

L^AT_EX 2_ε Workshop Complements

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Abstract

Some of the materials are are extracted from *STATS 782 FC 2002* notes by Dr. Ross Ihaka, of the Department of Statistics. The tables in Section 3 are extracted from my *STATS 780 SC 2002* Assignment 2.

1 Basic Document Layout

The basic structure of a $\text{\LaTeX} 2_{\epsilon}$ document is always:

```
\documentclass[ options ]{ format }  
...  
\begin{document}  
...  
\end{document}
```

Most commonly, the *format* specification is “**article**” but you may also encounter “**report**,” “**book**” and “**letter**.” The *options* specification consists of a comma-separated list of options. The most common of these are the page size (usually “**a4paper**” or “**letterpaper**”) and the font size (one of “**10pt**,” “**11pt**” or “**12pt**”).

The region between the `\documentclass` and `\begin{document}` is called the *document preamble* and usually consists of a series of extension package inclusions of the form

```
\usepackage{ package-name }
```

For example, the statement

```
\usepackage{times}
```

causes the document to be typeset using a Times-Roman font, rather than the default Computer-Modern font.

The region between `\begin{document}` and `\end{document}` is called the document body. It contains the text to be typeset together with the $\text{\LaTeX} 2_{\epsilon}$ markup instructions.

XEmacs Shortcuts

If you open a new $\text{\LaTeX} 2_{\epsilon}$ document with XEmacs, you can create the basic document structure by typing the keystrokes **C-c C-e** (insert environment). The minibuffer at the bottom of the frame will then contain the line:

```
Environment type: (default document)
```

which is asking you to verify that the environment to be inserted is a the basic template. You can confirm that this is what you want by pressing the enter key. You will then be asked to specify your desired format (the default is **article**) and a list of options.

2 Sectioning

An article consists of a number of sections (and subsections), each preceded by a header. Sections are declared with the $\text{\LaTeX} 2_{\epsilon}$ declaration

```
\section{ section-name }
```

and subsections are declared with a `\subsection` declaration. These declarations result in numbered sections and subsections. There are also `*`-variants which can be used to produce unnumbered sections and subsections.

```
\section*{ section-name }
```

Numbered sections and subsections can be labelled so that they can be referenced from elsewhere in the document. This is done by following the section or subsection declaration by a `\label` declaration. Labelled sections can be referenced from anywhere in the document using their label. When the document is typeset, the label is replaced by the section number.

```
\section{An Important Section}
\label{sec:important}
...
In section \ref{sec:important} it was proposed ...
```

XEmacs Shortcuts

In XEmacs, you can insert a section or subsection by typing `C-c C-s`. You will then be asked what level of sectioning you desire (section, subsection, subsubsection) and for the section title and label. If you don't want a label, just type the Enter key when asked.

3 Tables

3.1 Five Largest Canadian Cities

The population for Canada's five largest cities are shown in Table 1¹.

Table 1: Population in Five Largest Cities in Canada

	City	Province	2001 Population	1996 Population
1	Toronto	Ont	4 682 897	4 263 759
2	Montreal	Que	3 426 350	3 326 447
3	Vancouver	BC	1 986 965	1 831 665
4	Ottawa.Hull	Ont/Que	1 063 664	998 718
5	Calgary	Alta	951 395	821 628

3.2 Alcohol Available for Consumption

The tables² are shown in Table 2 to 3.

Table 2: Litres of Beverage

Quarters	Beer	Spirits	Wine	Total
<i>in 1 000 000 Litres</i>				
Mar-90	88.39	2.20		90.59
Jun-90	84.19	2.90		87.08
Sep-90	90.32	3.08		93.40
Dec-90	117.69	3.67		121.35
Mar-91	84.77	2.23		86.99
Jun-91	83.15	2.44		85.59
Sep-91	80.54	3.18		83.71
Dec-91	112.40	3.13		115.53
Mar-92	83.22	2.12		85.34
Jun-92	82.74	2.50		85.24
Sep-92	82.42	2.58		85.00
Dec-92	113.26	3.68		116.94
Mar-93	80.76	1.89		82.65
Jun-93	78.50	2.50		80.99
Sep-93	80.90	2.52		83.42
Dec-93	112.99	2.97		115.95
Mar-94	86.19	2.25		88.44
Jun-94	79.84	2.72		82.56
Sep-94	80.19	3.36	13.68	97.22
Dec-94	108.89	3.58	21.77	134.24
Mar-95	83.91	2.49	12.74	99.14
Jun-95	80.28	2.53	15.12	97.93
Sep-95	78.17	3.44	14.63	96.25
Dec-95	107.36	3.10	21.05	131.51

continued on next page

¹Source: <http://www12.statcan.ca/english/census01/products/standard/popdwell/Table-CMA-N.cfm?T=1&SR=1&S=3&O=D>

