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Chapter 1

Introduction

The introduction introduces the context and summarizes the manuscript. It is important to clearly state the contributions of this piece of work.

In this paper we present a new method for solving the model equation

$$\begin{cases} \partial_t u - \varepsilon^2 \Delta u + u^3 - u = 0, & \text{in } \Omega \times \mathcal{T}, \\ u(x, y, t) = g(t), & \text{on } \partial\Omega, \\ u(x, y, 0) = \varphi(x, y), & \text{on } \Omega. \end{cases} \quad (1.1)$$

where ε is a small parameter.

This is an example of quoting an equation (1.1).

The merits of our method are as follows:

- item one
- item two

- item three
1. item one
 2. item two
 3. item three

The outline is not required, but we show an example here.

The book is organized as follows. Our main results are in 3, our new algorithm is in 4, experimental results are in 5, discussion is in ?? and the conclusions follow in ??.

Chapter 2

Preliminaries

2.1 This is subsection

2.1.1 This is subsubsection

Chapter 3

Main results

We interleave text filler with some example theorems and theorem-like items.

Definition 3.1. This is a definition environment.

Lemma 3.1. *This is a lemma environment.*

Theorem 3.1. *This is a theorem environment.*

Proof. This is a proof environment. □

Lemma 3.2. *This is a lemma environment*

(i) *item A*

(ii) *item B*

$$\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n = e. \tag{3.1}$$

This is a citation example [1,5]. This statement requires citations [3–5].

Here we state our main result as 3.2.

Theorem 3.2 (*LDL^T Factorization [2]*). *If $A \in \mathbb{R}^{n \times n}$ is symmetric and the principal submatrix $A(1 : k, 1 : k)$ is nonsingular for $k = 1 : n - 1$, then there exists a unit lower triangular matrix L and a diagonal matrix*

$$D = \text{diag}(d_1, \dots, d_n),$$

such that $A = LDL^T$. The factorization is unique.

LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation. LaTeX is based on the idea that it is better to leave document design to document designers, and to let authors get on with writing documents.

Theorem 3.3 (*Mean Value Theorem*). *Suppose f is a function that is continuous on the closed interval $[a, b]$ and differentiable on the open interval (a, b) . Then there exists a number c such that $a < c < b$ and*

$$f'(c) = \frac{f(b) - f(a)}{b - a}.$$

In other words,

$$f(b) - f(a) = f'(c)(b - a).$$

Remark 3.1. Observe that 3.2, 3.3 correctly mix references to multiple labels.

Corollary 3.1. *Let $f(x)$ be continuous and differentiable everywhere. If $f(x)$ has at least two roots, then $f'(x)$ must have at least one root.*

Proof. Let a and b be two distinct roots of f . By 3.3, there exists a number c such that

$$f'(c) = \frac{f(b) - f(a)}{b - a} = \frac{0 - 0}{b - a} = 0.$$

□

Note that it may require two L^AT_EX compilations for the proof marks to show.

Display matrices can be rendered using environments from `amsmath`:

$$S = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \quad \text{and} \quad C = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix}. \quad (3.2)$$

Equation 3.2 shows some example matrices.

We calculate the Fréchet derivative of F as follows:

$$F'(U, V)(H, K) = \langle R(U, V), H\Sigma V^T + U\Sigma K^T - P(H\Sigma V^T + U\Sigma K^T) \rangle \quad (3.3a)$$

$$\begin{aligned} &= \langle R(U, V), H\Sigma V^T + U\Sigma K^T \rangle \\ &= \langle R(U, V)V\Sigma^T, H \rangle + \langle \Sigma^T U^T R(U, V), K^T \rangle. \end{aligned} \quad (3.3b)$$

3.3a is the first line, and 3.3b is the last line.

Chapter 4

Algorithm

Our analysis leads to the algorithm in 1.

