

RStudio is an application like Microsoft Word—except that instead of helping you write in English, RStudio helps you write in R. I use RStudio throughout the book because it makes using R much easier. Also, the RStudio interface looks the same for Windows, Mac OS, and Linux. That will help me match the book to your personal experience. You can download RStudio for free. Just click the “Download RStudio” button and follow the simple instructions that follow. Once you’ve installed RStudio, you can open it like any other program on your computer—usually by clicking an icon on your desktop.”

W. John Braum dan Duncan J. Murdoch dalam bukunya "A First Course in Statistical Programming with R" menyatakan sebagai berikut (2007, 1:4).

“R is an open-source computing package which has seen a huge growth in popularity in the last few years. Being open source, it is easily obtainable by students and economical to install in our computing lab. One of us (Murdoch) is a member of the R core development team, and the other (Braun) is a co-author of a book on data analysis using R. These facts made it easy for us to choose R, but we are both strong believers in the idea that there are certain universals of programming, and in this text we try to emphasize those: it is not a manual about programming in R, it is a course in statistical programming that uses R.

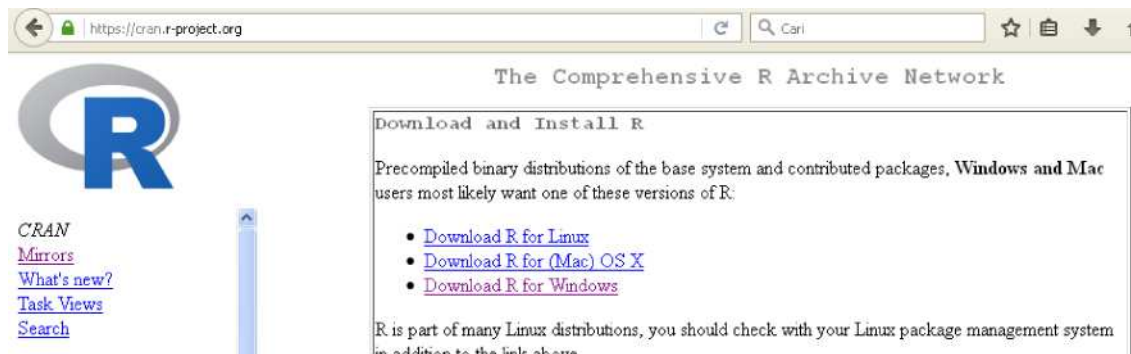
This book uses R, which is an open-source package for statistical computing. “Open source” has a number of different meanings; here the important one is that R is freely available, and its users are free to see how it is written, and to improve it. R is based on the computer language S, developed by John Chambers and others at Bell Laboratories in 1976. In 1993 Robert Gentleman and Ross Ihaka at the University of Auckland wanted to experiment with the language, so they developed an implementation, and named it R. They made it open source in 1995, and hundreds of people around the world have contributed to its development. S-PLUS is a commercial implementation of the S language. Because both R and S-PLUS are based on the S language, much of what is described in what follows will apply without change to S-PLUS.

R can be downloaded from <http://cran.r-project.org/>!. Most users should download and install a binary version. This is a version that has been translated (by compilers) into machine language for execution on a particular type of computer with a particular operating system. R is designed to be very portable: it will run on Microsoft Windows, Linux, Solaris, Mac OS X, and other operating systems, but different binary versions are required for each. In this book most of what we do would be the same on any system, but when we write system-specific instructions, we will assume that readers are using Microsoft Windows.”

Berdasarkan pemaparan sebelumnya terkait R, dapat ditarik informasi bahwa R merupakan bahasa pemrograman statistika yang dapat digunakan untuk analisis dan manipulasi data statistika (pemodelan statistika), dan grafik. R diciptakan (*was created*) oleh Ross Ihaka dan Robert Gentleman (nama depan sama-sama diawali dengan huruf R & R, **Ross** dan **Robert**) dari departemen statistika, di Universitas Auckland, New Zealand. Saat ini R dikembangkan oleh *R Development Core Team*. Munculnya R terinspirasi oleh bahasa statistika dengan nama S (*statistical language S*). Bahasa statistika S diciptakan oleh John Chambers dan rekan, di *Bell Labs* atau *AT&T Bell Laboratories*. Selain bahasa statistika S, bahasa pemrograman C juga dikembangkan di *AT&T Bell Laboratories*.

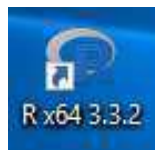
Beberapa *software* seperti SPSS, Minitab, SAS, EViews, dan sebagainya, perlu membayar sejumlah uang, untuk mendapatkan izin menggunakan, sementara R gratis. Di samping itu, R juga tersedia untuk di-*install* di sistem operasi *Windows*, *Mac OS X*, dan *Linux*. Gambar 1.1 merupakan tampilan

website <https://cran.r-project.org/>. Di website tersebut, R dapat di-download sesuai dengan sistem operasi. Jika sistem operasi yang digunakan adalah *Windows*, maka pilih *Download R for Windows*.

