

R on the Raspberry Pi 3

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2016-05-07

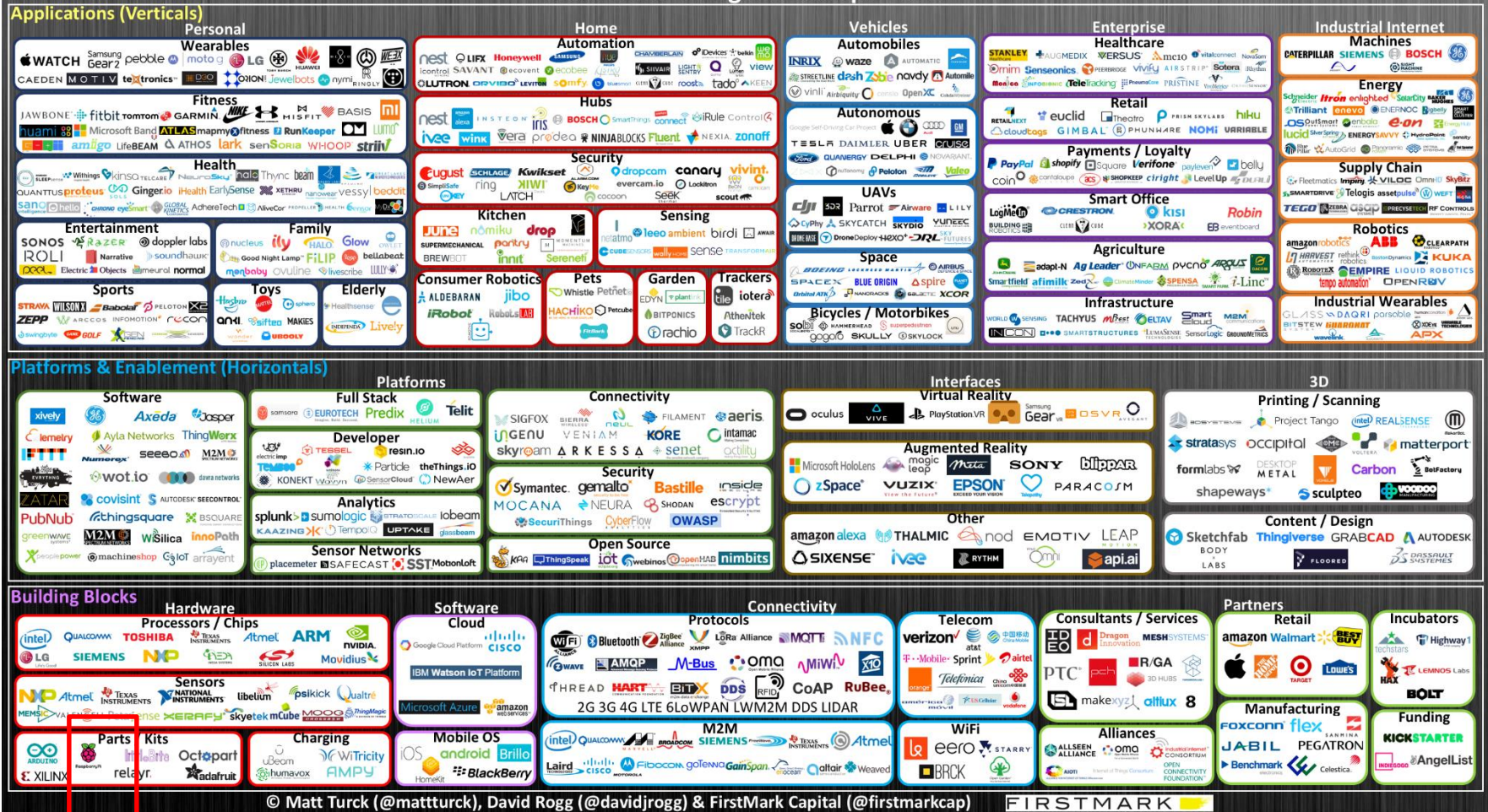
<http://earlglynn.github.io/kc-r-users-raspberry-pi-3/>

R on the Raspberry Pi 3

- Internet of Things
- Raspberry Pi 3
- Hardware for a Raspberry Pi 3 System
- Raspbian Operating System
- Installing R on Raspberry Pi 3
- Running R on Raspberry Pi 3
- Running “Headless”
- What’s Next?
- Raspberry Pi Resources

