# abaisero.sty

Andrea Baisero

June 28, 2024

## 1 Options

Options are processes left-to-right. If no options are provided, or none are enabled by the end of the processing, then by default they are all considered to be enabled.

| Option | Description |
|---|---|
| `all` | Enable all commands |
| `(no-)math` | Disable/enable mathematical commands |
| `(no-)linalg` | Disable/enable linear algebra commands |
| `(no-)optim` | Disable/enable optimization commands |
| `(no-)stats` | Disable/enable statistics commands |
| `(no-)dists` | Disable/enable distributions commands |
| `(no-)ml` | Disable/enable machine learning commands |
| `(no-)rl` | Disable/enable reinforcement learning commands |
| `(no-)marl` | Disable/enable multi-agent reinforcement learning commands |
| `(no-)theorem` | Disable/enable theorem commands |
| `(no-)misc` | Disable/enable miscellanea commands |

# 2 Commands

## Option [math]

| Symbol | Command | Description | Example |
|---|---|---|---|
| $\mathbb{N}$ | `\naturalset` | the set of natural numbers | $\mathbb{N} \doteq \{1, 2, 3, \dots\}$ |
| $\mathbb{Z}$ | `\integerset` | the set of integer numbers | $\mathbb{Z} \doteq \{0, 1, -1, 2, -3, \dots\}$ |
| $\mathbb{R}$ | `\realset` | the set of real numbers | $\sqrt{2} \in \mathbb{R}$ |
| $^*$ | `\kstar` | the Kleene star operator | $\mathcal{X}^* \doteq \bigcup_{k=0}^{\infty} \mathcal{X}^k$ |
| $^+$ | `\kplus` | the Kleene plus operator | $\mathcal{X}^+ \doteq \bigcup_{k=1}^{\infty} \mathcal{X}^k$ |
| softmax | `\softmax` | a.k.a. logsumexp, realsoftmax[1] | $\operatorname{softmax}(x_1, \dots, x_n) \doteq \log \sum_i \exp(x_i)$ |
| softmin | `\softmin` | | $\operatorname{softmin}(x_1, \dots, x_n) \doteq -\log \sum_i \exp(-x_i)$ |
| softargmax | `\softargmax` | a.k.a. softmax[1] | $\operatorname{softargmax}_i(x_1, \dots, x_n) \doteq \frac{\exp x_i}{\sum_i \exp x_i}$ |
| sign | `\sign` | | $x = \operatorname{sign} x \cdot \lvert x \rvert$ |

## Option [linalg]

| Symbol | Command | Description | Example |
|---|---|---|---|
| diag | `\diag` | | |
| rank | `\rank` | | |
| tr | `\trace` | | $\operatorname{tr}(M) \doteq \sum_{i=1}^{n} M_{ii}$ |
| col | `\colspace` | | |
| ker | `\nullspace` | Nullspace (a.k.a kernel) of a linear mapping | |
| span | `\spanspace` | | |
| $^\top$ | `\T` | Transpose superscript | symmetric $M \implies M = M^\top$ |
| $^{-1}$ | `\I` | Inverse superscript | invertible $M \implies MM^{-1} = I$ |
| $^+$ | `\PI` | Pseudo-inverse superscript | $MM^+M = M$ |
| $^{-\top}$ | `\IT` | Inverse transpose superscript | $M^{-\top} = (M^{-1})^\top = (M^\top)^{-1}$ |
| $^{+\top}$ | `\PIT` | Pseudo-inverse transpose superscript | $M^{+\top} = (M^+)^\top = (M^\top)^+$ |

## Option [optim]

| Symbol | Command | Description | Example |
|---|---|---|---|
| argmax | `\argmax` | | $\operatorname{argmax}_a Q^\pi(s, a)$ |
| argmin | `\argmin` | | $\theta^* \doteq \operatorname{argmin}_\theta \mathcal{L}(\theta)$ |
| $^*$ | `\opt` | Optimality superscript | $\pi^*(s) = \operatorname{argmax}_a Q^*(s, a)$ |

[1] The functions that in this document are called "softmax" and "softargmax" are poorly and inaccurately named in the broader math and ML fields (see `https://en.wikipedia.org/wiki/Softmax_function` and `https://en.wikipedia.org/wiki/LogSumExp`). Rather than stick to the more common naming conventions, I opt to rename the functions more accurately to appropriately reflect their actual properties. In any document where I would use these functions, I would need to define them anyway, so the risk of misunderstandings are minimal.