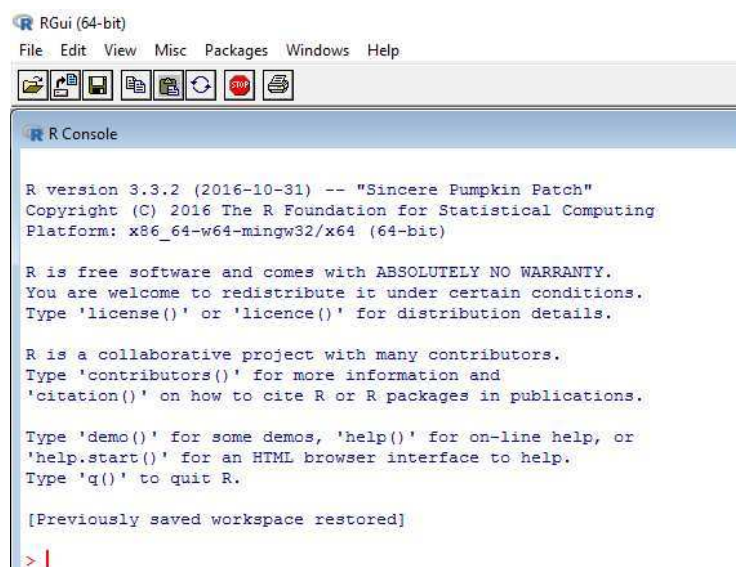


Gambar 1.1

Setelah *software R for Windows* di-download, di-install, dan dijalankan, maka akan muncul tampilan seperti pada Gambar 1.3. Pada Gambar 1.3, merupakan tampilan editor dasar R (*basic R editor*) ketika R dijalankan. Tampilan editor dasar R tersebut dikenal dengan nama *RGui*. *RGui* merupakan nama editor dasar R ketika *R for Windows* dijalankan, sementara nama editor dasar R ketika *R for Mac OS X* dijalankan adalah *R.app*.



Gambar 1.2 Lambang R Versi 3.3.2



Gambar 1.3 Editor Dasar *R for Windows* (RGui)

```

R Console

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Previously saved workspace restored]

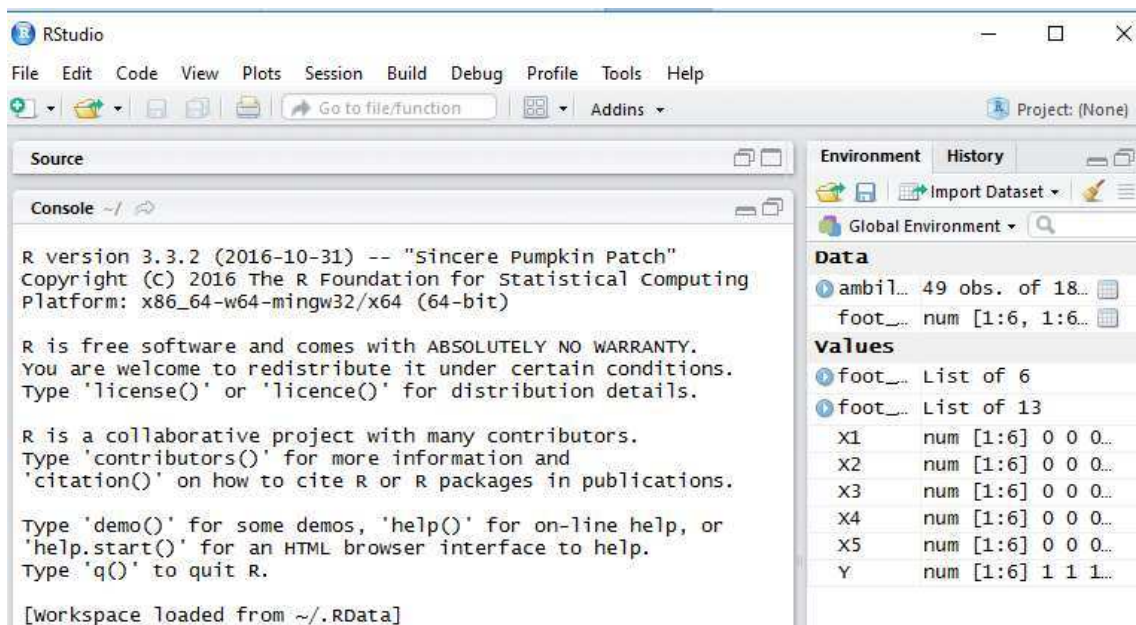
> A <- 1
> A
[1] 1
> B <- 5
> A+B
[1] 6
> C <- c(1,2,3)
> C
[1] 1 2 3
> |

```

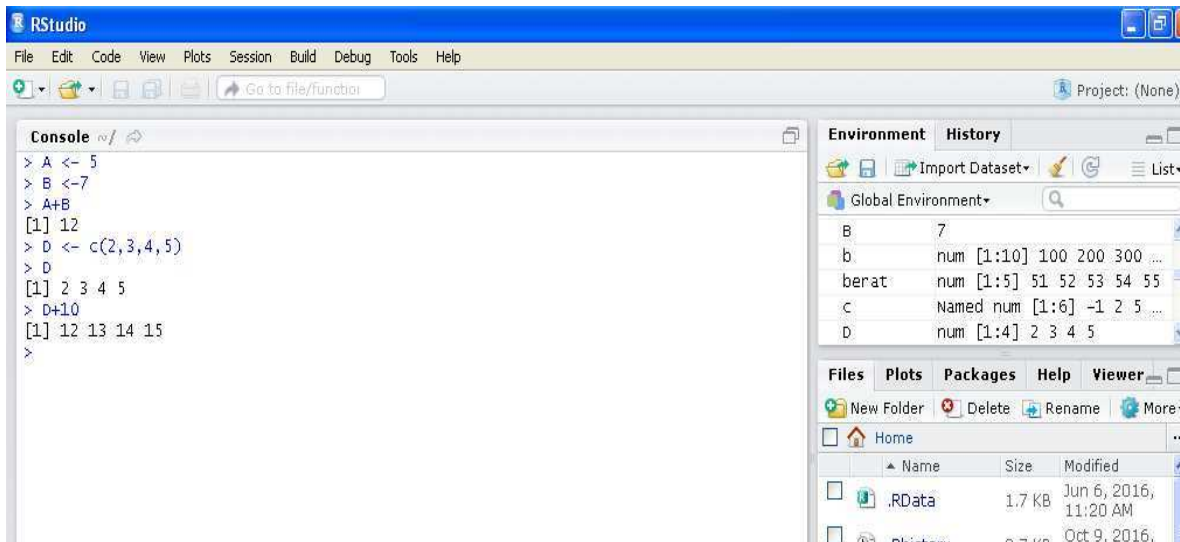
Gambar 1.4

Pada Gambar 1.3, secara otomatis muncul tampilan *R Console*. Pada bagian *R Console*, perintah R dibuat. Terdapat tanda “>” pada *R Console*. Tanda tersebut disebut *prompt*. Di depan *prompt* perintah R ditulis. Gambar 1.4 menampilkan beberapa perintah R, beserta hasil dari eksekusi perintah tersebut. Pada Gambar 1.4, di depan tanda “[]” merupakan hasil dari eksekusi perintah R.