Internet of Things

Internet of Things Landscape 2016



2016 Internet of Things Landscape

<http://mattturck.com/2016/03/28/2016-iot-landscape/>

Raspberry Pi 3

- CPU: 1.2 GHZ quad-core ARM Cortex A53
- GPU: Broadcom VideoCore IV @ 400 MHz
- Memory: 1 GB
- USB ports: 4
- Network: 10/100 MBPS Ethernet, 802.11n Wireless LAN, Bluetooth 4.0

New Features

- Built-in WiFi and Bluetooth
- 33% faster processor



Introducing the Raspberry Pi 3, Feb. 28, 2016

<http://hackaday.com/2016/02/28/introducing-the-raspberry-pi-3/>

Hardware for a Raspberry Pi 3 System



- Raspberry Pi 3, \$35
- Official Pi 3 case, \$9
- 16 GB Micro SDHC memory card, \$5.50 (Microcenter)
- Power supply, \$12 (can use phone charger if no other peripherals)

Hardware for a Raspberry Pi 3 System

Run “Headless”



Desktop System

- Keyboard
- Mouse
- HDMI cable
- HDMI monitor
- Audio

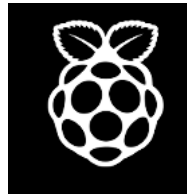


Raspbian Operating System



RASPBIAN

- Raspbian – Official Raspberry Pi operating system, which is based on Debian Linux