²Source: Statistics New Zealand

<i>continued from previous page</i>				
Quarters	Beer	Spirits	Wine	Total
Mar-96	83.40	3.04	13.35	99.79
Jun-96	80.53	3.34	15.30	99.17
Sep-96	71.76	2.73	15.21	89.70
Dec-96	101.56	3.57	22.23	127.36
Mar-97	73.74	2.60	13.36	89.70
Jun-97	71.04	4.14	15.71	90.89
Sep-97	69.42	3.57	15.09	88.08
Dec-97	101.40	8.53	23.32	133.25
Mar-98	76.53	5.75	12.90	95.18
Jun-98	73.89	6.53	15.49	95.91
Sep-98	68.10	6.08	15.66	89.84
Dec-98	96.88	8.95	22.88	128.71
Mar-99	76.38	5.61	13.88	95.87
Jun-99	66.07	6.08	16.62	88.78
Sep-99	70.33	7.30	16.79	94.42
Dec-99	104.13	9.81	25.01	138.96
Mar-00	72.06	6.55	13.26	91.87
Jun-00	68.69	7.51	17.06	93.26
Sep-00	68.00	8.96	16.41	93.37
Dec-00	96.87	11.19	25.11	133.17
Mar-01	73.86	7.54	11.49	92.89
Jun-01	67.42	9.29	16.65	93.35
Sep-01	69.25	8.11	18.20	95.56
Dec-01	95.81	12.67	24.53	133.02
Mar-02	74.86	8.51	14.84	98.22

Table 3: Litres of Alcohol Per Head of Population

Quarters	15 Years	18 Years	20 Years	Total Population
<i>in unit Litre</i>				
Mar-90	2.20	2.36	2.49	1.70
Jun-90	2.29	2.45	2.58	1.76
Sep-90	2.55	2.74	2.88	1.96
Dec-90	3.27	3.50	3.69	2.52
Mar-91	2.17	2.31	2.43	1.67
Jun-91	2.26	2.42	2.54	1.74
Sep-91	2.34	2.50	2.64	1.79
Dec-91	3.09	3.29	3.46	2.36
Mar-92	2.11	2.25	2.36	1.62
Jun-92	2.19	2.33	2.45	1.68
Sep-92	2.31	2.47	2.59	1.77
Dec-92	3.17	3.37	3.54	2.43
Mar-93	1.99	2.11	2.21	1.53
Jun-93	2.16	2.30	2.41	1.66
Sep-93	2.18	2.31	2.42	1.67
Dec-93	2.96	3.14	3.29	2.28
Mar-94	2.16	2.29	2.39	1.66
Jun-94	2.20	2.34	2.45	1.69
Sep-94	2.21	2.35	2.45	1.69
Dec-94	2.94	3.12	3.26	2.26

continued on next page

<i>continued from previous page</i>				
Quarters	15 Years	18 Years	20 Years	Total Population
Mar-95	2.09	2.21	2.31	1.61
Jun-95	2.16	2.29	2.40	1.66
Sep-95	2.20	2.34	2.44	1.69
Dec-95	2.83	3.00	3.13	2.18
Mar-96	2.04	2.16	2.25	1.57
Jun-96	2.16	2.29	2.38	1.66
Sep-96	1.92	2.03	2.12	1.48
Dec-96	2.69	2.86	2.97	2.07
Mar-97	1.81	1.92	2.00	1.40
Jun-97	2.02	2.14	2.23	1.56
Sep-97	1.90	2.01	2.09	1.46
Dec-97	2.95	3.12	3.25	2.27
Mar-98	1.90	2.01	2.10	1.46
Jun-98	2.05	2.17	2.26	1.58
Sep-98	1.95	2.06	2.14	1.50
Dec-98	2.77	2.94	3.06	2.13
Mar-99	1.91	2.02	2.10	1.47
Jun-99	1.95	2.06	2.15	1.50
Sep-99	2.06	2.18	2.27	1.59
Dec-99	2.95	3.13	3.25	2.28
Mar-00	1.88	1.99	2.07	1.45
Jun-00	2.05	2.17	2.25	1.58
Sep-00	2.08	2.20	2.29	1.60
Dec-00	2.91	3.08	3.20	2.24
Mar-01	1.87	1.98	2.06	1.45
Jun-01	2.07	2.19	2.28	1.60
Sep-01	2.07	2.19	2.28	1.60
Dec-01	2.82	2.99	3.11	2.18
Mar-02	2.00	2.12	2.21	1.55

4 Least Square Estimates

(Extracted from Chapter 3 of STATS 310/792 notes.)

Suppose $Y \sim N(\mathbf{X}\beta, \sigma^2 I)$, where \mathbf{X} is an $n \times p$ matrix of rank p . Show that the least-squares estimate of β is equal to³ $\hat{\beta} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}$.

Suppose that the Y_i 's are normally distributed about

$$E(Y_i) = \mu_i(\beta) = \sum_{j=1}^p \beta_j x_{ij}$$

with a common variance, σ^2 . Then it is straightforward to find the MLE of β . We have

$$L(\beta) = \prod_{i=1}^n \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{1}{2\sigma^2} ((y_i - \mu_i(\beta)))^2\right) \quad (1)$$

so that

$$\ell(\beta) = -n \log(\sigma) - \frac{1}{2\sigma^2} \sum_{i=1}^n (y_i - \mu_i(\beta))^2 - \frac{n}{2} \log(2\pi)$$

It follows that the MLE of β minimises:

$$\begin{aligned} S(\beta) &= \sum_{i=1}^n (y_i - \mu_i(\beta))^2 \\ &= (\mathbf{Y} - \mathbf{X}\beta)^T (\mathbf{Y} - \mathbf{X}\beta) \\ &= \|\mathbf{Y} - \mathbf{X}\beta\|^2 \end{aligned} \quad (2)$$

Now:

$$S(\beta) = \sum_{i=1}^n \left(y_i - \sum_{j=1}^p \beta_j x_{ij} \right)^2$$

Differentiating with respect to β_j 's:

$$\frac{\delta S}{\delta \beta_l} = -2 \sum_{i=1}^n x_{il} \left(y_i - \sum_{j=1}^p \beta_j x_{ij} \right) \quad l = 1, \dots, p$$