Selain editor R *RGui* (Gambar 1.3), terdapat alternatif editor R lain, yakni RStudio (Gambar 1.5 dan Gambar 1.6).

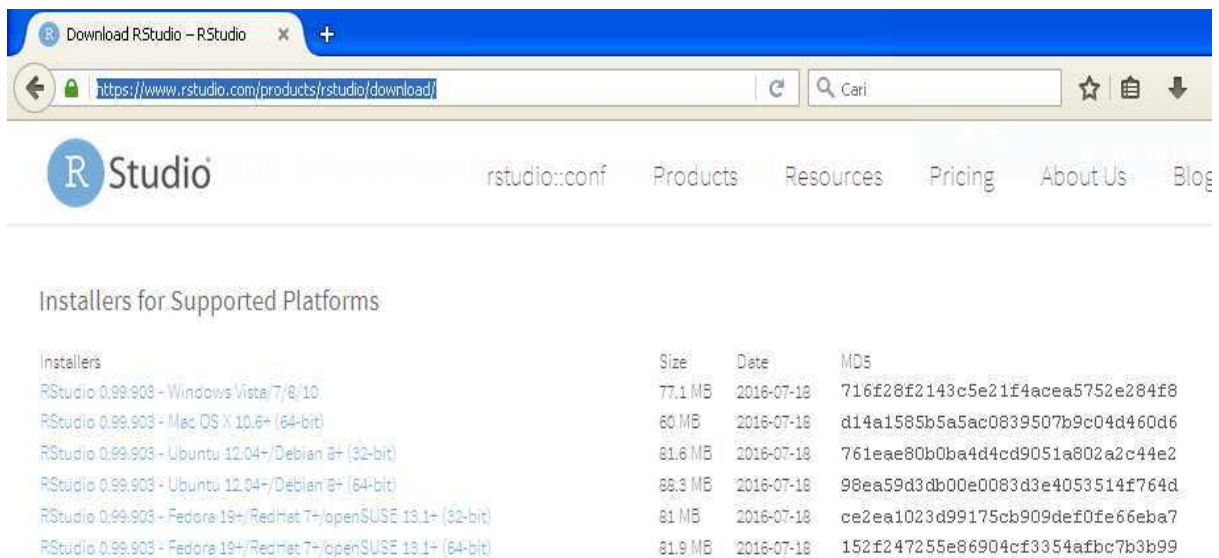


Gambar 1.5 Tampilan RStudio



Gambar 1.6 Tampilan RStudio

Pada RStudio menawarkan lebih banyak *editing environment* dibandingkan *RGui*. Gambar 1.7 menyajikan *website* <https://www.rstudio.com/products/rstudio/download/> di mana RStudio dapat di *download*.



Gambar 1.7

Dalam *website* <https://www.r-project.org/> juga menyajikan informasi seperti para kontributor R (Gambar 1.8), konferensi (Gambar 1.9), publikasi (Gambar 1.10), dan sebagainya.



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Help With R

Contributors

The current R is the result of a collaborative effort with contributions from all over the world. R was initially written by Robert Gentleman and Ross Ihaka—also known as “R & R” of the Statistics Department of the University of Auckland. Since mid-1997 there has been a core group with write access to the R source, currently consisting of

- Douglas Bates
- John Chambers
- Peter Dalgaard
- Robert Gentleman
- Kurt Hornik
- Ross Ihaka
- Michael Lawrence
- Friedrich Leisch
- Uwe Ligges
- Thomas Lumley
- Martin Maechler
- Martin Morgan
- Duncan Murdoch
- Paul Murrell
- Martyn Plummer
- Brian Ripley

Gambar 1.8



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Help With R

Conferences

The R project actively supports two conference series, organized regularly by members from the R community:

- useR!, providing a forum to the R user community.
- DSC, a platform for developers of statistical software.

A rough outline of the format for the respective conferences is given below; both conference formats were developed by the Austrian Association for Statistical Computing (AASC) in cooperation with the R Foundation for Statistical Computing.

R-related conferences are coordinated by the “R Foundation Conference Committee” (RFCC) currently consisting of Torsten Hothorn (Universität Zürich) and Achim Zeileis (Universität Innsbruck) plus ex officio secretary and treasurer of the R Foundation. The RFCC can be contacted by email at [R-conferences@r-project.org](mailto:conferences@r-project.org).

