Optimization Utilities

This repository implements a set of optimization tools and utilities using PyTorch and Autograd frameworks. Implementation of tools is provided in a simple and easy-to-read manner for future development. Most algorithms implemented can be found in textbook on Convex Optimization by Stephen Boyd & Lieven Vandenberghe or Numerical Optimization by Jorge Nocedal & Stephen Wright.

Organization

Following are the utilities provided in the current version-

Line Search

Utility	Description	Location
BacktrackLineSearch	Armijo's line search with termination criterion	`backtrack_line_search`
DiffLineSearch	Modified Armijo's line search with differential steps	`diff_line_search`

Vector Products

Utility	Description	Location
vjp	Vector-Jacobian Product	`vjp`
jvp	Jacobian-Vector Product	`jvp`
hvp	Hessian-Vector Product	`hvp`
vhp	Vector-Hessian Product	`vhp`

Descent Methods

Utility	Description	Location
GradDescent	Stochastic Gradient Descent	`grad_descent`
LangAscent	Stochastic Gradient Langevin Dynamics	`lang_ascent`
NaiveGaussNewtDescent	Naive Gauss-Newton Descent	`gn_descent`
NewtDescent	Newton-Raphson Descent with approximate Newton step	`app_newt_descent`
cg_solve	Conjugate Gradient Solver	`cg_solver`

Primal-Dual Methods

Utility	Description	Location

Utility	Description	Location
PrimalDualConstrainedDescent	Simultaneous descent on primal/dual problems for constraint satisfaction	`constraint_opt`
TunedLagrangianDescent	Simultaneous descent on Lagrange multiplier for automatic tuning	`lagrange_opt`
ConstrainedLagrangianDescent	Simultaneous descent on primal/dual problems and Lagrange multiplier Lagrange multiplier	`constraint_lagrange_opt`

Usage

To run Newton's descent method with backtracking line search on a simple MNIST classification problem, use the following-

```
python3 main.py --algo 'NewtDescent' --search_algo 'BacktrackLineSearch'
```

The default configuration runs gradient descent with line search for MNIST classification.

```
python3 main.py --algo 'GradDescent' --search_algo 'BacktrackLineSearch'
```

Reference

In case you find these implementations, then please cite the following-

```
@misc{karush17opt,
  author = {Karush Suri},
  title = {Optimization Utilities},
  year = {2021},
  howpublished = {\url{https://github.com/karush17/optimization_utils}}
}
```