Setting this equal to zero:

$$\sum_{i=1}^n \sum_{j=1}^p \hat{\beta}_j x_{ij} x_{il} = \sum_{i=1}^n y_i x_{il}$$

This gives us the *Normal Equations*:

$$\mathbf{X}^T \mathbf{X} \hat{\beta} = \mathbf{X}^T \mathbf{Y}$$

If $\mathbf{X}^T \mathbf{X}$ is non-singular, there is a unique solution, i.e.

$$\hat{\beta} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}$$

³This is a cut-down version of the formal proof

5 Standard Normal Distribution

(Extracted from STATS 782FC 2002 Assignment 3)

The standard normal distribution function is defined by

$$\Phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-u^2/2} du.$$

Using the power series expansion

$$e^x = \sum_{k=0}^{\infty} \frac{x^k}{k!}$$

derive the following power series for $\Phi(z)$.

$$\Phi(z) = \frac{1}{2} + \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \frac{(-1)^n z^{2n+1}}{n! 2^n (2n+1)}$$

Put

$$\exp\left\{-\frac{u^2}{2}\right\} = \sum_{n=0}^{\infty} \frac{(-u^2/2)^n}{n!}$$

Then we have:

$$\begin{aligned} \Phi &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z \sum_{n=0}^{\infty} \frac{(-u^2/2)^n}{n!} du \\ &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} \\ &= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^0 \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} du + \frac{1}{\sqrt{2\pi}} \int_0^z \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} du \\ &= \frac{1}{2} + \sum_{n=0}^{\infty} \int_0^z \frac{(-1)^n u^{2n}}{2^n n!} du \\ &= \frac{1}{2} + \sum_{n=0}^{\infty} \left[\frac{(-1)^n u^{2n+1}}{2^n n! (2n+1)} \right]_{u=0}^{u=z} \\ &= \frac{1}{2} + \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \left[\frac{(-1)^n z^{2n+1}}{2^n n! (2n+1)} - \frac{(-1)^n 0^{2n+1}}{2^n n! (2n+1)} \right] \\ &= \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \frac{(-1)^n z^{2n+1}}{2^n n! (2n+1)} \end{aligned}$$

6 Graphics

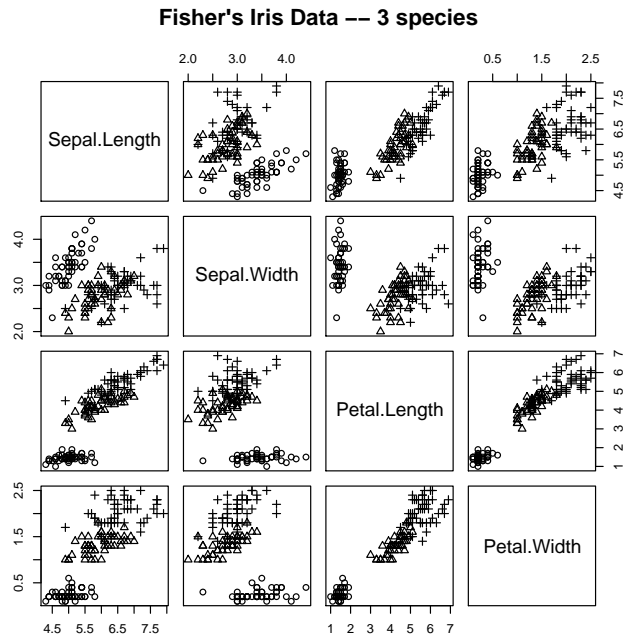


Figure 1: By Setting scale.

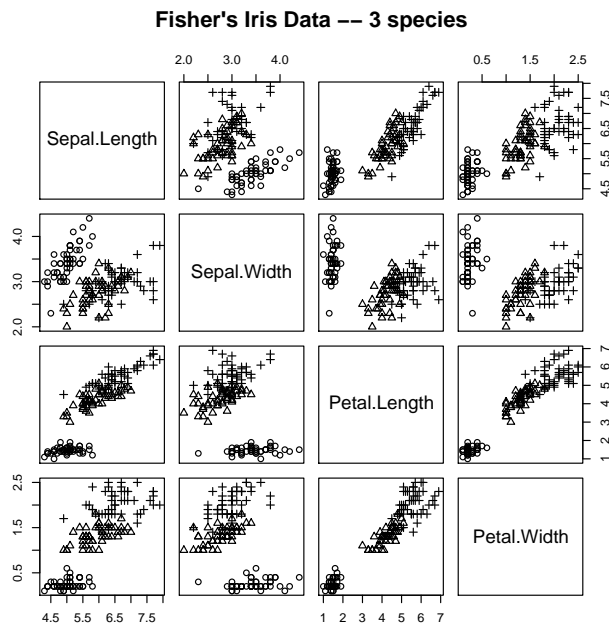


Figure 2: By Setting width.

7 Exercise

1. Typeset a short document that tells people your degree, major, research interests, where you were born and if not born in NZ, when you came to NZ. You must use at least 2 different font types, and either an `itemize` or an `enumerate` environment, you should also have several paragraphs (i.e. do not put everything in one paragraph).
2. The table on the next page shows the percentage of votes each party received and the corresponding seats in the parliament, in the 2002 New Zealand General Election⁴. Typeset the table into the document you have created above.