NOOBS

- NOOBS – New Out-of-Box Software

<https://www.raspberrypi.org/downloads/>

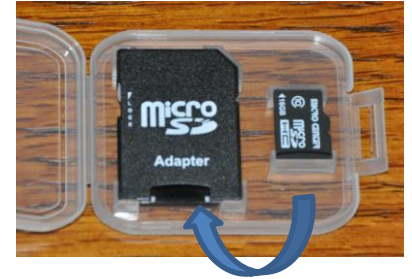
RPi Easy SD Card Setup

http://elinux.org/RPi_Easy_SD_Card_Setup

Installing Raspbian Operating System

- Use Formatter for Windows or Mac to Format MicroSD Card

<https://www.sdcard.org/downloads/index.html>



- Download NOOBS (New Out-of-Box Software), Unzip, and Copy to MicroSD Card

<https://www.raspberrypi.org/downloads/noobs/>

NOOBS_v1_9_0.zip

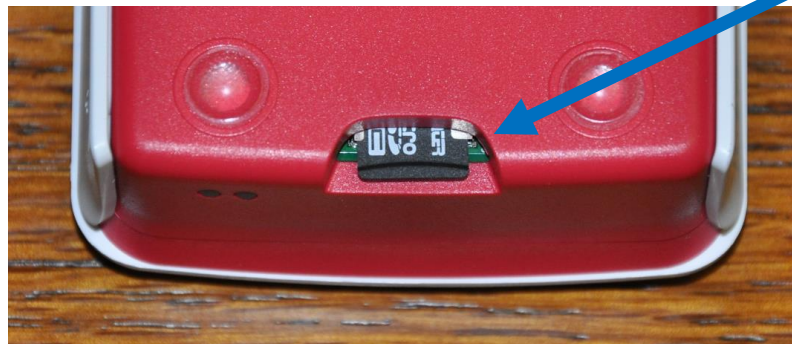
4/29/2016 9:12 PM

Compressed (zipped) Folder

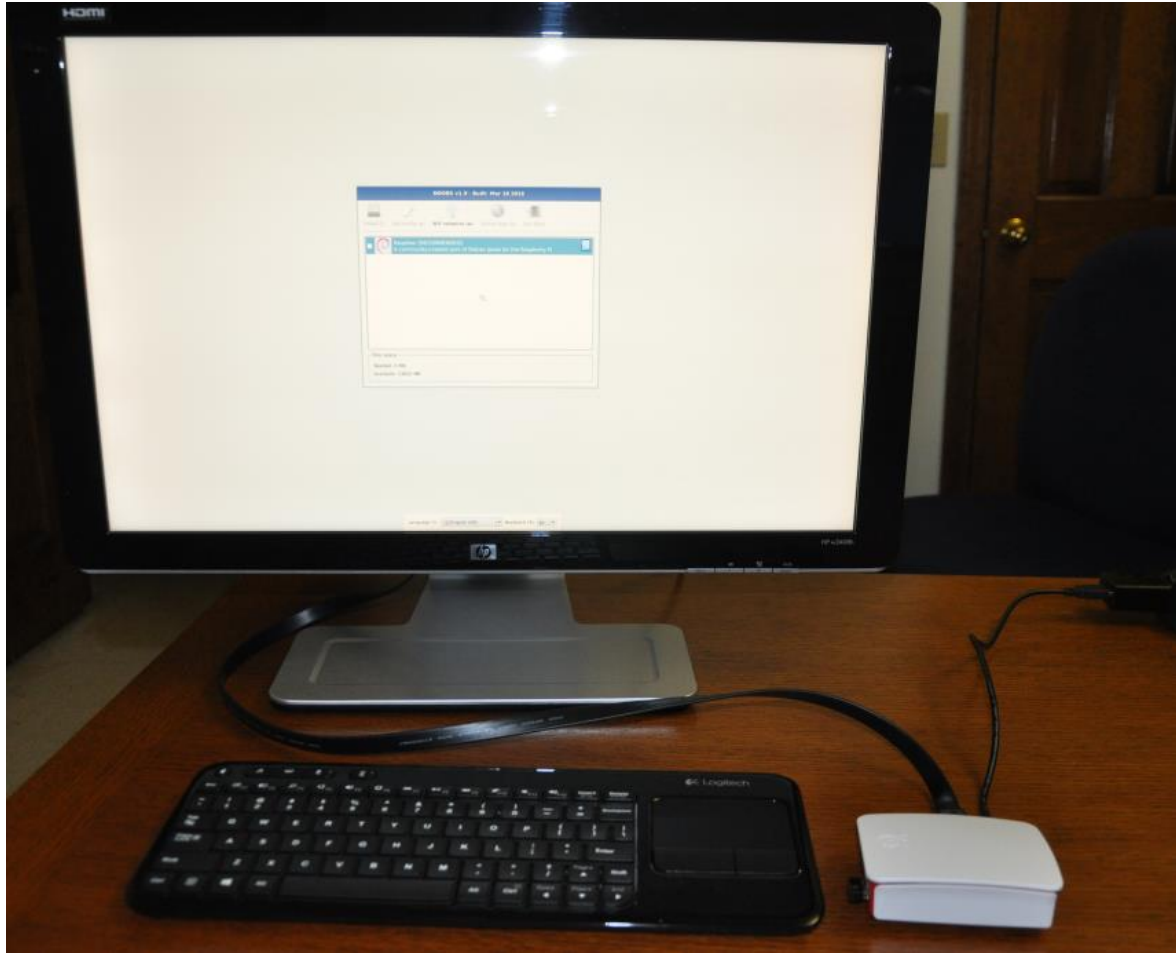
1,044,661 KB



