

Exploring the Physical Manifestation of Humanity's Subconscious Desires

A Practical Guide

Goro Akechi



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1. 緒論 (Introduction)

1.1 關於數位影像

1.1.1 成像原理 (Image Formation)

1.1.2 取樣 (Sampling)

1.1.3 量化 (Quantization)

1.2 關於數位影像處理

1.2.1 基本步驟 (Fundamental Steps)

以車牌辨識為範例，

1.2.2 核心任務 (Central Tasks)

物件分類 (classification)、偵測 (detection)、分割 (segmentation)



2. 影像強化 (Image Enhancement)

所謂影像強化 (image enhancement) 就是透過轉換影像像素點的亮度強度，以提升或增強影像的品質，使影像更適合顯示或者符合特定應用的需求。換言之，影像強化會使影像更清晰、對比度更佳或細節更顯著，例如：把過度曝光的照片調暗，或者增加灰階對比。

目前常見之影像強化演算法主要可分為空間域演算法 (spatial domain) 與頻率域演算法 (frequency domain)。空間域演算法為利用像素點所在的空間位置關係來決定亮度轉換的方式；頻率域演算法為利用傅立葉轉換 (Fourier Transform) 轉換影像到頻率空間後，以頻率空間影像作為強化的依據，而本章節內容主要包含空間域演算法 (spatial domain)。

一般來說，空間域影像強化演算法有可細分為直方圖處理 (histogram processing) 與空域濾波器 (spatial filter) 兩類演算法。直方圖處理意即透過分析整張影像的亮度直方圖作為亮度轉換的主要依據，此類演算法中最著名的為直方圖均化 (histogram equalization) 與直方圖匹配 (histogram matching)。空域濾波器就是根據鄰近像素的亮度值作為轉換亮度的依據，而此類演算法主要包含平滑 (Smoothing) 與銳化 (Sharpening) 兩類，於下列章節中將分別詳述直方圖處理域濾波器演算法。

2.1 直方圖處理 (Histogram Processing)

影像直方圖 (image histogram) 是一種以長條圖形式來描述影像中像素值出現次數的百分比分布 (通常簡稱為頻率)。簡單來說，影像直方圖的橫軸為像素值範

0	6	5	3	4	1	1	3	4	1
3	2	3	4	3	2	3	4	3	2
2	1	0	3	4	2	2	0	4	2
1	0	5	6	1	2	5	6	7	2
6	3	4	6	1	1	4	6	7	1
3	1	5	2	1	3	0	2	1	3
2	1	2	0	4	2	2	3	4	2
1	0	5	6	7	2	5	6	7	2
1	3	4	1	7	0	4	0	7	1
3	1	5	2	1	3	5	2	1	0

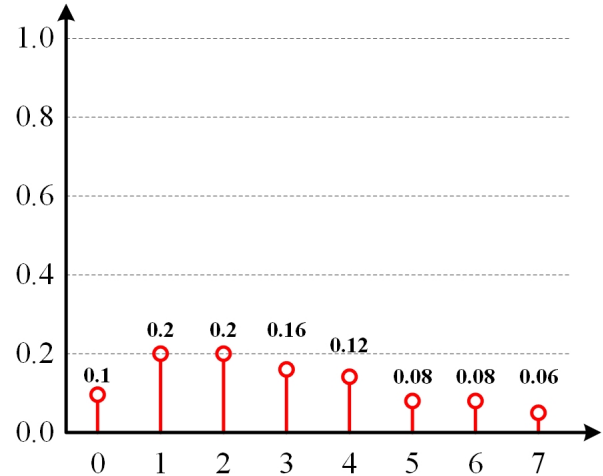


Figure 2.1: 解析度為 10x10 影像的直方圖範例

圖，以灰階影像為例，其像素值範圍由 0（黑色）到 255（白色）；影像直方圖的縱軸則為每個像素值出現次數的百分比（頻率）。

對於一張解析度為 $w \times h$ 且有 L 個像素值的影像，若其像素值分別表示為 r_0, r_1, \dots, r_{L-1} ，則直方圖 $p(\cdot)$ 定義為：

$$p(r_k) = \frac{n_k}{n}, k = 0, 1, \dots, r_{L-1} \quad (2.1)$$

其中 n_k 為影像中像素值等於 r_k 的像素點個數； $n = w \times h$ 為影像所有像素點的個數。如圖 2.1 左圖所示，以一張 10×10 且有 8 個像素值的影像為例（像素值範圍由 0 到 7），圖 2.1 右圖則為該影像的像素值分布直方圖，以像素值 $r_0 = 0$ 為例，影像中像素值等於 0 的像素共有 10 個（圖中紅色圓形所示），因此 $p(r_0 = 0) = \frac{10}{100} = 0.1$