Table 4: 2002 General Election Results

Party	Votes	Seats
Labour	41.26	52
National	20.93	27
NZ First	10.38	13
Act	7.14	9
Green	7.00	9
United Future	6.69	8
Progressive Coalition	1.70	2

3. Typeset the following:

$$\mathcal{I}(\theta) = -E \left(\frac{\delta U}{\delta \theta} \right) = -E \left(\frac{\delta^2 \log f(\mathbf{X}; \theta)}{\delta \theta^2} \right)$$

4. Typeset the paragraph on the next page:

⁴Source: <http://www.electionresults.govt.nz/partystatus.html>

We say that a random variable X has a **Normal Distribution**, if it has a **Probability Density Function, P.D.F**:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\} \quad -\infty < x < \infty$$

where μ and σ^2 are the parameters of the distribution, and they satisfy $-\infty < x < \infty$, and $\sigma > 0$. We write $X \sim N(\mu, \sigma^2)$.

The mean is given by:

$$\begin{aligned} E(X) &= \int_{-\infty}^{\infty} xf(x) dx \\ &= \int_{-\infty}^{\infty} x \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\} dx \\ &= \int_{-\infty}^{\infty} (\mu + \sigma z) \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{z^2}{2}\right\} dz \quad (\text{setting } z = \frac{x-\mu}{\sigma}) \\ &= \mu \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{z^2}{2}\right\} dz + \sigma \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}} z \exp\left\{-\frac{z^2}{2}\right\} dz \\ &= \mu \times 1 + 0 \\ &= \mu \end{aligned}$$

These hints may be useful:

- ∞ is produced with `\infty`.
- A big horizontal space in the equation may be produced with `\quad`.
- \sim may be produced with `\sim`.
- A big left $\{$ and right $\}$, may be produced with `\left\{` and `\right\}`, respectively.
- In math mode, if you wish to typeset normal text, you may want to use `\mbox{}`.
- \times may be produced by `\times`.

8 L^AT_EX 2_ε Codes

```
\documentclass[a4paper]{article}
\usepackage{alltt}
\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{amssymb}
\usepackage{a4wide}
\usepackage{graphicx}
\usepackage{longtable}
\usepackage{url}
\usepackage{xspace}

\newcommand{\cmd}[1]{\char92#1}
\newcommand{\latex}{\LaTeXe\xspace}
\newcommand{\opt}[1]{\textrm{\textit{#1}}}

\begin{document}
\title{\textbf{\latex Workshop Complements}}
\author{Ko-Kang Kevin Wang \\\
        Master of Science Student and SLC Tutor \\\
        Department of Statistics \\\
        University of Auckland}
\date{}
\maketitle
\tableofcontents
\medskip
\listoffigures
\medskip
\listoftables

\bigskip
\bigskip
\bigskip
\begin{abstract}
    Some of the materials are are extracted from \emph{STATS 782 FC
    2002} notes by Dr. Ross Ihaka, of the Department of Statistics.
    The tables in Section \ref{sec:tables} are extracted from my
    \emph{STATS 780 SC 2002} Assignment 2.
\end{abstract}

\newpage
\section{Basic Document Layout}
The basic structure of a \latex document is always:
\begin{quote}
\begin{alltt}
\cmd{documentclass}[\opt{ options }]{\opt{ format }}
\(\cdots\)
\cmd{begin}\{document\}
\(\cdots\)
\cmd{end}\{document\}
\end{alltt}
\end{quote}

\noindent
Most commonly, the \textit{format} specification is
“\texttt{article}” but you may also encounter “\texttt{report},”
“\texttt{book}” and “\texttt{letter}.” The \textit{options}
```

specification consists of a comma-separated list of options. The most common of these are the page size (usually ‘\texttt{a4paper}’ or ‘\texttt{letterpaper}’) and the font size (one of ‘\texttt{10pt},’ ‘\texttt{11pt}’ or ‘\texttt{12pt}’). \\

\noindent

The region between the \texttt{\cmd{documentclass}} and \texttt{\cmd{begin}\{document\}} is called the \emph{document preamble} and usually consists of a series of extension package inclusions of the form

```
\begin{quote}
\begin{alltt}
\cmd{usepackage}\{\opt{ package-name }\}
\end{alltt}
\end{quote}
```

For example, the statement

```
\begin{quote}
\begin{alltt}
\cmd{usepackage}\{times\}
\end{alltt}
\end{quote}
```

causes the document to be typeset using a Times-Roman font, rather than the default Computer-Modern font. \\

\noindent

The region between \texttt{\cmd{begin}\{document\}} and \texttt{\cmd{end}\{document\}} is called the document body. It contains the text to be typeset together with the \latex markup instructions.

\subsection*{XEmacs Shortcuts}

If you open a new \latex document with XEmacs, you can create the basic document structure by typing the keystrokes \texttt{C-c C-e} (insert environment). The minibuffer at the bottom of the frame will then contain the line:

```
\begin{quote}
\begin{alltt}
Environment type: (default document)
\end{alltt}
\end{quote}
```

which is asking you to verify that the environment to be inserted is a the basic template. You can confirm that this is what you want by pressing the enter key. You will then be asked to specify your desired format (the default is \texttt{article}) and a list of options.