Algorithm 1 Build tree

Define $P := T := \{\{1\}, \dots, \{d\}\}$

while $\#P > 1$ **do**

 Choose $C' \in \mathcal{C}_p(P)$ with $C' := \operatorname{argmin}_{C \in \mathcal{C}_p(P)} \varrho(C)$

 Find an optimal partition tree $T_{C'}$

 Update $P := (P \setminus C') \cup \{\bigcup_{t \in C'} t\}$

 Update $T := T \cup \{\bigcup_{t \in \tau} t : \tau \in T_{C'} \setminus \mathcal{L}(T_{C'})\}$

end while

return T

Adjust the width of the algorithm environment

Algorithm 2 Euclid's algorithm

1: procedure EUCLID(a, b)	▷ The g.c.d. of a and b
2: $r \leftarrow a \bmod b$	
3: while $r \neq 0$ do	▷ We have the answer if r is 0
4: $a \leftarrow b$	
5: $b \leftarrow r$	
6: $r \leftarrow a \bmod b$	
7: end while	
8: return b	▷ The gcd is b
9: end procedure	

Chapter 5

Experimental results

Some experimental results here. Some experimental results here. Some experimental results here. Some experimental results here. Some experimental results here. Some experimental results here.

Example 1. This is example environment.

Figure 5.1 shows some example results.

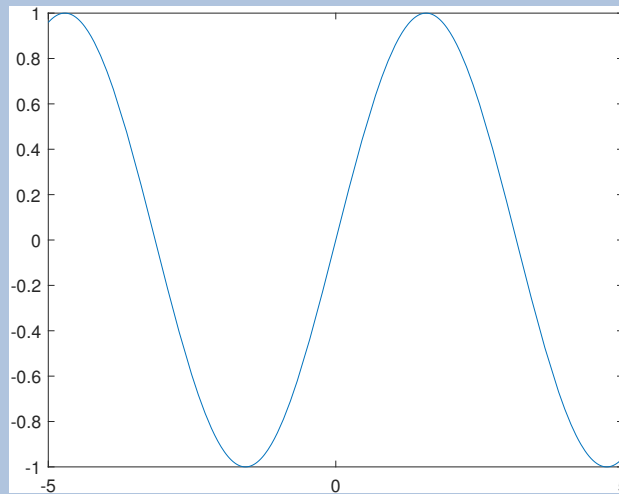


Figure 5.1. Example figure using external image files.

The two figures are placed side by side, sharing the same title, as shown in Figure 5.2.

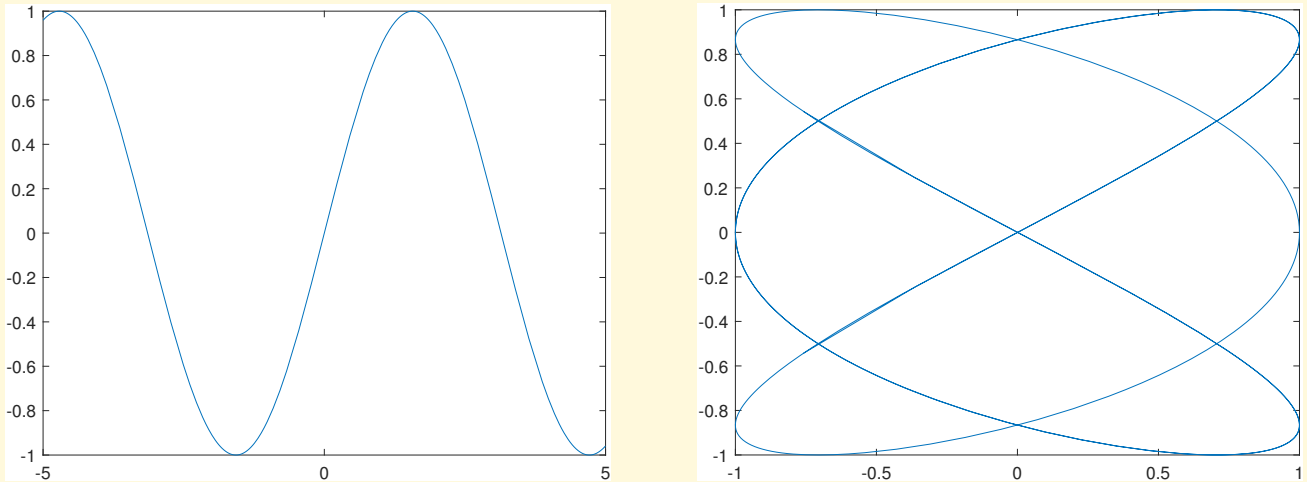


Figure 5.2. Left: Caption 1, Right: Caption 2.

