JavaScript 的方程式自動求解套件

A Preprint

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Abstract

我們使用爬山演算法，結合編譯器技術，創造了一個自動求的符號的解方程式套件 eq6.js，雖然並非所有方程式都能求得符號解，但是對《線性方程組、多項式與常係數微分方程式》而言，通常可以求得正確解答，而對其他更複雜的微分方程或偏微分方程，則無法保證能得到正確解答。

***K*eywords** 方程式求解 · 符號微分 · 人工智慧

1 簡介

電腦通常採用數值方法求解方程式，但是數值方法有以下幾個缺陷：

1. 只能求出數值解，但沒有公式解，人類不容易理解。
2. 數值計算容易有偏差，特別是對連續微分這類的問題偏差會很大！

本套件使用一組方程式的 BNF 語法進行符號微分，並透過爬山演算法尋找方程式的參數，目標是尋找解公式。

2 求解範例

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2.1 Headings: second level

Optimization equation : 中文測試

$$\int_0^\infty f(x)dx \tag{1}$$

xxx

*Use footnote for providing further information about author (webpage, alternative address)—*not* for acknowledging funding agencies.

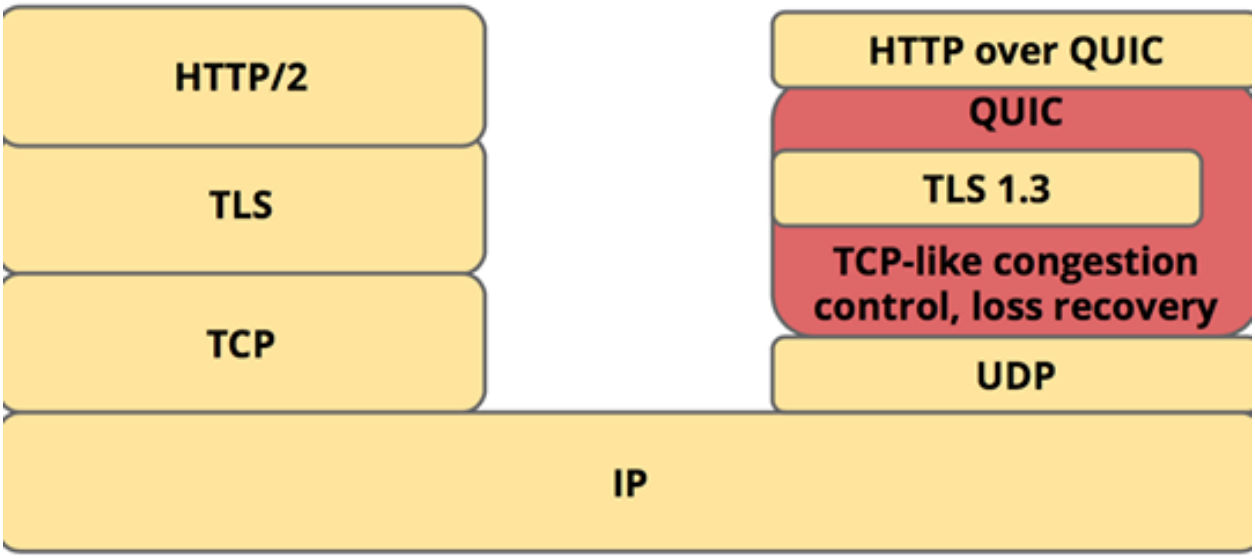

Figure 1: A boat.

$$\int_0^\infty f(x)dx\xi_{ij}(t) = P(x_t = i, x_{t+1} = j|y, v, w; \theta) = \frac{\alpha_i(t)a_{ij}^{w_t}\beta_j(t+1)b_j^{v_{t+1}}(y_{t+1})}{\sum_{i=1}^{N}\sum_{j=1}^{N}\alpha_i(t)a_{ij}^{w_t}\beta_j(t+1)b_j^{v_{t+1}}(y_{t+1})} \tag{2}$$

2.1.1 Headings: third level

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Paragraph Sed commodo posuere pede. Mauris ut est. Ut quis purus. Sed ac odio. Sed vehicula hendrerit sem. Duis non odio. Morbi ut dui. Sed accumsan risus eget odio. In hac habitasse platea dictumst. Pellentesque non elit. Fusce sed justo eu urna porta tincidunt. Mauris felis odio, sollicitudin sed, volutpat a, ornare ac, erat. Morbi quis dolor. Donec pellentesque, erat ac sagittis semper, nunc dui lobortis purus, quis congue purus metus ultricies tellus. Proin et quam. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Praesent sapien turpis, fermentum vel, eleifend faucibus, vehicula eu, lacus.

3 Examples of citations, figures, tables, references

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The documentation for `natbib` may be found at

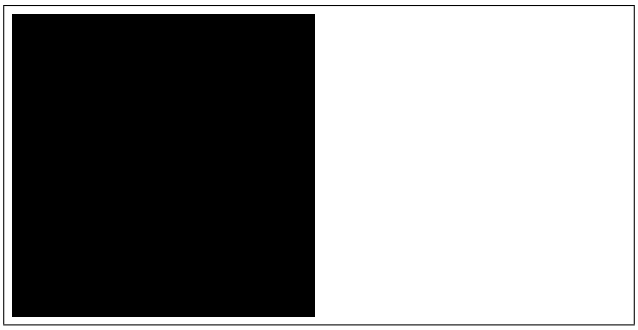

Figure 2: Sample figure caption.

Table 1: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

```
\citet{hasselmo} investigated\dots
```

produces

Hasselmo, et al. (1995) investigated…

`https://www.ctan.org/pkg/booktabs`

3.1 Figures

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3.2 Tables

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[2] Sample of the first footnote.

3.3 Lists

- Lorem ipsum dolor sit amet
- consectetur adipiscing elit.
- Aliquam dignissim blandit est, in dictum tortor gravida eget. In ac rutrum magna.

References

[1] 陳鍾誠 爬山演算法 (2017) github pages, e103.

[2] Meurer, Aaron and Smith, Christopher P. and Paprocki, Mateusz SymPy: symbolic computing in Python, (2017) SymPy: symbolic computing in Python. PeerJ Computer Science 3:e103.

[3] George Kour and Raid Saabne. Real-time segmentation of on-line handwritten arabic script. In *Frontiers in Handwriting Recognition (ICFHR), 2014 14th International Conference on*, pages 417–422. IEEE, 2014.

[4] George Kour and Raid Saabne. Fast classification of handwritten on-line arabic characters. In *Soft Computing and Pattern Recognition (SoCPaR), 2014 6th International Conference of*, pages 312–318. IEEE, 2014.

[5] Guy Hadash, Einat Kermany, Boaz Carmeli, Ofer Lavi, George Kour, and Alon Jacovi. Estimate and replace: A novel approach to integrating deep neural networks with existing applications. *arXiv preprint arXiv:1804.09028*, 2018.