\newpage

\section{Sectioning}

An article consists of a number of sections (and subsections), each preceded by a header. Sections are declared with the \latex declaration

```
\begin{quote}
\begin{alltt}
\cmd{section}\{\opt{ section-name }\}
\end{alltt}
\end{quote}
```

and subsections are declared with a `\texttt{\cmd{subsection}}` declaration. These declarations result in numbered sections and subsections. There are also `\texttt{*}`-variants which can be used to produce unnumbered sections and subsections.

```
\begin{quote}
\begin{alltt}
\cmd{section*}\{\opt{ section-name }\}
\end{alltt}
\end{quote}
```

Numbered sections and subsections can be labelled so that they can be referenced from elsewhere in the document. This is done by following the section or subsection declaration by a `\texttt{\cmd{label}}` declaration. Labelled sections can be referenced from anywhere in the document using their label. When the document is typeset, the label is replaced by the section number.

```
\begin{quote}
\begin{alltt}
\cmd{section}\{An Important Section\}
\cmd{label}\{sec:important\}
\(\cdots\)
In section \cmd{ref}\{sec:important\} it was proposed \ldots
\end{alltt}
\end{quote}
```

`\subsection*{XEmacs Shortcuts}`

In XEmacs, you can insert a section or subsection by typing `\texttt{C-c C-s}`. You will then be asked what level of sectioning you desire (section, subsection, subsubsection) and for the section title and label. If you don't want a label, just type the Enter key when asked.

```
\newpage
\section{Tables}
\label{sec:tables}
```

```
\subsection{Five Largest Canadian Cities}
\label{sec:canada}
```

The population for Canada's five largest cities are shown in Table `\ref{tab:can}` `\footnote{Source:`

```
\url{http://www12.statcan.ca/english/census01/products/standard/popdwell/Table-CMA-N.cfm?T=1&SR=1&S=3&O=D}}
```

```
\begin{table}[tbh]
```

```
\begin{center}
```

```
\caption{Population in Five Largest Cities in Canada}\bigskip
```

```
\label{tab:can}
```

```
\begin{tabular}{rllrr}
```

```
& City & Province & 2001 Population & 1996 Population & \[2mm]
```

```
1 & Toronto & Ont & 4 682 897 & 4 263 759 \
```

```
2 & Montreal & Que & 3 426 350 & 3 326 447 \
```

```
3 & Vancouver & BC & 1 986 965 & 1 831 665 \
```

```
4 & Ottawa.Hull & Ont/Que & 1 063 664 & 998 718 \
```

```
5 & Calgary & Alta & 951 395 & 821 628 \[3mm]
```

```
\end{tabular}
```

```
\end{center}
```

```
\end{table}
```

```
\subsection{Alcohol Available for Consumption}
```

```
\label{sec:alc}
```

The tables\footnote{Source: Statistics New Zealand} are shown in Table \ref{tab:beverage} to \ref{tab:alcoholPopn}.

```

\setlongtables
\begin{longtable}[c]{|lrrrr|}
\caption{Litres of Beverage} \\\hline
\label{tab:beverage}
Quarters & Beer & Spirits & Wine & Total \\\
& \multicolumn{4}{c|}{\small\sl in 1 000 000 Litres} \\\hline
\endfirsthead
\hline
\multicolumn{5}{|c|}{\small\slshape continued from previous page} \\\
Quarters & Beer & Spirits & Wine & Total \\\hline
\endhead
\hline
\multicolumn{5}{|c|}{\small\sl continued on next page} \\\hline
\endfoot
\hline
\endlastfoot
Mar$-$90 & 88.39 & 2.20 & & 90.59 \\\
Jun$-$90 & 84.19 & 2.90 & & 87.08 \\\
Sep$-$90 & 90.32 & 3.08 & & 93.40 \\\
Dec$-$90 & 117.69 & 3.67 & & 121.35 \\\
Mar$-$91 & 84.77 & 2.23 & & 86.99 \\\
Jun$-$91 & 83.15 & 2.44 & & 85.59 \\\
Sep$-$91 & 80.54 & 3.18 & & 83.71 \\\
Dec$-$91 & 112.40 & 3.13 & & 115.53 \\\
Mar$-$92 & 83.22 & 2.12 & & 85.34 \\\
Jun$-$92 & 82.74 & 2.50 & & 85.24 \\\
Sep$-$92 & 82.42 & 2.58 & & 85.00 \\\
Dec$-$92 & 113.26 & 3.68 & & 116.94 \\\
Mar$-$93 & 80.76 & 1.89 & & 82.65 \\\
Jun$-$93 & 78.50 & 2.50 & & 80.99 \\\
Sep$-$93 & 80.90 & 2.52 & & 83.42 \\\
Dec$-$93 & 112.99 & 2.97 & & 115.95 \\\
Mar$-$94 & 86.19 & 2.25 & & 88.44 \\\
Jun$-$94 & 79.84 & 2.72 & & 82.56 \\\
Sep$-$94 & 80.19 & 3.36 & 13.68 & 97.22 \\\
Dec$-$94 & 108.89 & 3.58 & 21.77 & 134.24 \\\
Mar$-$95 & 83.91 & 2.49 & 12.74 & 99.14 \\\
Jun$-$95 & 80.28 & 2.53 & 15.12 & 97.93 \\\
Sep$-$95 & 78.17 & 3.44 & 14.63 & 96.25 \\\
Dec$-$95 & 107.36 & 3.10 & 21.05 & 131.51 \\\
Mar$-$96 & 83.40 & 3.04 & 13.35 & 99.79 \\\
Jun$-$96 & 80.53 & 3.34 & 15.30 & 99.17 \\\
Sep$-$96 & 71.76 & 2.73 & 15.21 & 89.70 \\\
Dec$-$96 & 101.56 & 3.57 & 22.23 & 127.36 \\\
Mar$-$97 & 73.74 & 2.60 & 13.36 & 89.70 \\\
Jun$-$97 & 71.04 & 4.14 & 15.71 & 90.89 \\\
Sep$-$97 & 69.42 & 3.57 & 15.09 & 88.08 \\\
Dec$-$97 & 101.40 & 8.53 & 23.32 & 133.25 \\\
Mar$-$98 & 76.53 & 5.75 & 12.90 & 95.18 \\\
Jun$-$98 & 73.89 & 6.53 & 15.49 & 95.91 \\\
Sep$-$98 & 68.10 & 6.08 & 15.66 & 89.84 \\\
Dec$-$98 & 96.88 & 8.95 & 22.88 & 128.71 \\\
Mar$-$99 & 76.38 & 5.61 & 13.88 & 95.87 \\\
Jun$-$99 & 66.07 & 6.08 & 16.62 & 88.78 \\\

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Sep$-$99 & 70.33 & 7.30 & 16.79 & 94.42 \\
Dec$-$99 & 104.13 & 9.81 & 25.01 & 138.96 \\
Mar$-$00 & 72.06 & 6.55 & 13.26 & 91.87 \\
Jun$-$00 & 68.69 & 7.51 & 17.06 & 93.26 \\
Sep$-$00 & 68.00 & 8.96 & 16.41 & 93.37 \\
Dec$-$00 & 96.87 & 11.19 & 25.11 & 133.17 \\
Mar$-$01 & 73.86 & 7.54 & 11.49 & 92.89 \\
Jun$-$01 & 67.42 & 9.29 & 16.65 & 93.35 \\
Sep$-$01 & 69.25 & 8.11 & 18.20 & 95.56 \\
Dec$-$01 & 95.81 & 12.67 & 24.53 & 133.02 \\
Mar$-$02 & 74.86 & 8.51 & 14.84 & 98.22 \\
\end{longtable}