Use the `tabular` environment to generate **Table 5.1**. The commands `\tabcolsep` and `\tabcolsep` control the spacing between columns and the vertical space between rows, respectively.

Table 5.1. Event Schedule

Date	Location	Event Name	Remarks
2023-02	New York	Academic Symposium	Topic: Artificial Intelligence
2023-05	London	Academic Exchange	Focus: Mathematical Modeling
2023-09	Shanghai	Technology Exhibition	Display of New Chips
2024-02	Tokyo	Research Workshop	Subject: Quantum Computing
2024-06	Paris	International Conference	Theme: Climate Change

Use `minipage` package to set images side-by-side, each with its own title, as shown in Figure 5.3 and Figure 5.4.

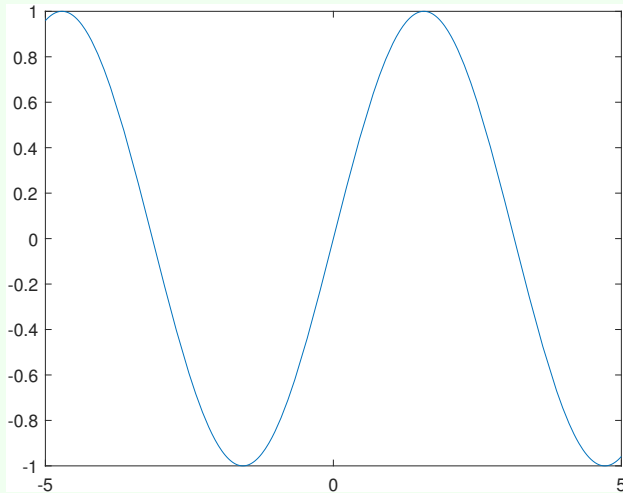


Figure 5.3. Caption A

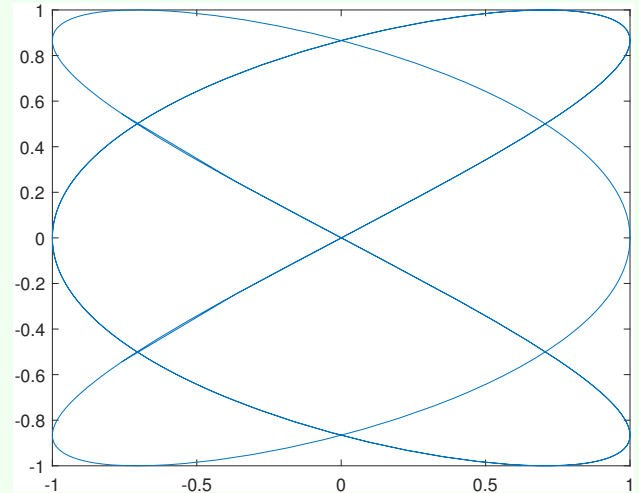
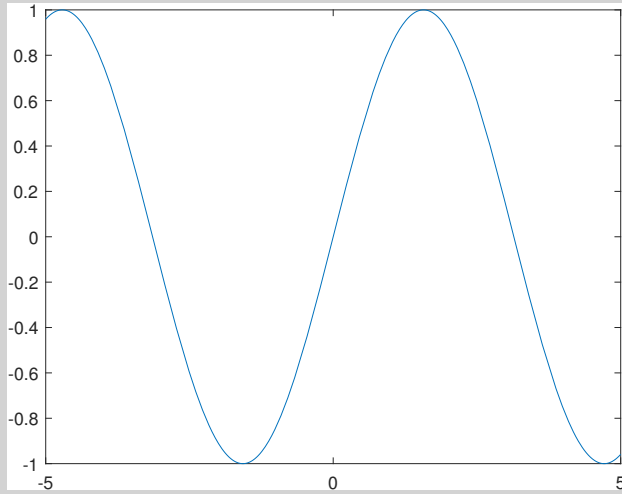
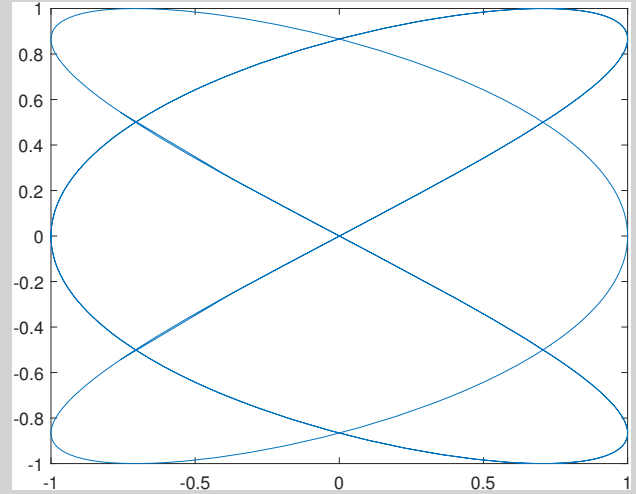