The R Foundation has a policy requiring codes of conduct at R conferences.

useR! — International R User Conference



This is the main meeting of the R user and developer community, its program consisting of both invited and user-contributed presentations:

- The invited keynote lectures cover a broad spectrum of topics ranging from technical and R-related

Gambar 1.9

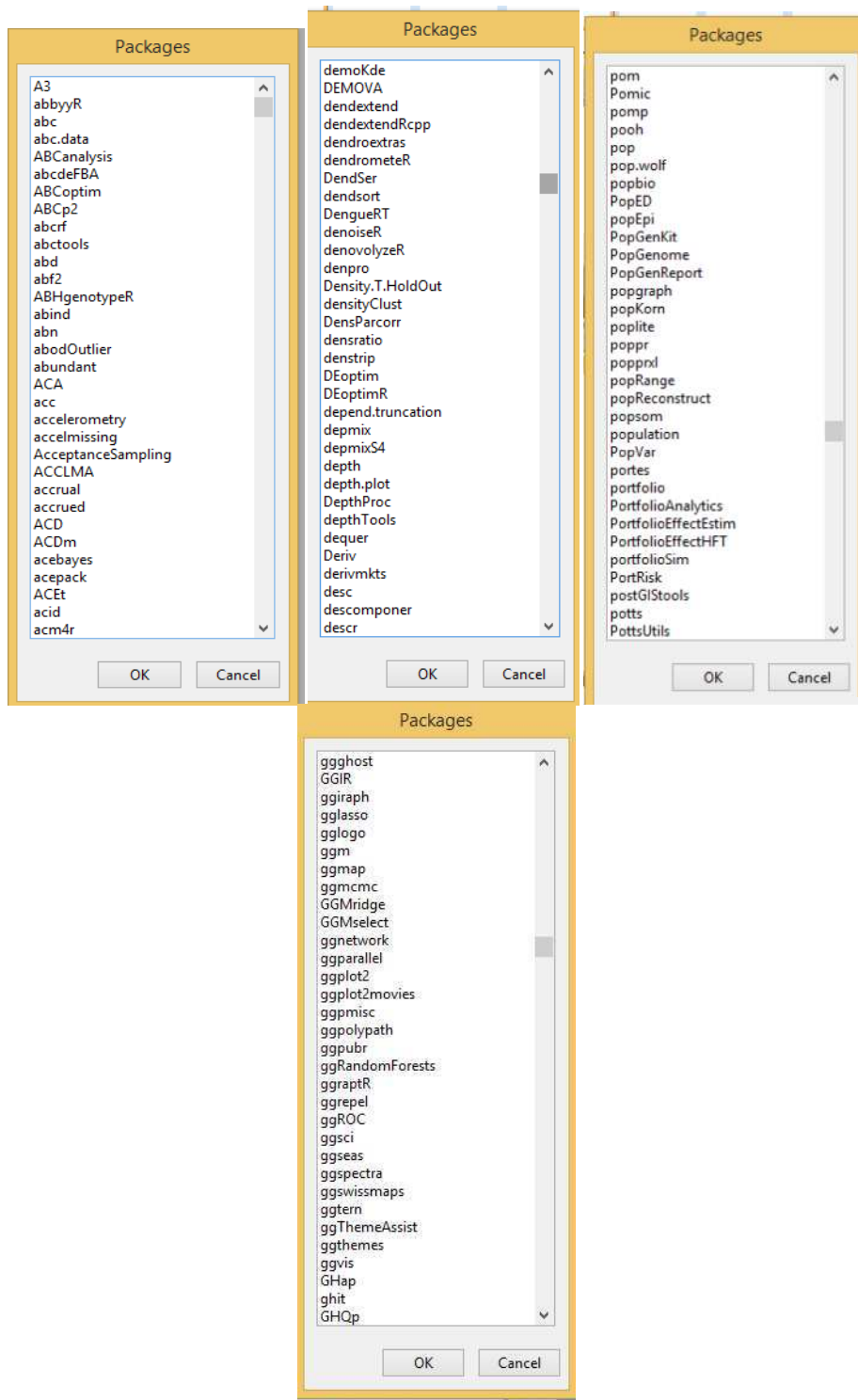
Home	<h2>About The R Journal</h2>								
Current Issue	<p>The <i>R Journal</i> is the open access, refereed journal of the R project for statistical computing. It features short to medium length articles covering topics that might be of interest to users or developers of R, including</p>								
Accepted Articles	<table><tr><td>Add-on packages:</td><td>short introductions to R extension packages.</td></tr><tr><td>Programmer's Niche:</td><td>hints for programming in R.</td></tr><tr><td>Help Desk:</td><td>hints for newcomers explaining aspects of R that might not be so obvious from reading the manuals and FAQs.</td></tr><tr><td>Applications:</td><td>demonstrating how a new or existing technique can be applied in an area of current interest using R, providing a fresh view of such analyses in R that is of benefit beyond the specific application.</td></tr></table>	Add-on packages:	short introductions to R extension packages.	Programmer's Niche:	hints for programming in R.	Help Desk:	hints for newcomers explaining aspects of R that might not be so obvious from reading the manuals and FAQs.	Applications:	demonstrating how a new or existing technique can be applied in an area of current interest using R, providing a fresh view of such analyses in R that is of benefit beyond the specific application.
Add-on packages:	short introductions to R extension packages.								
Programmer's Niche:	hints for programming in R.								
Help Desk:	hints for newcomers explaining aspects of R that might not be so obvious from reading the manuals and FAQs.								
Applications:	demonstrating how a new or existing technique can be applied in an area of current interest using R, providing a fresh view of such analyses in R that is of benefit beyond the specific application.								
Archive									
Submissions	<p>The <i>R Journal</i> intends to reach a wide audience and have a fast-track but thorough review process. Papers are expected to be reasonably short, clearly written, not too technical, and of course focused on R. Authors of refereed articles should take care to:</p> <ul style="list-style-type: none">• put their contribution in context, in particular discuss related R functions or packages;• explain the motivation for their contribution;• provide code examples that are reproducible.								
Editorial Board	<p>Continuing from R News, <i>The R Journal</i> also has a news section, including information on:</p> <table><tr><td>Changes in R:</td><td>new features of the latest release.</td></tr><tr><td>Changes on CRAN:</td><td>new add-on packages, manuals, binary distributions, mirrors,...</td></tr><tr><td>Upcoming conferences:</td><td>announcements of conferences related to R.</td></tr><tr><td>Conference reports:</td><td>overviews of past conferences related to R.</td></tr></table>	Changes in R:	new features of the latest release.	Changes on CRAN:	new add-on packages, manuals, binary distributions, mirrors,...	Upcoming conferences:	announcements of conferences related to R.	Conference reports:	overviews of past conferences related to R.
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Upcoming conferences:	announcements of conferences related to R.								
Conference reports:	overviews of past conferences related to R.								