一般而言，亮度分布直方圖為一種全域描述方式，其所呈現的亮度分布情況會反應影像的清晰程度，以花粉放大 700 倍的圖 2.2 為例，圖 2.2(a)(b)(c)(d) 上圖分別為光線不足、過度曝光、光線均勻但缺乏對比與正常均勻光線環境條件下所獲得的影像，下圖分別為所上圖影像所對應的亮度分布直方圖。光線不足與過度曝光影像（圖 2.2(a)(b)），其直方圖分別集中於亮度較低與較高的範圍；光線均勻但缺乏對比的影像直方圖則集中於某特定亮度區段，例如：圖 2.2(c) 其亮度主要分布於約 100 與 140 區間；正常均勻光線的影像直方圖則約略為均勻分布（分散於所有亮度區段）。

由於影像直方圖反應影像清晰程度，因此基於直方圖處理的影像強化演算法主要經由設計亮度轉換函數，透過改變影像的直方圖分布狀況，達到強化影像

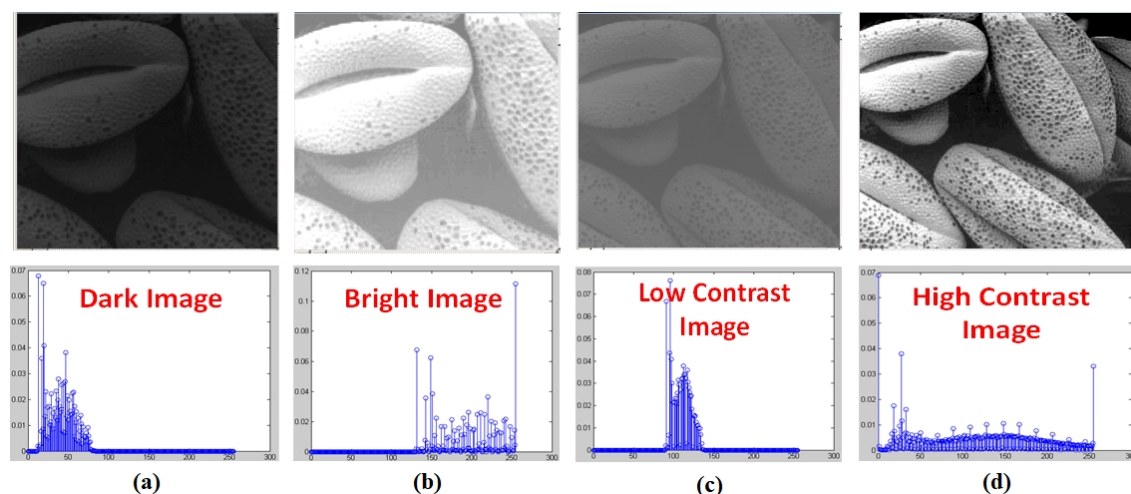


Figure 2.2: 不同光線環境條件下，放大 700 倍花粉影像圖，以及其所對應的亮度分布直方圖

的目的。目前常見的演算法為直方圖均化 (histogram equalization) 與直方圖匹配 (histogram matching)。

2.1.1 直方圖均化 (Histogram Equalization)

何謂直方圖均化演算法，其主要目的就是要設計一個轉換函數 T ，等化原始影像之亮度分布圖，

2.1.2 直方圖匹配 (Histogram Matching (Specification))

2.2 空間濾波 (Spatial Filtering)

2.2.1 平滑濾波器 (Smoothing Filters)

2.2.2 銳化濾波器 (Sharpening Filters)



3. 影像分割 (Image Segmentation)

3.1 門檻化區域分割

3.1.1 Otsu 演算法

3.1.2 雙遍連通元件標記 (Two-Pass Connected Component Labeling)


3.2 圖論區域分割



4. 特徵提取 (Feature Extraction)



5. 物件分類 (Object Classification)