Figure 5.4. Caption B

Use `subfig` package to set subfigure, each with its subcaption, as shown in Figure 5.5.



(a) Subcaption A



(b) Subcaption B

Figure 5.5. Two subfigures

Use the `tabularx` environment to generate Table 5.2.

Table 5.2. Height and weight sample of students from a school

Serial No.	Age	Height (cm)	Weight (kg)
001	15	156	42
002	16	158	45
003	14	162	48
004	15	163	50
Average	15	159.75	46.25

Additional results are available in the supplement in Table 5.3.

Table 5.3. Numerical error

degree	step-size h	L^2 -errors	order	H^1 -errors	order	L^∞ -errors	order
1	1/128	9.18E-06	2.02	7.70E-03	1.01	6.46E-07	2.02
	1/256	2.29E-06	2.01	1.92E-03	1.00	1.61E-07	2.01
	1/512	5.70E-07	2.00	9.56E-04	1.00	4.01E-08	2.00
2	1/128	1.39E-08	3.01	1.15E-05	2.01	3.48E-12	4.02
	1/256	1.73E-09	3.01	2.88E-06	2.01	3.27E-13	3.94
	1/512	2.17E-10	3.00	7.24E-06	2.00	6.66E-13	1.55
3	1/32	2.28E-09	4.05	6.92E-07	3.04	1.45E-15	8.21
	1/64	1.42E-10	4.03	8.65E-08	3.02	2.06E-14	3.85
	1/128	8.91E-12	4.01	1.08E-08	3.01	3.86E-14	0.91

5.1 Discussion of $Z = X \cup Y$

Some discussions here. Some discussions here. Some discussions here. Some discussions here. Some discussions here. Some discussions here. Some discussions here. Some discussions here.

5.2 Conclusions

Some conclusions here. Some conclusions here. Some conclusions here. Some conclusions here. Some conclusions here. Some conclusions here. Some conclusions here. Some conclusions here.

Appendix A

An example appendix

The contents of the appendix are here.

Lemma A.1. *Test Lemma.*

This is a equation in appendix.

$$a^2 + b^2 = c^2. \tag{A.1}$$

Appendix B

This is the second appendix

B.1 A sub section

The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog. The quick brown fox jumps over the lazy dog.

References

- [1] R. A. Adams and J. J. F. Fournier. *Sobolev spaces*. Elsevier, Amsterdam, 2nd edition, 2003.
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