Gambar 1.10

R menjadi lebih populer dibandingkan S/S-Plus, dikarenakan R gratis dan orang-orang bisa berkontribusi dalam R. R sering juga disebut dengan “GNU S”.R atau S merupakan *de facto standard* di antara ahli statistika (*among professional statisticians*). R merupakan *open-software nature* yang berarti mudah untuk mendapatkan bantuan dari *user community*, dan terdapat banyak fungsi baru dari hasil kontribusi pengguna R, banyak di antaranya adalah para ahli statistika terkemuka (*prominent statisticians*).

Para pengembang (*developers*) dapat dengan mudah menuliskan *software* mereka sendiri (*write their own software*) dan mendistribusikannya dalam bentuk *add-on packages*. Karena begitu mudahnya membuat (*create*) suatu *package* maka terdapat ribuan *packages* yang telah tersedia (Gambar 1.11).

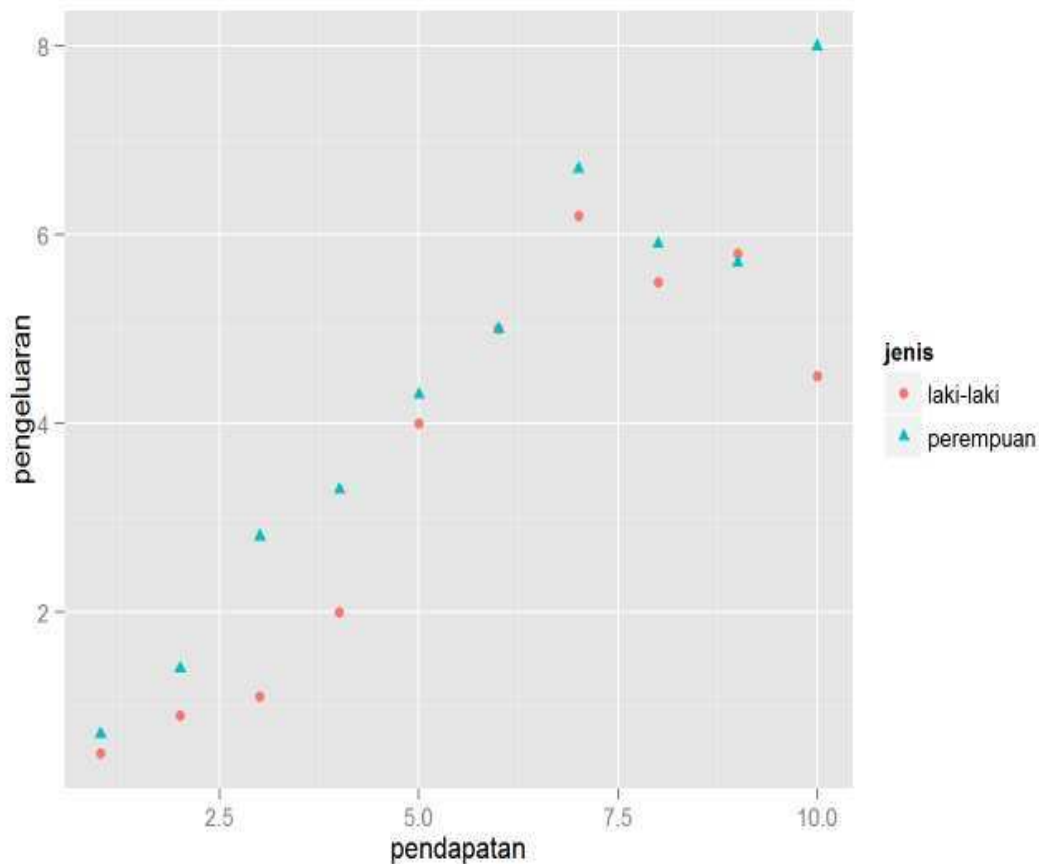
Faktanya banyak yang baru (tidak begitu baru) metode statistika yang dipublikasi pada suatu *package* R (Andrie de Vries dan Joris Meys, 2012). Sebagai contoh *package* MASS dan DiscriMiner, yang mana memuat metode statistika analisis diskriminan linear.



Gambar 1.11 Tampilan *Packages*

Sebagai contoh fungsi *ggplot()* yang terdapat dalam *package ggplot2*. Fungsi *ggplot()* dapat digunakan untuk menyajikan data seperti dalam bentuk diagram batang, histogram, diagram lingkaran, diagram pencar, dan sebagainya. Gambar 1.12 merupakan contoh terapan dari fungsi *ggplot*.