6. Sectioning Examples

6.1 Section Title

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6.1.1 Subsection Title

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6.1.1.1 Subsubsection Title

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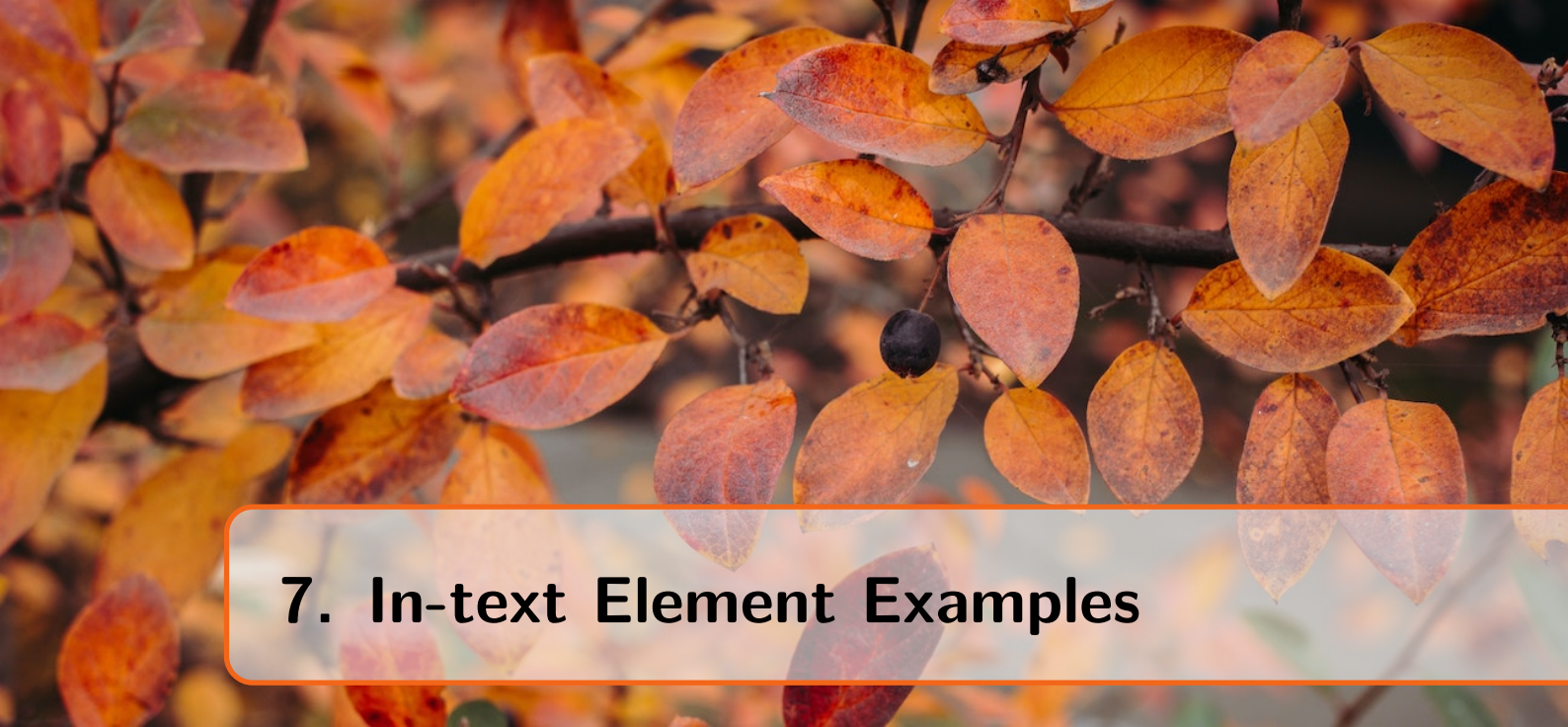
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Unnumbered Section

Unnumbered Subsection

Unnumbered Subsubsection



7. In-text Element Examples

7.1 Referencing Publications

This statement requires citation [Smith:2022jd]; this one is more specific [Smith:2021qr].

7.2 Link Examples

This is a URL link: [LaTeX Templates](#). This is an email link: example@example.com.

This is a monospaced URL link: `https://www.LaTeXTemplates.com`.

7.3 Lists

Lists are useful to present information in a concise and/or ordered way.

