The optprob package*

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Abstract

optprob is a package that offers you useful features for writing optimization problems in a structured manner. The package also provides highly customizable options for the appearance of the optimization problems.

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1 Introduction

1.1 Motivation

In order to illustrate optimization problems, one can utilize `alignat` environment from the `amsmath` package. A simple example like this,

```
\documentclass{article}
\usepakcge{amsmath}
\DeclareMathOperator*\maximize{maximize}
\begin{document}
    \begin{alignat}{2}
        & \mathord{\maximize_{x_1,x_2\in\mathbf{R}}} & \quad & c_1x_1+c_2x_2 \\
        & \text{subject to} & & a_{11}x_1+a_{12}x_2 \leq b_1 \\
        & & & a_{21}x_1+a_{22}x_2\leq b_2.
    \end{alignat}
\end{document}
```

*https://github.com/yudai-nkt/optprob

will produce

$$\underset{x_1,x_2\in\mathbf{R}}{\text{maximize}} \quad c_1x_1 + c_2x_2 \tag{1}$$

$$\text{subject to} \quad a_{11}x_1 + a_{12}x_2 \leq b_1 \tag{2}$$

$$a_{21}x_1 + a_{22}x_2 \leq b_2. \tag{3}$$

One can also use other `align`-variant environments or `array` environment.

Each method has its pros and cons, but none of them are very friendly when it comes to denoting optimization problem. Writing disgusting numbers of ampersands in every line for the proper alignment is really annoying (to me at least) and could sometimes look ugly if we only input inadequate ampersands. Also, it is difficult to intuitively grasp the role of each formulae at a glance upon the source code if we put them manually.

1.2 Objective of this package

The `optprob` package provides an elegant and semantic syntax for optimization problems. With the aid of this package, you are free from the concern about the number of ampersands. You can easily switch the spacing or other settings via $\langle key \rangle = \langle value \rangle$ syntax. Semantically-named macros enhance your code's readability compared to the bare LaTeX expression.

2 Requirements

The `optprob` package is supported on the following engines and format.

- TeX engine: TeX, pdfTeX, XeTeX, LuaTeX, pTeX and upTeX
- TeX format: LaTeX 2_ε (plain TeX and ConTeXt are not supported.)

This package requires `mathtools` and `pgfkeys` to make use of it, and listed below are necessary packages to typeset this documentation besides the prerequisite packages:

- `fontenc`
- `geometry`
- `hologo`
- `lmodern`
- `ltxdockit`
- `minted`
- `multicol`

All the packages above are bundled with recent TeX Live by default. If any of them are not installed in your TeX system, you can download them via CTAN.

3 Installation

Clone the repository or download from the Releases. It includes three files, i.e. `optprob.pdf`, `optprob.sty` and `optprob.tex`. Following TDS (TeX Directory Structure), move each file to the corresponding directories as follows:

- `optprob.pdf` and `optprob.tex` → `texmf/doc/latex/optprob/`
- `optprob.sty` → `texmf/tex/latex/optprob/`,

where `texmf` is either `$TEXMFLOCAL` or `$TEXMFHOME`. Make sure to run `mktexlsr` if necessary.

4 Usage

4.1 Package loading

Just put this line in your preamble:

```
\usepackage{optprob}
```

For the time being, this package has no options available.

4.2 Macros and environments

`\argmax`

prints "arg max", which denotes arguments of the maximum.

`\argmin`

is the minimum counterpart of `\argmax`.

`\begin{optimize}[`⟨*layout formatting*⟩`]{`⟨*operation type*⟩`}`

`\end{optimize}`

either `max` or `min` can be used for ⟨*operation type*⟩ according to the problem you want to represent. You can specify the design of the environment in the ⟨*layout formatting*⟩ option. Each setting can be given in ⟨*key*⟩ = ⟨*value*⟩ syntax as follows.

`abbrev=true`, `false` default: `false`

to or not to abbreviate the terms such as maximize, minimize and subject to.

`showeqnum=true`, `false` default: `true`

to or not to show the equation numbers in each line.

`space=`⟨*dimension*⟩ default: `1em`

space between two columns.

`\begin{maximize}[`⟨*layout formatting*⟩`]`

`\end{maximize}`

is equivalent to the `optimize` environment with the mandatory argument set to `max`.

`\begin{minimize}[`⟨*layout formatting*⟩`]`

`\end{minimize}`

is equivalent to the `optimize` environment with the mandatory argument set to `min`. Note that this and `maximize` environments are defined only if `\minimize` and `\maximize` are not defined in the preamble respectively.

Within these environments above, the following macros are locally defined:

`\objfunc[`⟨*variables*⟩`]{`⟨*objective function*⟩`}`

sets the objective function to be maximized or minimized and denotes the variables over which the objective function is optimized. The default value for optional argument is an empty string. You *must* use this macro once per one environment.

`\addconstraint{`⟨*constraint*⟩`}`

adds constraints of the problem. You can use this macro as many times as necessary.

4.3 Demos

I will demonstrate some simple examples.

```
\begin{optimize}{max}
    \objfunc[x, y]{2x-y}
    \addconstraint{x-y\le1}
    \addconstraint{-x+y\le-2}
    \addconstraint{x, y\ge0}
\end{optimize}
```

$$\begin{aligned}
\underset{x,y}{\text{maximize}} \quad & 2x - y && (4)\\
\text{subject to} \quad & x - y \leq 1 && (5)\\
& -x + y \leq -2 && (6)\\
& x, y \geq 0 && (7)
\end{aligned}$$

```
\begin{minimize}[
    abbrev=true,space=2em,showeqnum=false
]
    \objfunc{\sin\theta+2\cos\phi}
    \addconstraint{3\theta-\phi=7\pi}
\end{minimize}
```

$$\begin{aligned}
\text{min.} \quad & \sin\theta + 2\cos\phi\\
\text{s.t.} \quad & 3\theta - \phi = 7\pi
\end{aligned}$$

5 Acknowledgements

The author is thankful to those who made and/or have been mantaining the packages on which `optprob` has dependency.

6 License

7 Changelog

v0.2.0 (July 5, 2016)

- Add an option for switching the appearance of equation numbers.
- Change the way of specifying variables in `optimize` environment and friends.

v0.1.1 (July 5, 2016)

- Fix the incompatibility with `minipage` environment.

v0.1.0 (May 25, 2016)

- Fisrt publication.