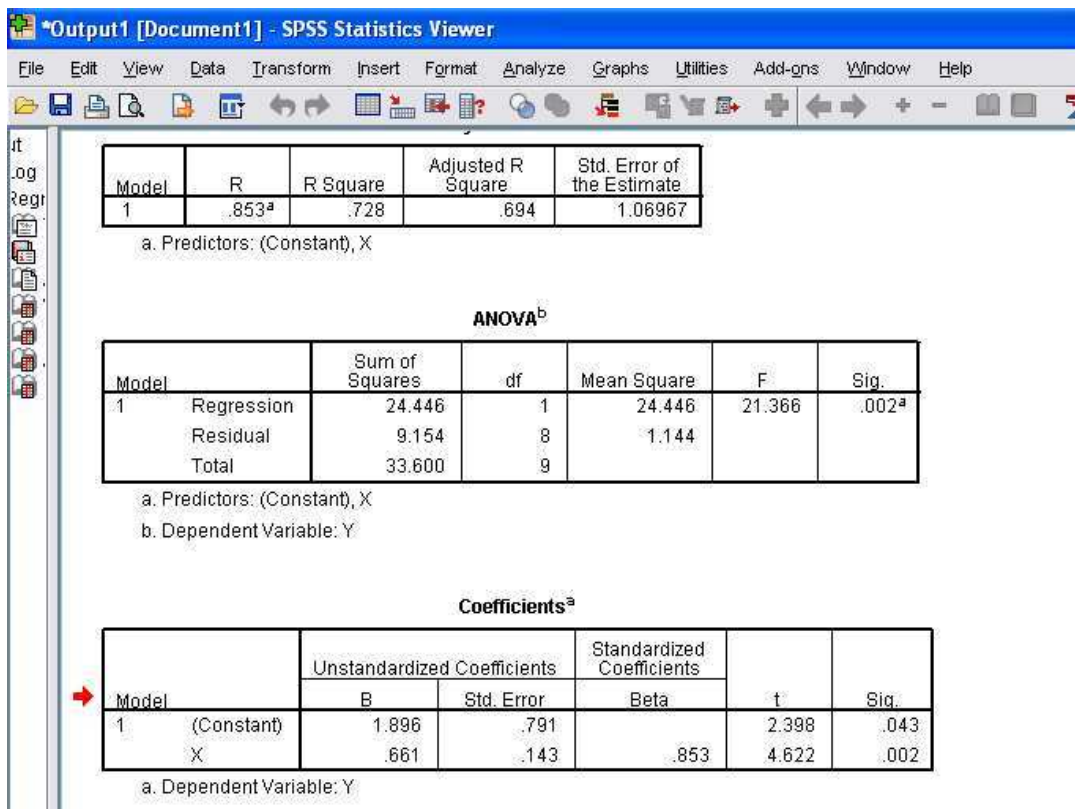
```
ggplot(simpan, aes(pendapatan, pengeluaran)) + geom_point(aes(color = jenis, shape = jenis))
```



Gambar 1.12

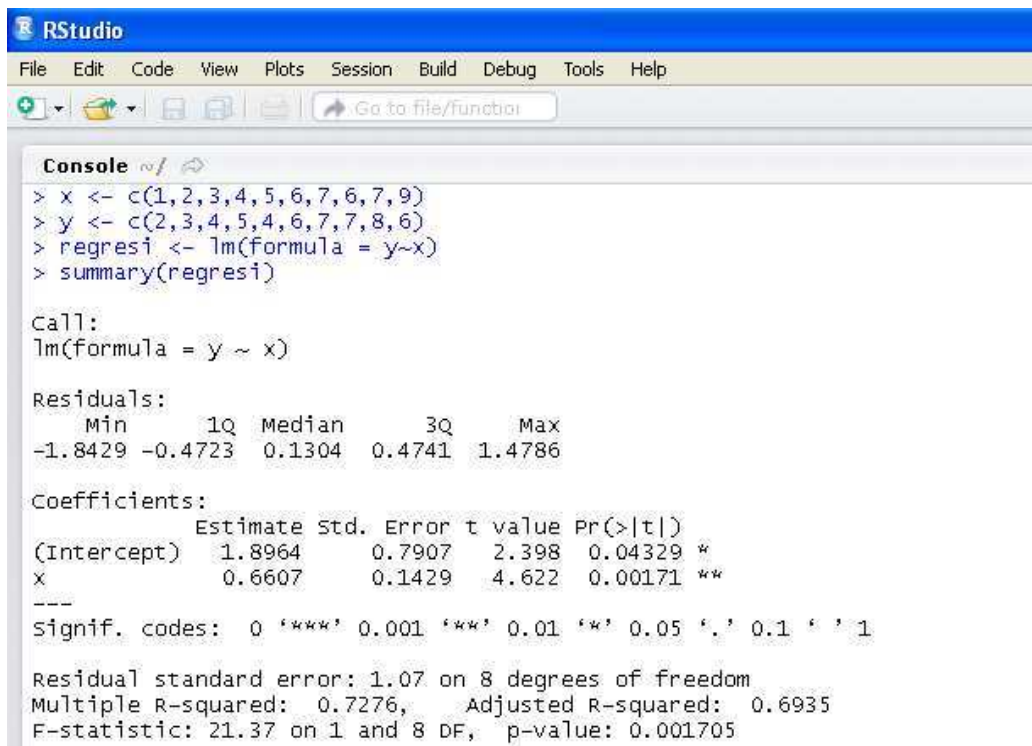
Sebagai contoh salah satu kelebihan dari R, ketika melakukan analisis regresi dalam R, misalkan digunakan menggunakan fungsi *lm()*, fungsi tersebut akan mengembalikan sebuah objek yang mengandung seluruh hasil (*containing all the results*), seperti *estimated coefficients*, *standard errors*, *residuals*, dan sebagainya. Kemudian dari hasil tersebut, dapat diambil atau dipilih, bagian mana dari objek tersebut untuk dipilih untuk ditampilkan, sesuai yang diinginkan.

Berbeda dengan, ketika melakukan analisis regresi dalam *software*, katakanlah SPSS atau MINITAB, akan diperoleh atau ditampilkan banyak *output*, seperti *correlation*, *coefficient of determination*, dan sebagainya (*mountain of output*). Perhatikan ilustrasi Gambar 1.13. Pada Gambar 1.13 merupakan hasil SPSS untuk analisis regresi.