```

```

\setlongtables
\begin{longtable}[c]{|lrrrr|}
\caption{Litres of Alcohol Per Head of Population} \\ \hline
\label{tab:alcoholPopn}
Quarters & 15 Years & 18 Years & 20 Years & Total Population \\
& \multicolumn{4}{c|}{\small\sl in unit Litre} \\ \hline
\endfirsthead
\hline
\multicolumn{5}{|c|}{\small\slshape continued from previous page} \\
Quarters & 15 Years & 18 Years & 20 Years & Total Population \\ \hline
\endhead
\hline
\multicolumn{5}{|c|}{\small\sl continued on next page} \\ \hline
\endfoot
\hline
\endlastfoot
%\hline
Mar$-$90 & 2.20 & 2.36 & 2.49 & 1.70 \\
Jun$-$90 & 2.29 & 2.45 & 2.58 & 1.76 \\
Sep$-$90 & 2.55 & 2.74 & 2.88 & 1.96 \\
Dec$-$90 & 3.27 & 3.50 & 3.69 & 2.52 \\
Mar$-$91 & 2.17 & 2.31 & 2.43 & 1.67 \\
Jun$-$91 & 2.26 & 2.42 & 2.54 & 1.74 \\
Sep$-$91 & 2.34 & 2.50 & 2.64 & 1.79 \\
Dec$-$91 & 3.09 & 3.29 & 3.46 & 2.36 \\
Mar$-$92 & 2.11 & 2.25 & 2.36 & 1.62 \\
Jun$-$92 & 2.19 & 2.33 & 2.45 & 1.68 \\
Sep$-$92 & 2.31 & 2.47 & 2.59 & 1.77 \\
Dec$-$92 & 3.17 & 3.37 & 3.54 & 2.43 \\
Mar$-$93 & 1.99 & 2.11 & 2.21 & 1.53 \\
Jun$-$93 & 2.16 & 2.30 & 2.41 & 1.66 \\
Sep$-$93 & 2.18 & 2.31 & 2.42 & 1.67 \\
Dec$-$93 & 2.96 & 3.14 & 3.29 & 2.28 \\
Mar$-$94 & 2.16 & 2.29 & 2.39 & 1.66 \\
Jun$-$94 & 2.20 & 2.34 & 2.45 & 1.69 \\
Sep$-$94 & 2.21 & 2.35 & 2.45 & 1.69 \\
Dec$-$94 & 2.94 & 3.12 & 3.26 & 2.26 \\
Mar$-$95 & 2.09 & 2.21 & 2.31 & 1.61 \\
Jun$-$95 & 2.16 & 2.29 & 2.40 & 1.66 \\
Sep$-$95 & 2.20 & 2.34 & 2.44 & 1.69 \\
Dec$-$95 & 2.83 & 3.00 & 3.13 & 2.18 \\
Mar$-$96 & 2.04 & 2.16 & 2.25 & 1.57 \\
Jun$-$96 & 2.16 & 2.29 & 2.38 & 1.66 \\
Sep$-$96 & 1.92 & 2.03 & 2.12 & 1.48 \\
Dec$-$96 & 2.69 & 2.86 & 2.97 & 2.07 \\

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Mar$-$97 & 1.81 & 1.92 & 2.00 & 1.40 \\
Jun$-$97 & 2.02 & 2.14 & 2.23 & 1.56 \\
Sep$-$97 & 1.90 & 2.01 & 2.09 & 1.46 \\
Dec$-$97 & 2.95 & 3.12 & 3.25 & 2.27 \\
Mar$-$98 & 1.90 & 2.01 & 2.10 & 1.46 \\
Jun$-$98 & 2.05 & 2.17 & 2.26 & 1.58 \\
Sep$-$98 & 1.95 & 2.06 & 2.14 & 1.50 \\
Dec$-$98 & 2.77 & 2.94 & 3.06 & 2.13 \\
Mar$-$99 & 1.91 & 2.02 & 2.10 & 1.47 \\
Jun$-$99 & 1.95 & 2.06 & 2.15 & 1.50 \\
Sep$-$99 & 2.06 & 2.18 & 2.27 & 1.59 \\
Dec$-$99 & 2.95 & 3.13 & 3.25 & 2.28 \\
Mar$-$00 & 1.88 & 1.99 & 2.07 & 1.45 \\
Jun$-$00 & 2.05 & 2.17 & 2.25 & 1.58 \\
Sep$-$00 & 2.08 & 2.20 & 2.29 & 1.60 \\
Dec$-$00 & 2.91 & 3.08 & 3.20 & 2.24 \\
Mar$-$01 & 1.87 & 1.98 & 2.06 & 1.45 \\
Jun$-$01 & 2.07 & 2.19 & 2.28 & 1.60 \\
Sep$-$01 & 2.07 & 2.19 & 2.28 & 1.60 \\
Dec$-$01 & 2.82 & 2.99 & 3.11 & 2.18 \\
Mar$-$02 & 2.00 & 2.12 & 2.21 & 1.55 \\
\end{longtable}

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\newpage
\section{Least Square Estimates}
\label{sec:ls}

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\noindent
(Extracted from Chapter 3 of STATS 310/792 notes.) \\

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\noindent
Suppose  $Y \sim N(\mathbf{X}\beta, \sigma^2 I)$ , where  $\mathbf{X}$  is
an  $n \times p$  matrix of rank  $p$ . Show that the least-squares
estimate of  $\beta$  is equal tofootnote{This is a cut-down version of
the formal proof}  $\hat{\beta} = (X^T X)^{-1} X^T Y$ . \\

