# Contents

# Chapter 1

# Introduction

## 1.1 Curve Fitting

### Problem 1

This can be solved by substituting the definition of:

$$y(x, \mathbf{w}) = \sum_{j=0}^{M} w_j x^j$$

into the error function and then taking the derivative.

$$\begin{aligned}
E(\mathbf{w}) &= \frac{1}{2} \sum_{n=1}^{N} (y(x, \mathbf{w}) - t_n)^2 \\
&= \frac{1}{2} \sum_{n=1}^{N} \left( \sum_{j=0}^{M} w_j x^j - t_n \right)^2 && \text{Substitute} \\
\frac{dE(\mathbf{w})}{dw_i} &= \sum_{n=1}^{N} \left( \left( \sum_{j=0}^{M} w_j x^j - t_n \right) x^i \right) && \text{Take the derivative} \\
0 &= \sum_{n=1}^{N} \left( \left( \sum_{j=0}^{M} w_j x^j - t_n \right) x^i \right) && \text{Set derivative to 0} \\
0 &= \sum_{n=1}^{N} \left( \sum_{j=0}^{M} w_j x^j x^i - t_n x^i \right) && \text{Set derivative to 0} \\
\sum_{n=1}^{N} t_n x^i &= \sum_{n=1}^{N} \sum_{j=0}^{M} w_j x^j x^i \\
\sum_{n=1}^{N} t_n x^i &= \sum_{n=1}^{N} \sum_{j=0}^{M} w_j x^{i+j}
\end{aligned}$$

### Problem 2

This is solved in almost the same way we just have one additional term for the regularization so:

$$
\begin{aligned}
E(\mathbf{w}) &= \frac{1}{2}\sum_{n=1}^{N}(y(x,\mathbf{w})-t_n)^2 + \frac{\lambda}{2}\|\mathbf{w}\|^2 \\
&= \frac{1}{2}\sum_{n=1}^{N}\left(\sum_{j=0}^{M} w_j x^j - t_n\right)^2 + \frac{\lambda}{2}\|\mathbf{w}\|^2
\end{aligned}
$$

$$
\frac{dE(\mathbf{w})}{dw_i} = \sum_{n=1}^{N}\left(\left(\sum_{j=0}^{M} w_j x^j - t_n\right)x^i\right) + \lambda w_i
$$

$$
\begin{aligned}
-\lambda w_i &= \sum_{n=1}^{N}\left(\left(\sum_{j=0}^{M} w_j x^j - t_n\right)x^i\right) + \lambda w_i \\
-\lambda w_i &= \sum_{n=1}^{N}\left(\sum_{j=0}^{M} w_j x^j x^i - t_n x^i\right) \\
\sum_{n=1}^{N} t_n x^i - \lambda w_i &= \sum_{n=1}^{N}\sum_{j=0}^{M} w_j x^j x^i \\
\sum_{n=1}^{N} t_n x^i - \lambda w_i &= \sum_{n=1}^{N}\sum_{j=0}^{M} w_j x^{i+j}
\end{aligned}
$$

## 1.2 Probability Theory

### Problem 3

The Probability of Selecting an Apple can be decomposed as:

$$
\begin{aligned}
\mathcal{P}(apple) &= \mathcal{P}(apple, red) + \mathcal{P}(apple, blue) + prob(apple, green) \\
&= \mathcal{P}(apple|red)\mathcal{P}(red) + \mathcal{P}(apple|blue)\mathcal{P}(blue) + \mathcal{P}(apple|green)\mathcal{P}(green) \\
&=
\end{aligned}
$$

The probability that observing an orange came from the green box can be solved using Bayes rule:

$$a$$