Gambar 1.13

Sementara pada Gambar 1.14 dan Gambar 1.15 merupakan hasil dengan menggunakan R untuk analisis regresi.



Gambar 1.14

```

RStudio
File Edit Code View Plots Session Build Debug Tools Help
Go to file/function

Console ~/
Call:
lm(formula = y ~ x)

Residuals:
    Min       1Q   Median       3Q      Max
-1.8429 -0.4723  0.1304  0.4741  1.4786

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.8964      0.7907   2.398  0.04329 *
x            0.6607      0.1429   4.622  0.00171 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.07 on 8 degrees of freedom
Multiple R-squared:  0.7276,    Adjusted R-squared:  0.6935
F-statistic: 21.37 on 1 and 8 DF,  p-value: 0.001705

> regresis$coefficient[1] #Memilih untuk menampilkan intersep
(Intercept)
1.896429
> regresis$coefficient[2] #Memilih untuk menampilkan koefisien regresi x
x
0.6607143
> regresis$residual #Memilih untuk menampilkan nilai residual
      1      2      3      4      5      6      7      8
-0.5571429 -0.2178571  0.1214286  0.4607143 -1.2000000  0.1392857  0.4785714  1.1392857
      9     10
 1.4785714 -1.8428571
> |

```

Gambar 1.15

Hasil analisis regresi dalam SPSS (Gambar 1.13), secara umum menampilkan tumpukan *output* seperti korelasi, koefisien determinasi, dan sebagainya, sedangkan dalam R, dapat dipilih hasil mana saja yang hendak diperlihatkan (Gambar 1.15).

R dapat dikatakan sebagai bahasa berbasis vektor (*vectorized-based language*). Suatu vektor dapat dipandang sebagai suatu baris atau kolom dari bilangan atau *text*. Sebagai contoh daftar dari bilangan {1,2,3,4,5} dapat dipandang sebagai vektor (Andrie de Vries dan Joris Meys, 2012). Perhatikan ilustrasi berikut (Gambar 1.16).

```

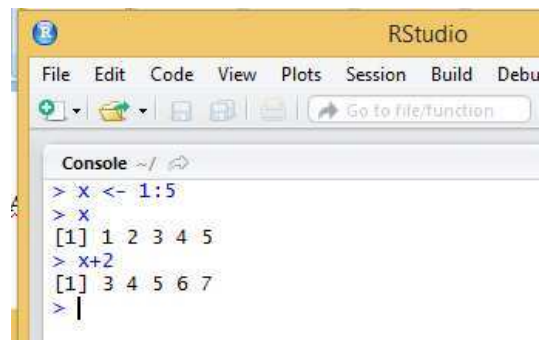
RStudio
File Edit Code View Plots Session Build
Go to file/function

Console ~/
> x <- 1:5
> x
[1] 1 2 3 4 5
>

```

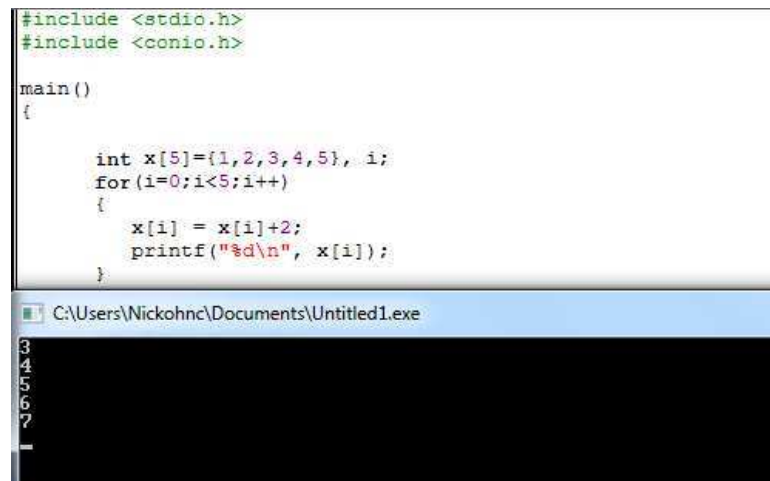
Gambar 1.16

Berdasarkan Gambar 1.16, perintah R pada baris pertama `x <- 1:5` dapat diartikan menugaskan bilangan 1,2,3,4,5 ke vektor `x`, kemudian perintah R pada baris kedua `x` menampilkan seluruh elemen dalam vektor `x`. Perhatikan lagi ilustrasi Gambar 1.17.



Gambar 1.17

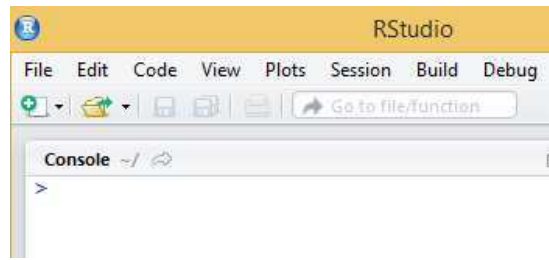
Berdasarkan Gambar 1.17, perintah R `x+2` berarti menjumlahkan nilai 2 terhadap masing-masing elemen vektor `x`. Untuk melakukan hal tersebut dalam bahasa pemrograman yang tidak berbasis vektor (*that aren't vectorized*), diperlukan menggunakan *explicit loop*, untuk mencapai hasil yang sama. Sebagai contoh diberikan ilustrasi dalam bahasa pemrograman C (Gambar 1.18).