- Install MicroSD card in Raspberry Pi

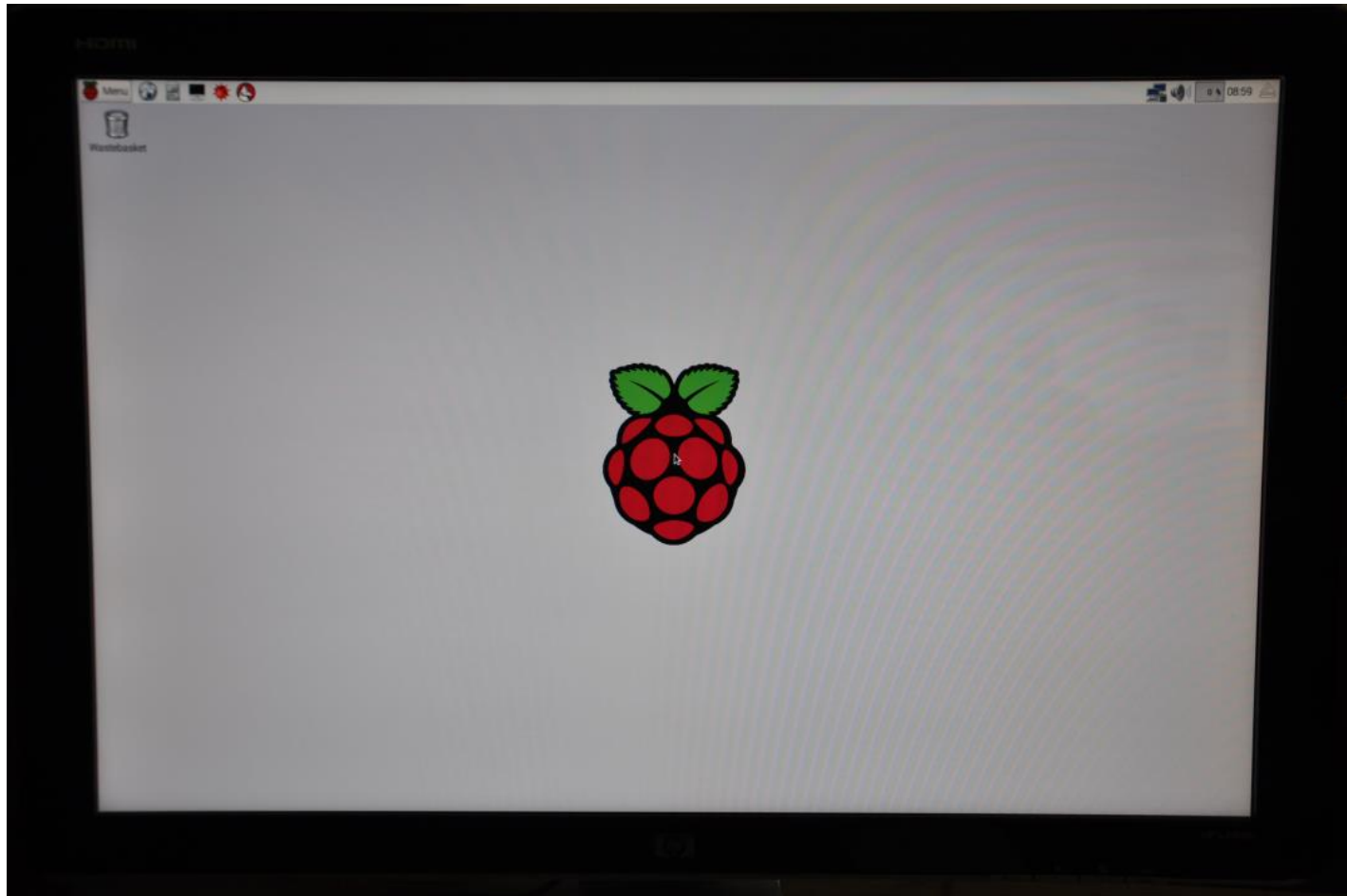


Installing Raspbian Operating System



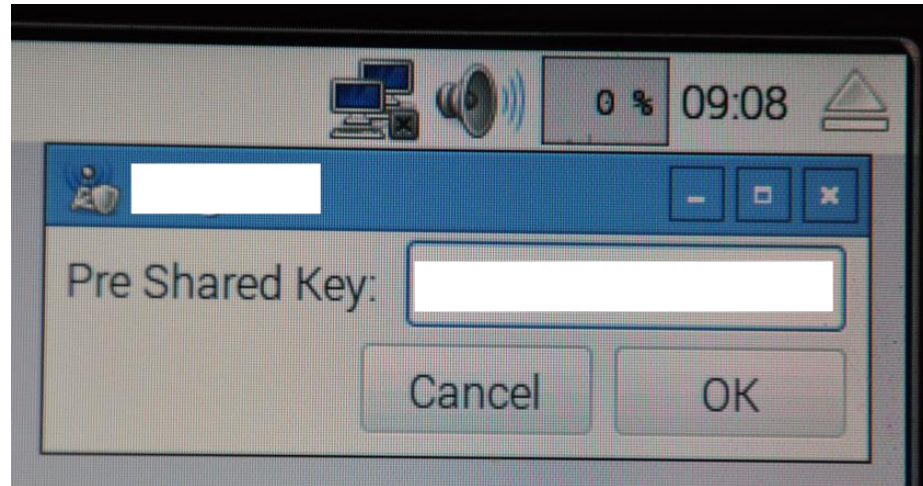
Loading Raspbian takes 10+ minutes

Initial Boot Raspbian Operating System



Internet Connection

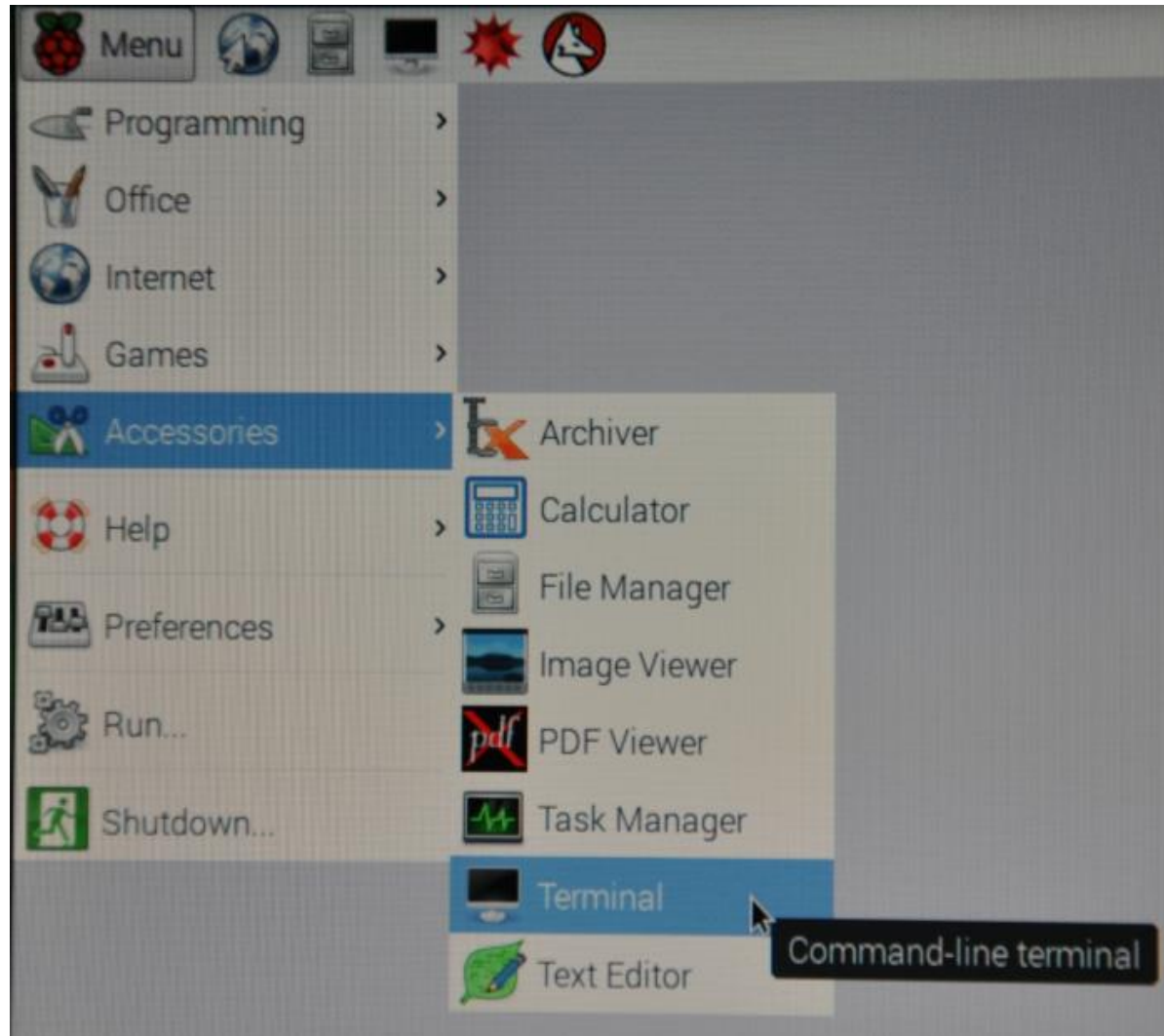
Raspberry Pi 3 New Feature: Built-in WiFi



Wired connection is still possible



Prepare to Install R



Prepare to Install R

Update and upgrade Raspbian

```
sudo apt-get update
```

```
sudo apt-get upgrade
```

Install useful tools

```
sudo apt-get install gedit
```


Installing R on Raspberry Pi 3

“Easy” install

```
sudo apt-get install r-base
```

A terminal window screenshot from a Raspberry Pi. The title bar shows 'pi@raspberrypi:~'. The menu bar includes 'File', 'Edit', 'Tabs', and 'Help'. The prompt is 'pi@raspberrypi:~ \$' followed by the command 'R'. The output shows 'R version 3.1.1 (2014-07-10) -- "Sock it to Me"', 'Copyright (C) 2014 The R Foundation for Statistical Computing', and 'Platform: arm-unknown-linux-gnueabi (32-bit)'.

```
pi@raspberrypi:~  
File Edit Tabs Help  
pi@raspberrypi:~ $ R  
R version 3.1.1 (2014-07-10) -- "Sock it to Me"  
Copyright (C) 2014 The R Foundation for Statistical Computing  
Platform: arm-unknown-linux-gnueabi (32-bit)
```