## Option [stats]

| Symbol | Command | Description | Example |
|---|---|---|---|
| $\mathbb{C}$ | \Cov | Covariance | $\mathbb{C}(x, y) = \mathbb{E}[xy] - \mathbb{E}[x]\,\mathbb{E}[y]$ |
| $\mathbb{H}$ | \Ent | Entropy | $\mathbb{H}[x] = -\mathbb{E}[\log \Pr(x)]$ |
| $\mathbb{E}$ | \Exp | Expectation | $\mathbb{E}[f(x)] = \sum_x \Pr(x) f(x)$ |
| $\mathbb{I}$ | \Ind | Indicator function | $\Pr(x = 0) = \mathbb{E}[\mathbb{I}[x = 0]]$ |
| KL | \KL | KL-divergence | $\mathrm{KL}(p \,\|\|\, q) \doteq \mathbb{E}_{x\sim p}[\log p(x) - \log q(x)]$ |
| $\mathrm{D}_{\mathrm{KL}}$ | \DKL | KL-divergence (alternative) | |
| $\mathbb{I}$ | \MI | Mutual Information | |
| $\mathbb{V}$ | \Var | Variance | $\mathbb{V}[x] = \mathbb{E}\left[x^2\right] - \mathbb{E}[x]^2$ |

## Option [dists]

| Symbol | Command | Description |
|---|---|---|
| Categorical | \Categorical | Categorical |
| Dirichlet | \Dirichlet | Dirichlet |
| Normal | \Normal | Normal |
| Uniform | \Uniform | Uniform |

## Option [ml]

| Symbol | Command | Description | Example |
|---|---|---|---|
| $\mathcal{D}$ | \data | Data set | $\mathcal{D} \doteq \{(x_i, y_i)\}_{i=1}^N$ |
| $\mathcal{L}$ | \loss | Loss function | $\mathcal{L}(\theta; x, y) = \frac{1}{2}\|y - f(x; \theta)\|^2$ |
| nll | \nll | Neg-log-likelihood | $\mathrm{nll}(x) \doteq -\log \Pr(x)$ |
| MSE | \mse | Mean-squared-error | |

## Option [rl]

| Symbol | Command | Description |
|---|---|---|
| $\mathcal{A}$ | \aset | Action set |
| $\mathcal{B}$ | \bset | Belief set |
| $\mathcal{H}$ | \hset | History set |
| $\mathcal{O}$ | \oset | Observation set |
| $\mathcal{R}$ | \rset | Reward set |
| $\mathcal{S}$ | \sset | State set |
| D | \dfn | Dynamics function |
| G | \gfn | Generative function |
| O | \ofn | Observation function |
| R | \rfn | Reward function |
| T | \tfn | Transition function |
| $\varepsilon$ | \nohistory | Empty history |
| $\pi$ | \policy | policy |
| $Q^\pi$ | \qpolicy | Q policy values |
| $\hat{Q}$ | \qmodel | Parametric model |
| $V^\pi$ | \vpolicy | V policy values |
| $\hat{V}$ | \vmodel | Parametric model |
| $A^\pi$ | \apolicy | A policy values |
| $\hat{A}$ | \amodel | Parametric model |
| $U^\pi$ | \upolicy | U policy values |
| $\hat{U}$ | \umodel | Parametric model |

## Option [marl]

| Symbol | Command | Description |
|---|---|---|
| $\bar{\pi}$ | \policies | Joint policy |
| $\bar{h}$ | \hs | Joint history |
| $\bar{a}$ | \as | Joint action |
| $\bar{o}$ | \os | Joint observation |
| $Q^{\bar{\pi}}$ | \qpolicies | Q joint-policy values |
| $V^{\bar{\pi}}$ | \vpolicies | V joint-policy values |
| $A^{\bar{\pi}}$ | \apolicies | A joint-policy values |
| $U^{\bar{\pi}}$ | \upolicies | U joint-policy values |

## Option [theorem]

| Symbol | Command | Description |
|---|---|---|
| | \begin{definition} | |
| | \begin{example} | |
| | \begin{axiom} | |
| | \begin{conjecture} | |
| | \begin{proposition} | |
| | \begin{lemma} | |
| | \begin{theorem} | |
| | \begin{corollary} | |
| | \begin{generalization} | |

## Option [misc]

| Symbol | Command | Description |
|---|---|---|
| $\dagger$ | \D | Dagger superscript |
| $(k)$ | \iter{k} | Superscript indicating iteration |