable

typically $\alpha$ is small ($\sim 10^{-3}$) and $\beta \in (0.1, 0.8)$

backtracking line search ensures sufficient decrease
if $f(\underline{x})$ does not decrease enough, then step is not accepted

### curvature condition




sufficient decrease is always satisfied if steps are very small

to guard against too small steps, we can also introduce a curvature condition

$$\nabla f(\underline{x} + t\underline{s})^T \underline{s} \geq \gamma \nabla f(\underline{x})^T \underline{s}$$

with $\gamma \in (\alpha, 1)$ (typically $\gamma \in (0.1, 0.9)$)

this ensures that derivative is decreasing as well

* notebook example "correcting" previous bad steps, introduce unbalanced quadratic to motivate Newton's method