Solution Manual for **Pattern Recognition and Machine Learning**

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Chapter 1

Introduction

1.1 EXERCISES

Example:Polynomial Curve Fitting

1. Consider the sum-of-squares error function given by (1.2) in which the function $y(x, w)$ is given by the polynomial (1.1). Show that the coefficients $\mathbf{w} = \{w_i\}$ that minimize this error function are given by the solution to the following set of linear equations

$$\sum_{j=0}^{M} A_{ij} w_j = T_i$$

where

$$A_{ij} = \sum_{n=1}^{N} (x_n)^{i+j}, \qquad T_i = \sum_{n=1}^{N} (x_n)^i t_n.$$

Here a suffix i or j denotes the index of a component, whereas $(x)^i$ denotes x raised to the power of i.

Solution:

(1.1) $y(x, \mathbf{w}) = \sum_{j=0}^{M} w_j x^j$, (1.2) $E(\mathbf{w}) = \frac{1}{2} \sum_{n=1}{}_{N} y(x_n, \mathbf{w}) - {t_n}^2$

i. $\frac{dy}{dx} - \sin(x + y) = 0$ **ii.** $\frac{dy}{dx} = 4y^2 - 3y + 1$

iii. $\frac{ds}{dt} = t \ln(s^{2t}) + 8t^2$

Chapter 2

Below are all samples.

2.1 EXERCISES

1. In problem i.-iii., determine whether the given differential equation is separable

i. $\frac{dy}{dx} - \sin(x+y) = 0$ **ii.** $\frac{dy}{dx} = 4y^2 - 3y + 1$

iii. $\frac{ds}{dt} = t\ln(s^{2t}) + 8t^2$

2. In problem iv.-vii., solve the equation

iv. $\frac{dx}{dt} = 3xt^2$ **v.** $y^{-1}dy + ye^{\cos x}\sin x dx = 0$

vi. $(x + xy^2)dx + ye^{\cos x}\sin x dx = 0$ **vii.** $\frac{dy}{dt} = \frac{y}{t+1} + 4t^2 + 4t, \quad y(1) = 10$

2.2 EXERCISES

Another exercise.

1. If you don't need a horizontal list, you can simply use `\Question`

Chapter 3

Second

3.1 EXERCISES

1. Eight systems of differential equations and five direction fields are given below. Determine the system that corresponds to each direction field and sketch the solution curves that correspond to the initial conditions $(x_0, y_0) = (0, 1)$ and $(x_0, y_0) = (1, -1)$.

i. $$\frac{dx}{dt} = -x, \quad \frac{dy}{dt} = y - 1$$

ii. $$\frac{dx}{dt} = x^2 - 1, \quad \frac{dy}{dt} = y$$

iii. $$\frac{dx}{dt} = x + 2y, \quad \frac{dy}{dt} = -y$$

iv. $$\frac{dx}{dt} = 2x, \quad \frac{dy}{dt} = y$$

v. $$\frac{dx}{dt} = x, \quad \frac{dy}{dt} = 2y$$

vi. $$\frac{dx}{dt} = x - 1, \quad \frac{dy}{dt} = -y$$

vii. $$\frac{dx}{dt} = x^2 - 1, \quad \frac{dy}{dt} = -y$$

viii. $$\frac{dx}{dt} = x - 2y, \quad \frac{dy}{dt} = -y$$

3.2 EXERCISES

Since these are systems, maybe it's better to put the `aligned` enviroment within `\left\{` and `\right.`:

1. Eight systems of differential equations and five direction fields are given below. Determine the system that corresponds to each direction field and sketch the solution curves that correspond to the initial conditions $(x_0, y_0) = (0, 1)$ and $(x_0, y_0) = (1, -1)$.

i. $$\left\{\begin{aligned} \frac{dx}{dt} &= -x \\ \frac{dy}{dt} &= y - 1 \end{aligned}\right.$$

ii. $$\left\{\begin{aligned} \frac{dx}{dt} &= x^2 - 1 \\ \frac{dy}{dt} &= y \end{aligned}\right.$$

iii. $$\left\{\begin{aligned} \frac{dx}{dt} &= x + 2y \\ \frac{dy}{dt} &= -y \end{aligned}\right.$$

iv. $$\left\{\begin{aligned} \frac{dx}{dt} &= 2x \\ \frac{dy}{dt} &= y \end{aligned}\right.$$

v. $$\left\{\begin{aligned} \frac{dx}{dt} &= x \\ \frac{dy}{dt} &= 2y \end{aligned}\right.$$

vi. $$\left\{\begin{aligned} \frac{dx}{dt} &= x - 1 \\ \frac{dy}{dt} &= -y \end{aligned}\right.$$

vii. $$\left\{\begin{aligned} \frac{dx}{dt} &= x^2 - 1 \\ \frac{dy}{dt} &= -y \end{aligned}\right.$$

viii. $$\left\{\begin{aligned} \frac{dx}{dt} &= x - 2y \\ \frac{dy}{dt} &= -y \end{aligned}\right.$$

Chapter 4

Answer to all problems

CHAPTER 2

Exercises 2.1, page 5

1. **i.** This is a solution of Ex 1
   ii. This is a solution of Ex 2
   iii. This is a solution of Ex 3
2. **iv.** This is a solution of Ex 4
   v. This is a solution of Ex 5
   vi. This is a solution of Ex 6
   vii. This is a solution of Ex 7

Exercises 2.2, page 5

1. This is a solution of Ex 1

CHAPTER 3

Exercises 3.1, page 7

1. **i.** This is a solution of Ex 1
   ii. This is a solution of Ex 2
   iii. This is a solution of Ex 3
   iv. This is a solution of Ex 4
   v. This is a solution of Ex 5
   vi. This is a solution of Ex 6
   vii. This is a solution of Ex 7
   viii. This is a solution of Ex 8

Exercises 3.2, page 8

1. **i.** This is a solution of Ex 1
   ii. This is a solution of Ex 2
   iii. This is a solution of Ex 3
   iv. This is a solution of Ex 4
   v. This is a solution of Ex 5
   vi. This is a solution of Ex 6
   vii. This is a solution of Ex 7
   viii. This is a solution of Ex 8