Installs *old* version of R from 2014

Installing R on Raspberry Pi 3

Build current R version (3.2.5) from Source Code

```
# Fetch dependencies
```

```
sudo apt-get install gfortran libreadline6-dev libx11-dev libxt-dev  
libpng-dev libjpeg-dev libcairo2-dev xvfb
```

```
# Fetch latest R source code
```

```
mkdir R_HOME && cd R_HOME  
wget http://cran.rstudio.com/src/base/R-3/R-3.2.5.tar.gz && tar zxvf R-  
3.2.5.tar.gz
```

```
# Build R from source (takes about an hour)
```

```
cd R-3.2.5  
./configure --with-cairo --with-jpeglib && make && sudo make install
```

```
# Set link to R executable in one of $PATH directories
```

```
cd /usr/bin  
sudo ln -s /home/pi/R_HOME/R-3.2.5/bin/R .
```

Based on “Compile and Install R-3.1.2 (32-bit) in Raspberry Pi Model B/B+”

<http://mygeeks014.blogspot.com/2015/09/compiling-and-install-r-312-32-bit-in.html>

Installing R on Raspberry Pi 3

Installing R Packages from Online Source Code

```
# Install additional packages from KU repository
repo <- "http://rweb.crmda.ku.edu/cran/src/contrib"

# RColorBrewer has no other package dependencies
install.packages( file.path(repo, "RColorBrewer_1.1-
2.tar.gz"), repo=NULL, type="source")
```

Installing R on Raspberry Pi 3

Installing R Packages from Online Source Code

```
# stringr has two dependencies.  
# Install dependencies first, then stringr package  
install.packages( file.path(repo,  
"stringi_1.0-1.tar.gz"), repo=NULL, type="source")  
  
install.packages( file.path(repo,  
"magrittr_1.5.tar.gz"), repo=NULL, type="source")  
  
install.packages( file.path(repo,  
"stringr_1.0.0.tar.gz"), repo=NULL, type="source")
```

Running R on Raspberry Pi 3

```
[87 pi raspberrypi3 2016-04-30 13:07:18 /home/pi/projects]
```

```
R
```

```
R version 3.2.5 (2016-04-14) -- "Very, Very Secure Dishes"  
Copyright (C) 2016 The R Foundation for Statistical Computing  
Platform: armv7l-unknown-linux-gnueabi (32-bit)
```

```
> capabilities()
```

jpeg	png	tiff	tcltk	X11	aqua
TRUE	TRUE	FALSE	FALSE	TRUE	FALSE
http/ftp	sockets	libxml	fifo	cledit	iconv
TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
NLS	profmem	cairo	ICU	long.double	libcurl
TRUE	FALSE	TRUE	FALSE	FALSE	FALSE

[illegible]

Running “Headless”