7.3.1 Numbered List

1. First numbered item
 - a. First indented numbered item
 - b. Second indented numbered item
 - i. First second-level indented numbered item
2. Second numbered item
3. Third numbered item

7.3.2 Bullet Point List

- First bullet point item
 - First indented bullet point item
 - Second indented bullet point item
 - First second-level indented bullet point item
- Second bullet point item
- Third bullet point item

7.3.3 Descriptions and Definitions

Name Description

Word Definition

Comment Elaboration

7.4 International Support

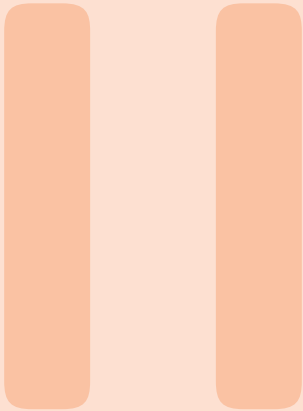
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7.5 Ligatures

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Part Two Title

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8. Mathematics

8.1 Theorems

8.1.1 Several equations

This is a theorem consisting of several equations.

Theorem 8.1 — Name of the theorem. In $E = \mathbb{R}^n$ all norms are equivalent. It has the properties:

$$||\mathbf{x}|| - ||\mathbf{y}|| \leq ||\mathbf{x} - \mathbf{y}|| \quad (8.1)$$

$$||\sum_{i=1}^n \mathbf{x}_i|| \leq \sum_{i=1}^n ||\mathbf{x}_i|| \quad \text{where } n \text{ is a finite integer} \quad (8.2)$$

8.1.2 Single Line

This is a theorem consisting of just one line.

Theorem 8.2 A set $\mathcal{D}(G)$ is dense in $L^2(G)$, $|\cdot|_0$.

8.2 Definitions

A definition can be mathematical or it could define a concept.

Definition 8.1 — Definition name. Given a vector space E , a norm on E is an

application, denoted $||\cdot||$, E in $\mathbb{R}^+ = [0, +\infty[$ such that:

$$||\mathbf{x}|| = 0 \Rightarrow \mathbf{x} = \mathbf{0} \quad (8.3)$$

$$||\lambda \mathbf{x}|| = |\lambda| \cdot ||\mathbf{x}|| \quad (8.4)$$

$$||\mathbf{x} + \mathbf{y}|| \leq ||\mathbf{x}|| + ||\mathbf{y}|| \quad (8.5)$$

8.3 Notations

■ **Notation 8.1** Given an open subset G of \mathbb{R}^n , the set of functions φ are:

1. Bounded support G ;
2. Infinitely differentiable;

a vector space is denoted by $\mathcal{D}(G)$.

8.4 Remarks

This is an example of a remark.

R The concepts presented here are now in conventional employment in mathematics. Vector spaces are taken over the field $\mathbb{K} = \mathbb{R}$, however, established properties are easily extended to $\mathbb{K} = \mathbb{C}$.

8.5 Corollaries

Corollary 8.1 — Corollary name. The concepts presented here are now in conventional employment in mathematics. Vector spaces are taken over the field $\mathbb{K} = \mathbb{R}$, however, established properties are easily extended to $\mathbb{K} = \mathbb{C}$.

8.6 Propositions

8.6.1 Several equations

Proposition 8.1 — Proposition name. It has the properties:

$$|||\mathbf{x}|| - ||\mathbf{y}||| \leq ||\mathbf{x} - \mathbf{y}|| \quad (8.6)$$

$$||\sum_{i=1}^n \mathbf{x}_i|| \leq \sum_{i=1}^n ||\mathbf{x}_i|| \quad \text{where } n \text{ is a finite integer} \quad (8.7)$$

8.6.2 Single Line

Proposition 8.2 Let $f, g \in L^2(G)$; if $\forall \varphi \in \mathcal{D}(G)$, $(f, \varphi)_0 = (g, \varphi)_0$ then $f = g$.

8.7 Examples

8.7.1 Equation Example

■ **Example 8.1** Let $G = \{x \in \mathbb{R}^2 : |x| < 3\}$ and denoted by: $x^0 = (1, 1)$; consider the function:

$$f(x) = \begin{cases} e^{|x|} & \text{si } |x - x^0| \leq 1/2 \\ 0 & \text{si } |x - x^0| > 1/2 \end{cases} \quad (8.8)$$

The function f has bounded support, we can take $A = \{x \in \mathbb{R}^2 : |x - x^0| \leq 1/2 + \varepsilon\}$ for all $\varepsilon \in]0; 5/2 - \sqrt{2}[$. ■

