# abaisero.sty

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## 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 | $\mathcal{X}^+ \doteq \bigcup_{k=1}^{\infty} \mathcal{X}^k$ |
| $\mathcal{P}$ | `\powerset` | power set | $\mathcal{P}(\mathcal{X}) \doteq \left\{\hat{\mathcal{X}} \mid \hat{\mathcal{X}} \subseteq \mathcal{X}\right\}$ |
| $\mathbb{I}$ | `\Ind` | Indicator function | $\Pr(x = 0) = \mathbb{E}\left[\mathbb{I}\left[x = 0\right]\right]$ |
| $[\![\cdot]\!]$ | `\iverson{\cdot}` | Iverson brackets | $[\![x \geq 0]\!]$ maps $x$ to binaries |
| 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] | $\operatorname{softargmax}(x_1, \dots, x_n)_i \doteq \frac{\exp(x_i)}{\sum_k \exp(x_k)}$ |
| sign | `\sign` | | $x = \operatorname{sign} x \cdot \lvert x \rvert$ |
| supp | `\supp` | support operator | $\operatorname{supp}(f) \doteq \{x \mid f(x) \neq 0\}$ |

## 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 | $\pi^*(s) = \operatorname{argmax}_a Q^*(s, a)$ |
| stop | `\stopg` | Stop-gradient operator | $\nabla_x \operatorname{stop}\left[f(x)\right] = 0$ |

[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 |
|---|---|---|---|
| $\perp$ | `\indep` | Independence | $X \perp Y \mid Z$ |
| do | `\causaldo` | Pearl's *do* operator | $\Pr(Y \mid \mathrm{do}(X = x)) \neq \Pr(Y \mid X = s)$ |
| $\mathbb{C}$ | `\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 | $\mathbb{E}[f(x)] = \sum_x \Pr(x) f(x)$ |
| KL | `\KL` | KL-divergence | $\mathrm{KL}(p \mid\mid q) \doteq \mathbb{E}_{x\sim p}[\log p(x) - \log q(x)]$ |
| $\mathrm{D}_{\mathrm{KL}}$ | `\DKL` | KL-divergence (alternative) | |
| $\mathbb{I}$ | `\MI` | Mutual Information | |
| $\mathbb{B}$ | `\Bias` | Bias | $\mathbb{B}\left[\hat{f}(x)\right]$ is the bias of estimator $\hat{f}$ |
| $\mathbb{V}$ | `\Var` | Variance | $\mathbb{V}\left[\hat{f}(x)\right] = \mathbb{E}\left[\hat{f}(x)^2\right] - \mathbb{E}\left[\hat{f}(x)\right]^2$ |

## Option [dists]

| Symbol | Command | Description | Example |
|---|---|---|---|
| Categorical | `\Categorical` | Categorical | |
| Dirichlet | `\Dirichlet` | Dirichlet | |
| Geometric | `\Geometric` | Geometric | |
| 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 | |
| $\rightsquigarrow$ | `\trainedto` | Model is trained to approximate some value | $\hat{V}(s) \rightsquigarrow V^\pi(s) \overset{\text{hope}}{\Longrightarrow} \hat{V}(s) \approx V^\pi(s)$ |

## Option [rl]

| Symbol | Command | Description | Example |
|---|---|---|---|
| $\mathcal{A}$ | `\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 | |
| $\varepsilon$ | `\nohistory` | Empty history | |
| $\pi$ | `\policy` | policy | |
| $Q^\pi$ | `\qpolicy` | Q policy values | |
| $Q^\mu$ | `\qpolicy[\mu]` | Q policy values w/ optional argument | |
| $\hat{Q}$ | `\qmodel` | Parametric model | |
| $V^\pi$ | `\vpolicy` | V policy values | |
| $V^\mu$ | `\vpolicy[\mu]` | V policy values w/ optional argument | |
| $\hat{V}$ | `\vmodel` | Parametric model | |
| $A^\pi$ | `\apolicy` | A policy values | |
| $A^\mu$ | `\apolicy[\mu]` | A policy values w/ optional argument | |
| $\hat{A}$ | `\amodel` | Parametric model | |
| $U^\pi$ | `\upolicy` | U policy values | |
| $U^\mu$ | `\upolicy[\mu]` | U policy values w/ optional argument | |
| $\hat{U}$ | `\umodel` | Parametric model | |
| $B_\pi$ | `\bpolicy` | Policy Bellman operator | |
| $B_\mu$ | `\bpolicy[\mu]` | Policy Bellman operator w/ optional argument | |

## Option [marl]

| Symbol | Command | Description | Example |
|---|---|---|---|
| $\bar{x}$ | `\joint{x}` | Joint formatting (redefinable) | |
| $\bar{\mathcal{A}}$ | `\jaset` | Joint action set | |
| $\bar{\mathcal{O}}$ | `\joset` | Joint observation set | |
| $\bar{\mathcal{H}}$ | `\jhset` | Joint history set | |
| $\bar{a}$ | `\ja` | Joint action | $\bar{a} \in \bar{\mathcal{A}}$ |
| $\bar{o}$ | `\jo` | Joint observation | $\bar{o} \in \bar{\mathcal{O}}$ |
| $\bar{h}$ | `\jh` | Joint history | $\bar{h} \in \bar{\mathcal{H}}$ |
| $\bar{\pi}$ | `\jpolicy` | Joint policy | $\bar{\pi}(\bar{h}, \bar{a}) \doteq \prod_i \pi_i(h_i, a_i)$ |
| $Q^{\bar{\pi}}$ | `\jqpolicy` | Q joint-policy values | |
| $V^{\bar{\pi}}$ | `\jvpolicy` | V joint-policy values | |
| $A^{\bar{\pi}}$ | `\japolicy` | A joint-policy values | |
| $U^{\bar{\pi}}$ | `\jupolicy` | U joint-policy values | |
| $B_{\bar{\pi}}$ | `\jbpolicy` | Joint policy Bellman operator | |
| $B_{\bar{\mu}}$ | `\bpolicy[\joint\mu]` | Joint policy Bellman operator w/ optional argument | |

## Option [theorem]

| Symbol | Command | Description | Example |
|---|---|---|---|
| | `\begin{definition}`, `\end{definition}`<br>`\begin{assumption}`, `\end{assumption}`<br>`\begin{example}`, `\end{example}` | | |
| | `\begin{axiom}`, `\end{axiom}`<br>`\begin{conjecture}`, `\end{conjecture}`<br>`\begin{proposition}`, `\end{proposition}`<br>`\begin{lemma}`, `\end{lemma}`<br>`\begin{theorem}`, `\end{theorem}`<br>`\begin{corollary}`, `\end{corollary}`<br>`\begin{generalization}`, `\end{generalization}` | | |

## Option [misc]

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

## Option [utils]

| Symbol | Command | Description | Example |
|---|---|---|---|
|  | `\phantomeq` | The width of an =, for alignment purposes (bounding box shown) | |