Find IP address of Pi:

```
[144 pi raspberrypi3 2016-04-30 15:50:29 /home/pi]
ifconfig
eth0      Link encap:Ethernet  HWaddr b8:27:eb:3c:c8:bd
          inet6 addr: fe80::6e2e:5077:935b:69eb/64 Scope:Link
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:136 errors:0 dropped:0 overruns:0 frame:0
          TX packets:136 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:11472 (11.2 KiB)  TX bytes:11472 (11.2 KiB)

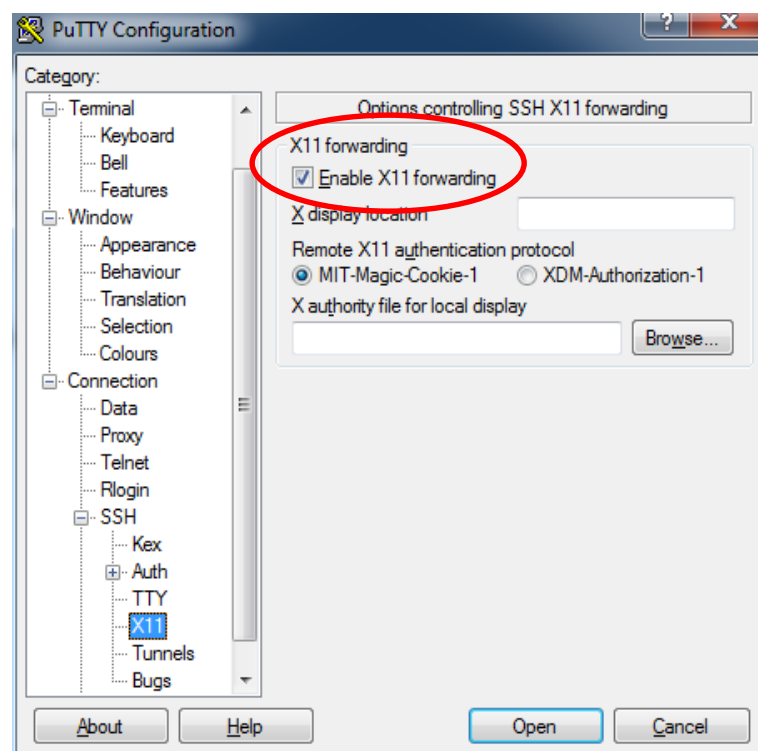
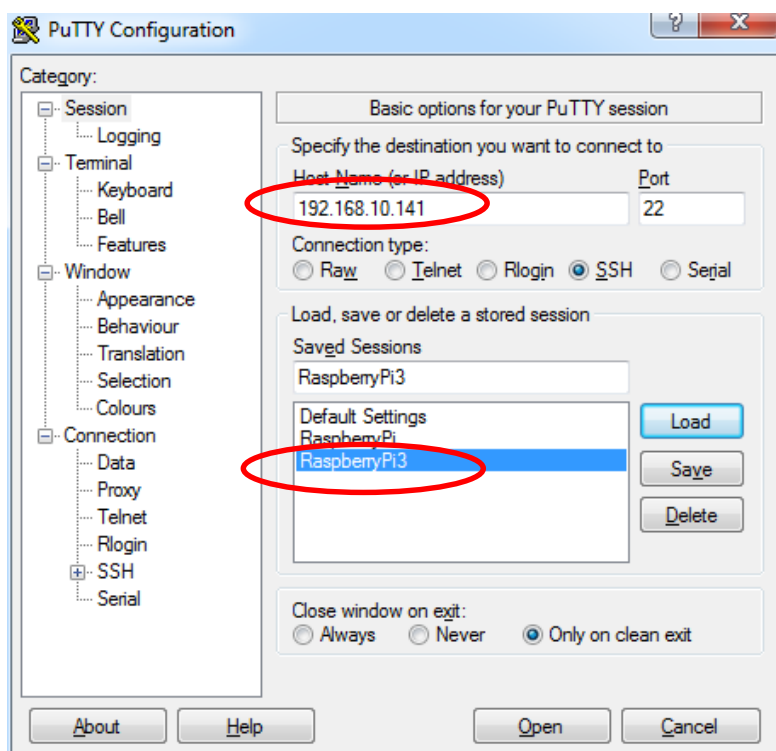
wlan0     Link encap:Ethernet  HWaddr b8:27:eb:69:9d:e8
          inet addr:192.168.10.141 Bcast:192.168.10.255 Mask:255.255.255.0
          inet6 addr: fe80::ba27:ebff:fe69:9de8/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:963 errors:0 dropped:47 overruns:0 frame:0
          TX packets:146 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:128173 (125.1 KiB)  TX bytes:23945 (23.3 KiB)
```

Headless setup: no keyboard, display or frustration, April 2014
<https://www.raspberrypi.org/forums/viewtopic.php?t=74176>

Running “Headless”

From PC or Mac using SSH:

Install and configure X11 client, such as PuTTY:

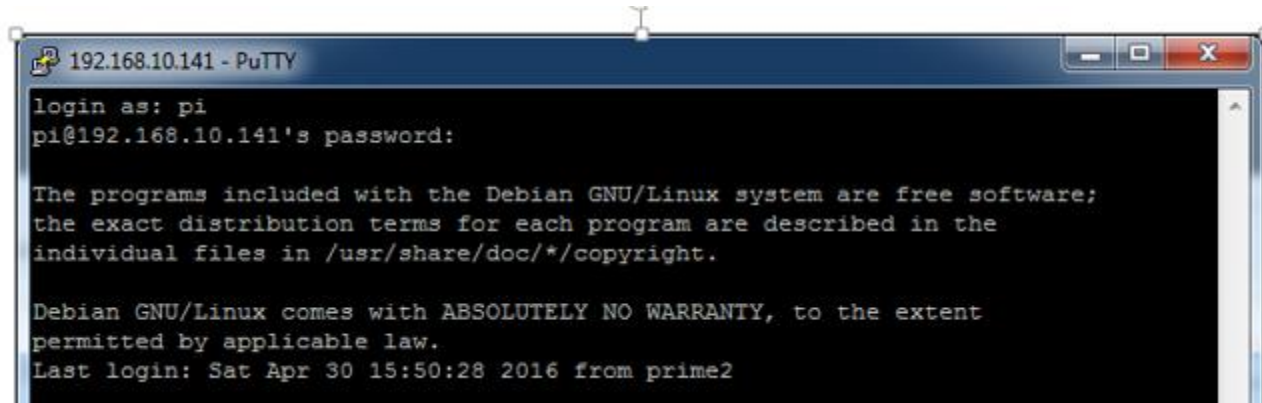


Installing/Configuring PuTTY and Xming

http://www.geo.mtu.edu/geoschem/docs/putty_install.html

Running “Headless”

Login to Pi from PC, Mac or Linux with X11:

A screenshot of a PuTTY terminal window titled "192.168.10.141 - PuTTY". The terminal shows a login prompt "login as: pi", followed by the password prompt "pi@192.168.10.141's password:". Below the password prompt, there is a message about Debian GNU/Linux being free software and the location of copyright files. This is followed by a disclaimer: "Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent permitted by applicable law." and a log message: "Last login: Sat Apr 30 15:50:28 2016 from prime2".

```
192.168.10.141 - PuTTY
login as: pi
pi@192.168.10.141's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Apr 30 15:50:28 2016 from prime2
```

- Default Login: pi
- Default Password: raspberry

Running “Headless”

Run R on Raspberry Pi:

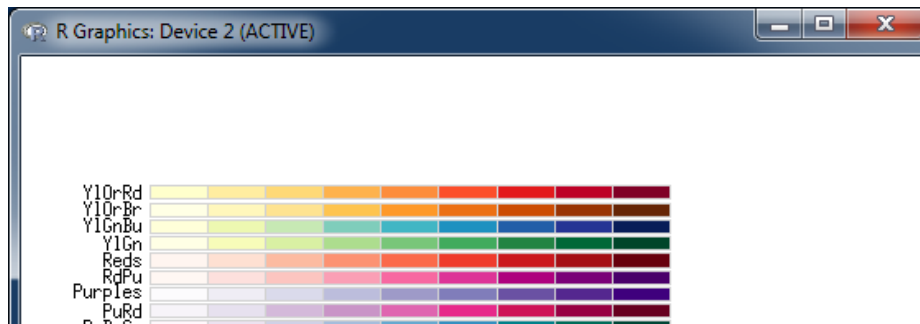


```
192.168.10.141 - PuTTY  
[148 pi raspberrypi3 2016-04-30 16:47:39 /home/pi]  
R  
R version 3.2.5 (2016-04-14) -- "Very, Very Secure Dishes"  
Copyright (C) 2016 The R Foundation for Statistical Computing  
Platform: armv7l-unknown-linux-gnueabi (32-bit)
```

Invoke R commands on Pi creating graphics:

```
> library(RColorBrewer)  
> display.brewer.all()
```

See R output from Pi on PC in new window (slow):



What's Next?

- Use sensors attached to Raspberry Pi to collect real-time data.
- Use R to analyze and visualize data in near real-time.



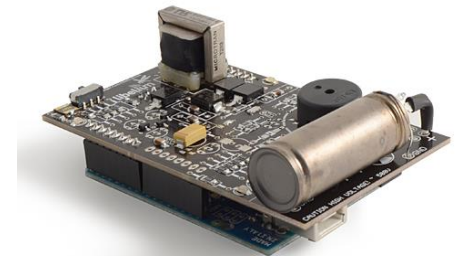
Gas sensor



Motion sensor



Temperature/
Humidity



Radiation sensor

Raspberry Pi Resources

- Raspberry Pi Weekly Newsletter

<https://www.raspberrypi.org/weekly/>

- 

An Introduction to Programming the Internet of Things
Specialization <https://www.coursera.org/specializations/iot>

- Raspberry Pi Platform and Python Programming for the Raspberry Pi
- Interfacing with the Raspberry Pi

- Install Shiny Server on Raspberry Pi

<http://withr.me/install-shiny-server-on-raspberry-pi/>

Take Home Messages

- The “Internet of Things” may provide great new opportunities for real-time data collection with a wide variety of sensors.
- The Raspberry Pi open hardware platform is a great way to experiment with “Internet of Things” sensors to collect data.
- R is a great tool for near real-time data analysis on the Raspberry Pi 3 processor.