Trying Out Ways to Typeset Mathematical Formulation of Optimization Problems

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December 2, 2020

Abstract

This is an attempt to try out ways to typeset mathematical formulation of optimization problems [1].

Contents

Revision History

Revision history:

1. Version 1, December 1, 2020. Initial version of this document.

1 Attempting Solutions from [1]

The suggested implementations in LaTeX are actually from John Hammersley, who provided the LaTeX document. I modified the author list of the hyperlinked LaTeX document to reflect this. In addition, John Hammersley incorporated a suggestion from Vince Knight for typesetting mathematical optimization models in LaTeX.

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1.1 Array-based Formulation from [1]

Using the array-based formulation from [1].

$$\begin{aligned} \min_x \quad & c^T x \\ \text{s.t.} \quad & Ax \leq b \\ & \sum_{i=0}^{n} x_i = 1 \\ & x_j \geq 0 \qquad \forall j \in N \end{aligned} \tag{1}$$

Notes:

1. "As you see, first column in the array is used for 'min' and 'subject to'. Hence, all lines except first two start with '&' symbol. Second, third and fourth columns are used to define constraints."
2. "Note that, using eqnarray instead of array may lead some spacing inconsistencies."
3. "Advantages: Clean and tidy output, works well even for long constraints / models"
4. "Disadvantages: You need to add '\displaystyle' every time you use a summation symbol"
5. "(Tip: Adding \everymath{\displaystyle} before \begin{document} is another option as noted in comments)"

1.2 Aligned Formulation from [1]

Using the aligned formulation from [1].

$$\begin{aligned} \min_x \quad & c^T x \\ \text{s.t.} \quad & Ax \leq b_i \\ & \sum_{i=1}^{n} x_i = 1 \\ & x_j, \forall j \in N. \end{aligned} \tag{2}$$

Notes:

1. "Advantages: No need for '\displaystyle' "
2. "Disadvantages: Alignment is not flexible (everything is left-aligned), multi-column is not available (if you have a long objective function, there will be some problems)"

1.3 Matrix Formulation from [1]

Using the matrix formulation from [1].

$$\begin{aligned} \min_x \quad & c^T x \\ \text{s.t.} \quad & Ax \leq b \\ & \sum_{i=1}^{n} x_i = 1 \\ & x_j \geq 0 \qquad \forall j \in N \end{aligned} \tag{3}$$

Notes:

1. "This has similar problems to Aligned method. If your constraints have similar size, then you may like the result. To me, it looks good for this example."
2. "Disadvantages: Again, you need to switch between style modes (\displaystyle)"

1.4 Align Formulation from [1]

Using the align formulation from [1].

$$\begin{aligned} \min_{x} \quad & c^T x \\ & Ax \leq b \\ & \sum_{i=1}^{n} x_i = 1 \\ & x_j \geq 0 \quad \forall j \in N \end{aligned}$$

Notes:

1. "You can also get the same result if you use 'aligned', but this one is a different approach. You can think align as an array with two columns, where first column is always right-aligned and second column is always left-aligned. I trimmed 's.t.' since it leads a dirty result."
2. "Advantages: Clean and easy-to-edit"
3. "Disadvantages: Manual alignment of extra parts (for all, etc.), objective function may shift if you use long constraints"

1.5 Comparison of Methods from [1]

"There's no method that is simply the best, it's all about applying the one which works for your needs. If you already published some papers, you'll already have a method in your mind to do it. I tried some of them for my research notes, and I prefer the first method. Flexibility of the first method is the key for my models. But, in the end, all methods has some features that serve you better than others."

"Jesus Lago Garcia commented that they have a LaTeX package for defining optimization problems named `optidef`. Thanks for the package and letting us know Jesus." See https://www.ctan.org/pkg/optidef about `optidef`.

References

[1] Sertalp Bilal Çay. Latex templates for optimization models. Available online from *OR-Complete: Computer*, and hosted by *Lehigh University: P.C. Rossin College of Engineering & Applied Science: Department of Industrial and Systems Engineering, located at Harold S. Mohler Laboratory* at: http://www.orcomplete.com/computer/sertalpbilal/latex-templates-for-optimization-models; December 1, 2020 was the last accessed date, October 22 2013.