```

```

\noindent
Suppose that the  $Y_i$ 's are normally distributed about
\[
E(Y_i) = \mu_i(\beta) = \sum_{j=1}^p \beta_j x_{ij}
\]

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\noindent
with a common variance,  $\sigma^2$ . Then it is straightforward to
find the MLE of  $\beta$ . We have

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```

\begin{eqnarray}
\label{eqn:L}
L(\beta) &= & \prod_{i=1}^n
& \frac{1}{\sqrt{2\pi}\sigma}
& \exp\left\{-\frac{1}{2\sigma^2}
& \left(y_i - \mu_i(\beta)\right)^2
& \right\}
\end{eqnarray}

```

```

\noindent
so that
\[
\ell(\beta) = -n \log\{\sigma\} -

```

$$\frac{1}{2\sigma^2} \sum_{i=1}^n (y_i - \mu_i(\beta))^2 - \frac{n}{2} \log(2\pi)$$

\noindent

It follows that the MLE of β minimises:

$$\begin{aligned} S(\beta) &= \sum_{i=1}^n (y_i - \mu_i(\beta))^2 \\ &= (\mathbf{Y} - \mathbf{X}\beta)^T (\mathbf{Y} - \mathbf{X}\beta) \\ &= \|\mathbf{Y} - \mathbf{X}\beta\|^2 \end{aligned}$$

\noindent

Now:

$$S(\beta) = \sum_{i=1}^n \left(y_i - \sum_{j=1}^p \beta_j x_{ij} \right)^2$$

\noindent

Differentiating with respect to β_j 's:

$$\frac{\partial S}{\partial \beta_1} = -2 \sum_{i=1}^n x_{i1} \left(y_i - \sum_{j=1}^p \beta_j x_{ij} \right)$$

$l = 1, \dots, p$

\noindent

Setting this equal to zero:

$$\sum_{i=1}^n \sum_{j=1}^p \hat{\beta}_j x_{ij} x_{il} = \sum_{i=1}^n y_i x_{il}$$

\noindent

This gives us the **Normal Equations**:

$$\mathbf{X}^T \mathbf{X} \hat{\beta} = \mathbf{X}^T \mathbf{Y}$$

\noindent

If $\mathbf{X}^T \mathbf{X}$ is non-singular, there is a unique solution, i.e.

$$\hat{\beta} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}$$

\]

\newpage
\section{Standard Normal Distribution}
\label{sec:normal}

\noindent
(Extracted from STATS 782FC 2002 Assignment 3) \\
\noindent

The standard normal distribution function is defined by
\[
\Phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-u^2/2} du.
\]

Using the power series expansion

\[
e^x = \sum_{k=0}^{\infty} \frac{x^k}{k!}

\] derive the following power series for $\Phi(z)$.
\[

\Phi(z) = \frac{1}{2} + \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \frac{(-1)^n z^{2n+1}}{n! 2^{n(2n+1)}}\]

\noindent

Put
\[
\exp\left\{-\frac{u^2}{2}\right\} = \sum_{n=0}^{\infty} \frac{\left(-u^2/2\right)^n}{n!}

