Your Title

Your Subtitle

Your name

Email: XXX@xxx.cuhk.edu.hk
Office: Pavilion of Harmony, CUHK

The Chinese University of Hong Kong

March 26, 2024

Outline

Outline

Cite and Footnote I

Attention Is All You Need[1]

[1] Vaswani et al., "Attention is All you Need", 2017.

Cite and Footnote II

Long Short-Term Memory[2]

[2] Hochreiter and Schmidhuber, “Long Short-Term Memory”, 1997.

Outline

Text and lists

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Text and lists

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- Time-dependent Schrödinger's equation:

$$i\hbar\frac{\partial}{\partial t}|\Psi(t)\rangle = \hat{H}|\Psi(t)\rangle$$

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- Mathematically, a function $f(x)$ is linear iff $f(u+v) = f(u) + f(v)$ and $f(cu) = cf(u)$.

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Figure

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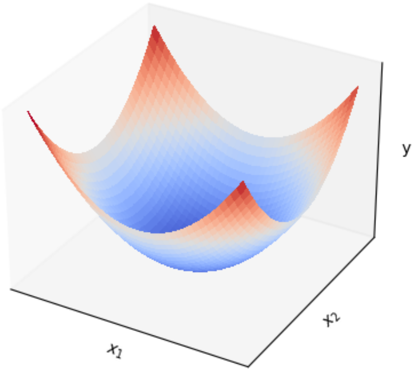

Figure 1: Convex Surface

Table

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Index	Areas (m^2)	Rent (HKD)
1	40	134072
2	92	182241
3	37	134731
4	124	204325
5	88	187375
...	...	...

Outline

Columns

1. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium.
2. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit.
3. Totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo.

Columns

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Figure 2: Lenna

Code

Algorithm 1 An algorithm with caption

```
Require: n ≥ 0
Ensure: y = x^n
  y ← 1
  X ← x
  N ← n
  while N ≠ 0 do
      if N is even then
          X ← X × X
          N ← N/2                                  ▷ This is a comment
      else if N is odd then
          y ← y × X
          N ← N − 1
      end if
  end while
```

Links

- Beamer (LaTex) - Wikipedia
- Please refer to page 2.
- https://en.wikipedia.org/wiki/Beamer_(LaTeX)

Footnote

- **Beamer** is a LaTeX document class for creating presentation slides, with a wide range of templates and a set of features for making slideshow effects. It supports pdfLaTeX, LaTeX + dvips, LuaLaTeX and XeLaTeX. The name is taken from the German word "Beamer" as a pseudo-anglicism for "video projector". [1]

[1] https://en.wikipedia.org/wiki/Beamer_(LaTeX)

Outline

Example

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Theorem

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$\mathbf{X}^T\mathbf{X}$ *is invertible* $\iff$ $\mathbf{X}$ *has linearly independent columns.*

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$\mathbf{X}^T\mathbf{X}$ *is invertible* $\iff$ $\mathbf{X}$ *has linearly independent columns.*

Proof.

Firstly, note that $\mathbf{X}^T\mathbf{X} \in \mathbf{R}^{n\times n}$. We denote $N(\mathbf{X})$ as the kernel (nullspace) of $\mathbf{X}$, and $R(\mathbf{X})$ as the range (column space) of $\mathbf{X}$.
We prove $\mathbf{X}^T\mathbf{X}$ and $\mathbf{X}$ share the same kernel such that once $N(\mathbf{X}) = 0$, $N(\mathbf{X}^T\mathbf{X}) = 0$ and vice versa. □

Proof

Proof.

1) Prove $N(\mathbf{X}) \subset N(\mathbf{X}^T\mathbf{X})$
$\forall v \in N(\mathbf{X})$, $\mathbf{X}^T\mathbf{X}v = \mathbf{X}^T 0 = 0$
$\implies v \in N(\mathbf{X}^T\mathbf{X}) \implies N(\mathbf{X}) \subset N(\mathbf{X}^T\mathbf{X})$.

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$\implies v \in N(\mathbf{X}^T\mathbf{X}) \implies N(\mathbf{X}) \subset N(\mathbf{X}^T\mathbf{X})$.

2) Prove $N(\mathbf{X}^T\mathbf{X}) \subset N(\mathbf{X})$
$\forall v \neq 0 \in N(\mathbf{X}^T\mathbf{X})$, $\mathbf{X}^T\mathbf{X}v = 0 \implies v \in N(\mathbf{X}^T)$ or $\mathbf{X}v \in N(\mathbf{X}^T)$.
However, we have $R(\mathbf{X}) \perp N(\mathbf{X}^T)$ and $\mathbf{X}v \in R(\mathbf{X})$,
$\implies \mathbf{X}v \perp N(\mathbf{X}^T) \implies \mathbf{X}v \notin N(\mathbf{X}^T) \implies v \in N(\mathbf{X}^T)$
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1), 2) $\implies \mathbf{N(X^TX) = N(X)}$ $\square$

Outline

References I

[1] Ashish Vaswani et al. "Attention is All you Need". In: *Advances in Neural Information Processing Systems*. Ed. by I. Guyon et al. Vol. 30. Curran Associates, Inc., 2017.

[2] Sepp Hochreiter and Jürgen Schmidhuber. "Long Short-Term Memory". In: *Neural Computation* 9.8 (Nov. 1997), pp. 1735–1780. ISSN: 0899-7667.

Reference Links

- Overleaf Documentation
- Learn LaTeX in 30 Minutes
- LaTeX Beamer - Overleaf
- Beamer Presentations: A Tutorial for Beginners