8.7.2 Text Example

■ **Example 8.2 — Example name.** Aliquam arcu turpis, ultrices sed luctus ac, vehicula id metus. Morbi eu feugiat velit, et tempus augue. Proin ac mattis tortor. Donec tincidunt, ante rhoncus luctus semper, arcu lorem lobortis justo, nec convallis ante quam quis lectus. Aenean tincidunt sodales massa, et hendrerit tellus mattis ac. Sed non pretium nibh. Donec cursus maximus luctus. Vivamus lobortis eros et massa porta porttitor. ■

8.8 Exercises

Exercise 8.1 This is a good place to ask a question to test learning progress or further cement ideas into students' minds. ■

8.9 Problems

Problem 8.1 What is the average airspeed velocity of an unladen swallow?

8.10 Vocabulary

Define a word to improve a students' vocabulary.

- **Vocabulary 8.1 — Word.** Definition of word.



9. Presenting Information and Results with a Long Chapter Title

9.1 Table

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Treatments	Response	Response
	1	2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 9.1: Table caption.

Referencing Table 9.1 in-text using its label.

Treatments	Response	Response
	1	2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 9.2: Floating table.

9.2 Figure

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Figure 9.1: Figure caption.

Referencing Figure 9.1 in-text using its label.

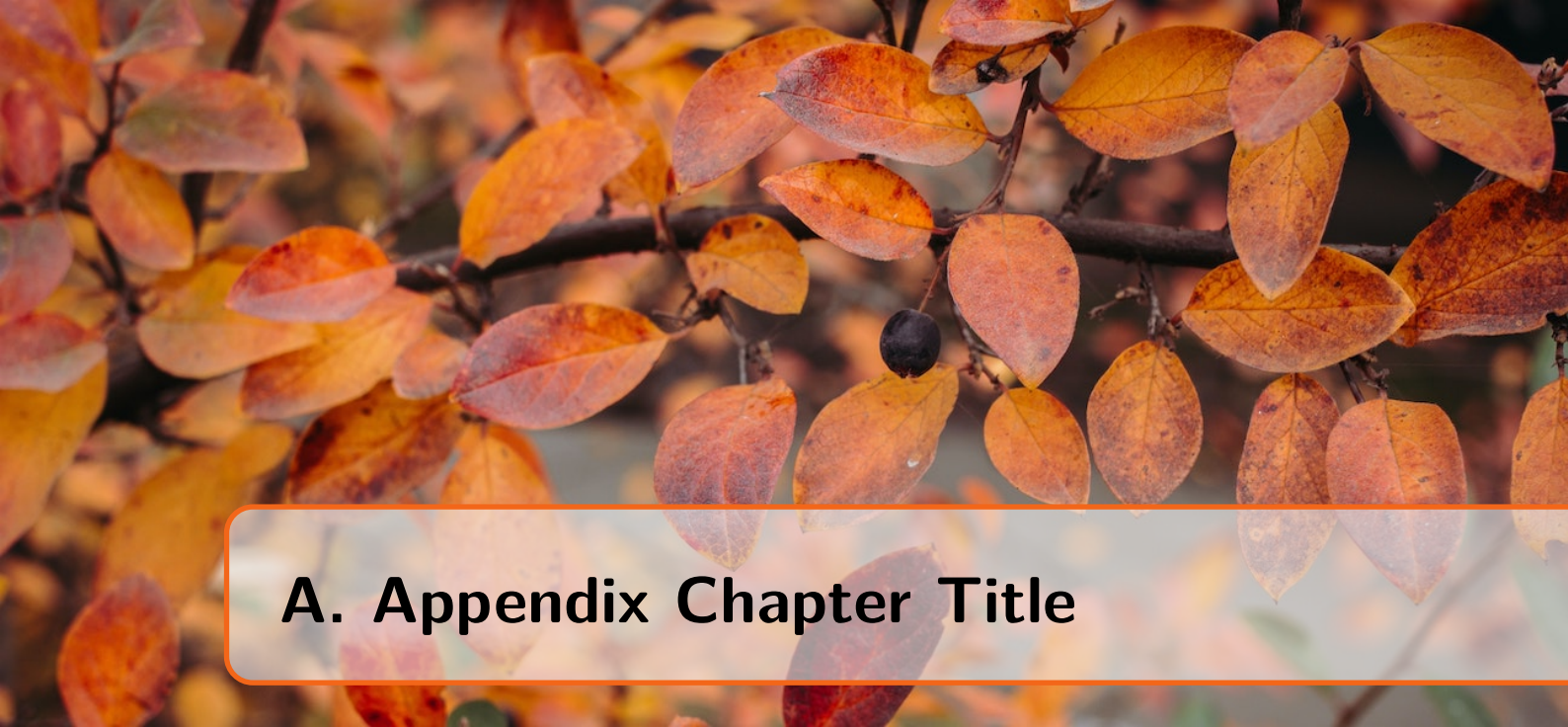


Figure 9.2: Floating figure.