Gambar 1.18

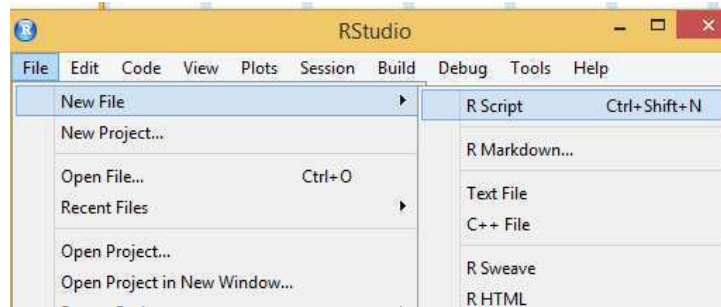
Oleh karena itu R sangat ampuh (*this feature of R extremely powerful*) dikarenakan R dapat melakukan banyak operasi (*many operation*) hanya dengan satu langkah, seperti yang telah diperlihatkan dari Gambar 1.16 hingga Gambar 1.18 (Andrie de Vries dan Joris Meys, 2012).

Norman Matloff (2009) menyatakan R memiliki 2 *mode*, yakni *interactive mode* dan *batch mode*. Gambar 1.19 merupakan contoh tampilan R dalam *interactive mode*. Pada *interactive mode* dijumpai tanda *prompt* “>”. Pada *interactive mode*, perintah R ditulis di depan tanda “>”, seperti pada Gambar 1.16 dan Gambar 1.17.



Gambar 1.19

Sementara pada *batch mode*, seluruh perintah R ditulis terlebih dahulu, seperti pada Gambar 1.21. Perintah R pada Gambar 1.21 bertujuan untuk membuat histogram, kemudian tampilan histogram tersebut disimpan dalam file dengan format **pdf**, dengan nama **membuat_histogram.pdf** (Gambar 1.23 dan Gambar 1.24). Setelah seluruh perintah R ditulis, seperti pada Gambar 1.21, selanjutnya, seluruh perintah R dieksekusi (perhatikan Gambar 1.22).

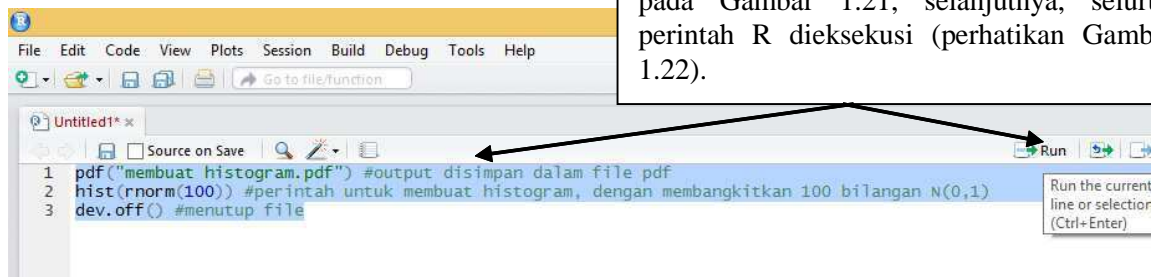


Gambar 1.20



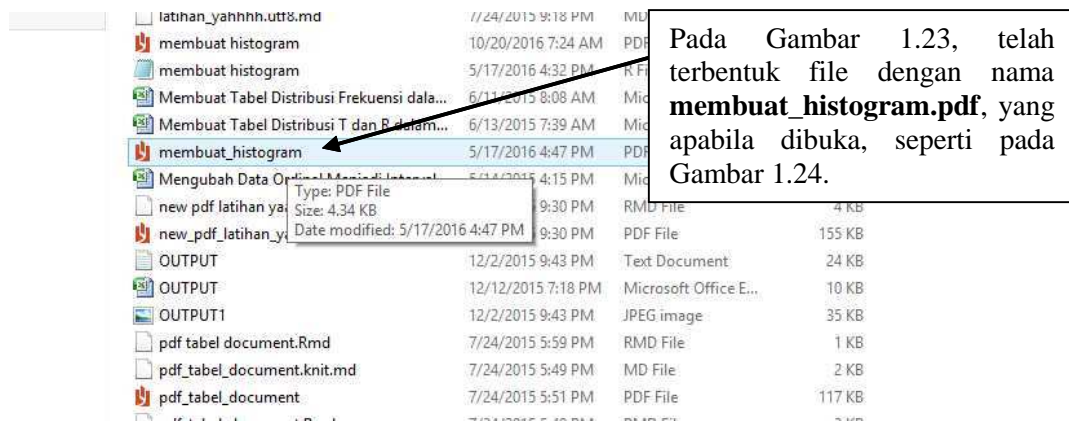
Gambar 1.21

Setelah seluruh perintah R ditulis, seperti pada Gambar 1.21, selanjutnya, seluruh perintah R dieksekusi (perhatikan Gambar 1.22).

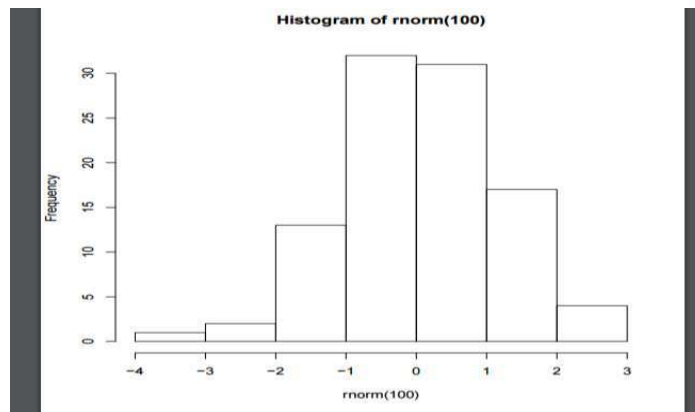


Gambar 1.22

Pada Gambar 1.23, telah terbentuk file dengan nama **membuat_histogram.pdf**, yang apabila dibuka, seperti pada Gambar 1.24.



Gambar 1.23



Gambar 1.24