\noindent

Then we have:

```
{\setlength\arraycolsep{2pt}
\begin{eqnarray*}
\Phi & = & \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z \sum_{n=0}^{\infty} \frac{\left(-u^2/2\right)^n}{n!} du \\
& = & \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} du \\
& = & \frac{1}{\sqrt{2\pi}} \int_0^z \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} du \\
& + & \frac{1}{\sqrt{2\pi}} \int_{-\infty}^0 \sum_{n=0}^{\infty} \frac{(-1)^n u^{2n}}{2^n n!} du \\
& = & \frac{1}{2} + \sum_{n=0}^{\infty} \int_0^z \frac{(-1)^n u^{2n}}{2^n n!} du \\
& = & \frac{1}{2} + \sum_{n=0}^{\infty} \left[ \frac{(-1)^n u^{2n+1}}{2^n n! (2n+1)} \right]_{u=0}^u \\
& = & \frac{1}{2} + \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \left[ \frac{(-1)^n z^{2n+1}}{2^n n! (2n+1)} - \frac{(-1)^n 0^{2n+1}}{2^n n! (2n+1)} \right] \\
& = & \frac{1}{\sqrt{2\pi}} \sum_{n=0}^{\infty} \frac{(-1)^n z^{2n+1}}{2^n n! (2n+1)}
\end{eqnarray*}
```

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\end{eqnarray*}
}

\newpage
\section{Graphics}
\label{sec:graph}

\begin{figure}[h!]
\centering
\begin{center}
\includegraphics[scale = .6, clip]{Iris}
\end{center}
\caption{By Setting scale.}
\label{fig:iris1}
\end{figure}

\begin{figure}[h!]
\centering
\begin{center}
\includegraphics[width = .6\textwidth, clip]{Iris}
\end{center}
\caption{By Setting width.}
\label{fig:iris2}
\end{figure}

\newpage
\section{Exercise}
\label{sec:ex}

\begin{enumerate}
\item Typeset a short document that tells people your degree, major,
research interests, where you were born and if not born in NZ, when
you came to NZ. You must use at least 2 different font types, and
either an \texttt{itemize} or an \texttt{enumerate} environment, you
should also have several paragraphs (i.e. do not put everything in
one paragraph).
\item The table on the next page shows the percentage of votes each
party received and the corresponding seats in the parliament, in the
2002 New Zealand General Election\footnote{Source:
\url{http://www.electionresults.govt.nz/partystatus.html}}.
Typeset the table into the document you have created above.
\begin{table}[htbp]
\centering
\caption{2002 General Election Results}\bigskip
\label{tab:election}
\begin{tabular}{lrr}
\textbf{Party} & \textbf{Votes} & \textbf{Seats}\\
Labour & 41.26 & 52 \\
National & 20.93 & 27 \\
NZ First & 10.38 & 13 \\
Act & 7.14 & 9 \\
Green & 7.00 & 9 \\
United Future & 6.69 & 8 \\
Progressive Coalition & 1.70 & 2 \\
\end{tabular}
\end{table}
\item Typeset the following:
% \[

```

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%   _1\mbox{F}_1 (a;b;z) =
%   1 + \frac{az}{b} + \frac{(a)_2 z^2}{(b)_2 2!}
%       + \cdots + \frac{(a)_n z^n}{(b)_n n!} + \cdots
% \]
% \[
% \mathcal{I}(\theta) = -E\left(\frac{\delta U}{\delta \theta}\right) =
% -E\left(\frac{\delta^2 \log f(\mathbf{X}; \theta)}{\delta \theta^2}\right)
% \]

\item Typeset the paragraph on the next page:
\newpage
\begin{center}
\line(1,0){190}
\end{center}
\begin{quote}
We say that a random variable  $X$  has a Normal
Distribution, if it has a Probability Density Function,
P.D.F):
\begin{eqnarray*}
\label{eq:standnorm}
f(x) &= & \frac{1}{\sqrt{2\pi}\sigma}
& \exp\left\{-\frac{(x - \mu)^2}{2\sigma^2}\right\} \\
& & \quad \quad \quad \text{\quad} \\
& & & -\infty < x < \infty
\end{eqnarray*}
where  $\mu$  and  $\sigma^2$  are the parameters of the distribution, and
they satisfy  $-\infty < x < \infty$ , and  $\sigma > 0$ . We write  $X$ 
 $\sim N(\mu, \sigma^2)$ .

The mean is given by:
\begin{eqnarray*}
E(X) &= & \int_{-\infty}^{\infty} xf(x) dx \\
&= & \int_{-\infty}^{\infty} x \frac{1}{\sqrt{2\pi}\sigma}
& \exp\left\{-\frac{(x - \mu)^2}{2\sigma^2}\right\} dx \\
&= & \int_{-\infty}^{\infty} (\mu + \sigma z) \frac{1}{\sqrt{2\pi}}
& \exp\left\{-\frac{z^2}{2}\right\} dz \\
& & (\text{setting } z = \frac{x - \mu}{\sigma}) \\
&= & \mu \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi}}
& \exp\left\{-\frac{z^2}{2}\right\} dz + \sigma \int_{-\infty}^{\infty}
& \frac{1}{\sqrt{2\pi}} z
& \exp\left\{-\frac{z^2}{2}\right\} dz \\
& & = \mu \times 1 + 0 \\
& & = \mu
\end{eqnarray*}
\end{quote}
\begin{center}
\line(1,0){190}
\end{center}

```

These hints may be useful:

```

\begin{itemize}
\item  $\infty$  is produced with \verb@\infty@.
\item A big horizontal space in the equation may be produced with
\verb@\quad@.
\item  $\sim$  may be produced with \verb@\sim@.
\item A big left  $\left\{\right.$  and right  $\left.\right\}$ , may be
produced with \verb@\left\{@ and \verb@\right\}@, respectively.
\item In math mode, if you wish to typeset normal text, you may
want to use \verb@\mbox{@.
\item  $\times$  may be produced by \verb@\times@.
\end{itemize}
\end{enumerate}

\newpage
\section{\latex Codes}
\label{sec:codes}

\end{document}

```