Bibliography

Articles

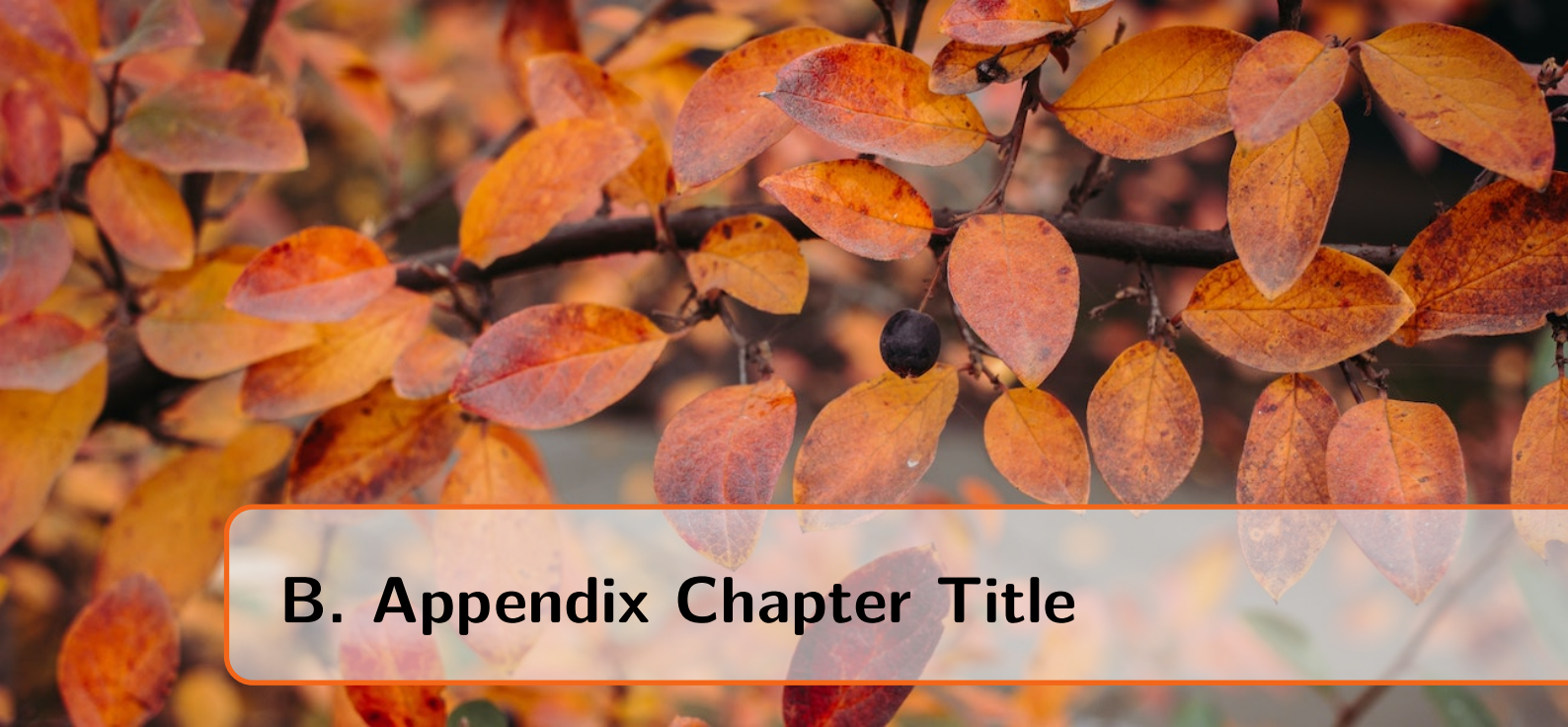
Books



A. Appendix Chapter Title

A.1 Appendix Section Title

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B. Appendix Chapter Title

B.1 Appendix Section Title

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