Intro to the Raspberry Pi (RPi) & The Internet of Things (IoT)

Class 1 – 2018 / 03 / 11

Welcome & Organizational Stuff

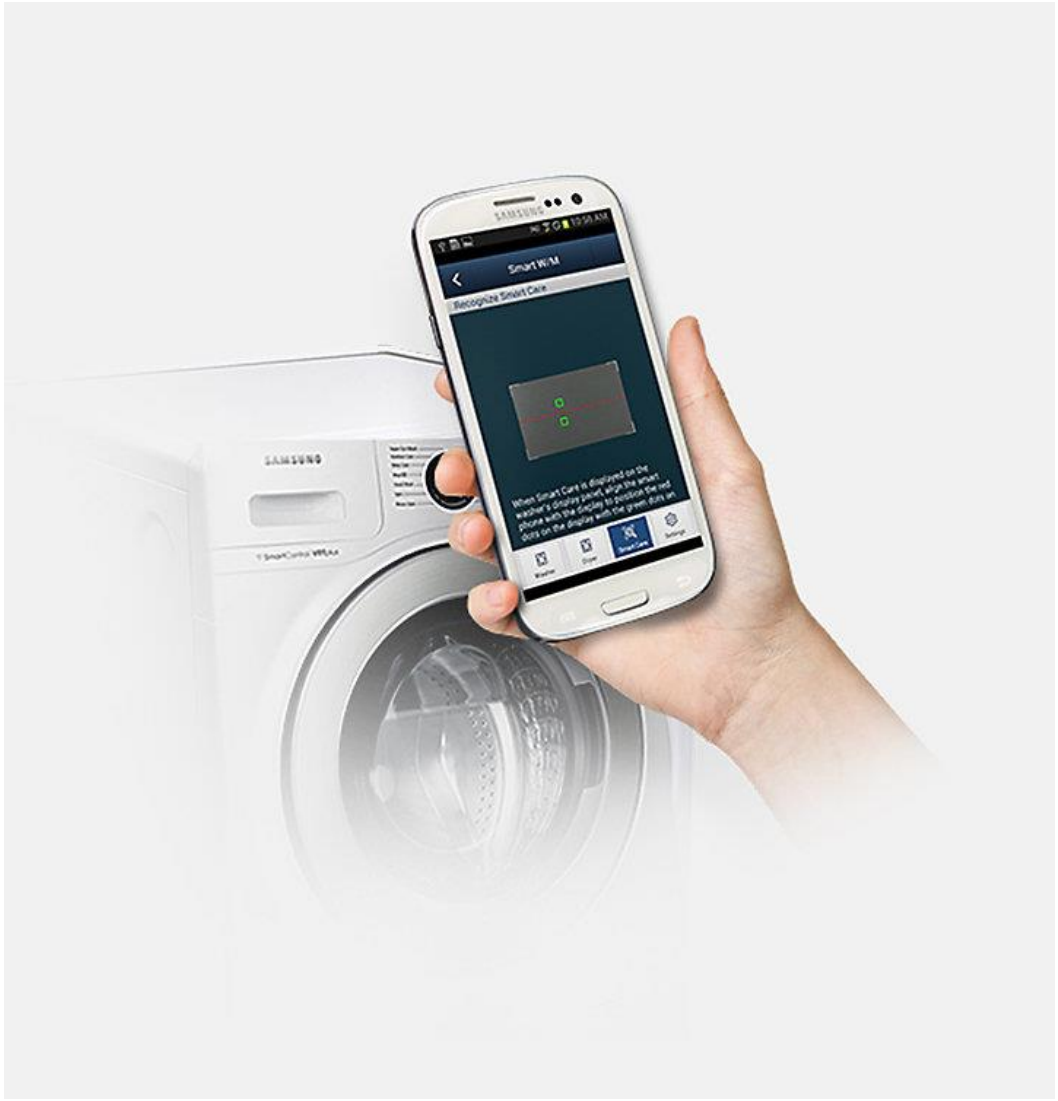
- Time
  - Sundays from 3.15 pm to 6.15 pm
  - Break of 15 minutes
- Instructors
  - Gloria from InnoBotics
  - Michael / Mike
- You don‘t need to bring your laptop
  - We will use the Raspberry Pi instead
- You will get everything you need for class

The Purpose of this Class

- This is an introductory class
  - Raspberry Pi and IoT „101“
  - We do not assume any prior knowledge of Linux, Python, Electronics, the Internet, …
  - You can *always* *ask* *any* *time*
  - If you already know a lot of Python, we will figure out projects that will keep you engaged

- „Drivers License“ for Raspberry Pi
  - Will enable you to build simple IoT devices
  - Understand, rebuild, extent projects from the Raspberry Pi Maker Community
  - Use your RPI for a variety of interesting things
  - Learn Basics of Linux, the Internet, Python, Hardware Tinkering

IoT Home Appliances



More…


nest
COOLING
75
78


AMCREST


nest
21
21


9:41 AM
100%
Save
Device name:
Kitchen
Auto
Begin brewing
07:00 AM
Notify when brewing
Aroma
Keep warm
40 Minu

EzPro
BrewGenie
menu
auto brew
aroma connect


ring

More Traditional…

Definition of IoT

What is it? From Wikipedia:

The **Internet of things** (**IoT**) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data.[1][2][3] Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure.

The figure of online capable devices increased 31% from 2016 to 8.4 billion in 2017.[4] Experts estimate that the IoT will consist of about 30 billion objects by 2020.[5] It is also estimated that the global market value of IoT will reach $7.1 trillion by 2020.[6]

Q: Who knows what an IP address is?

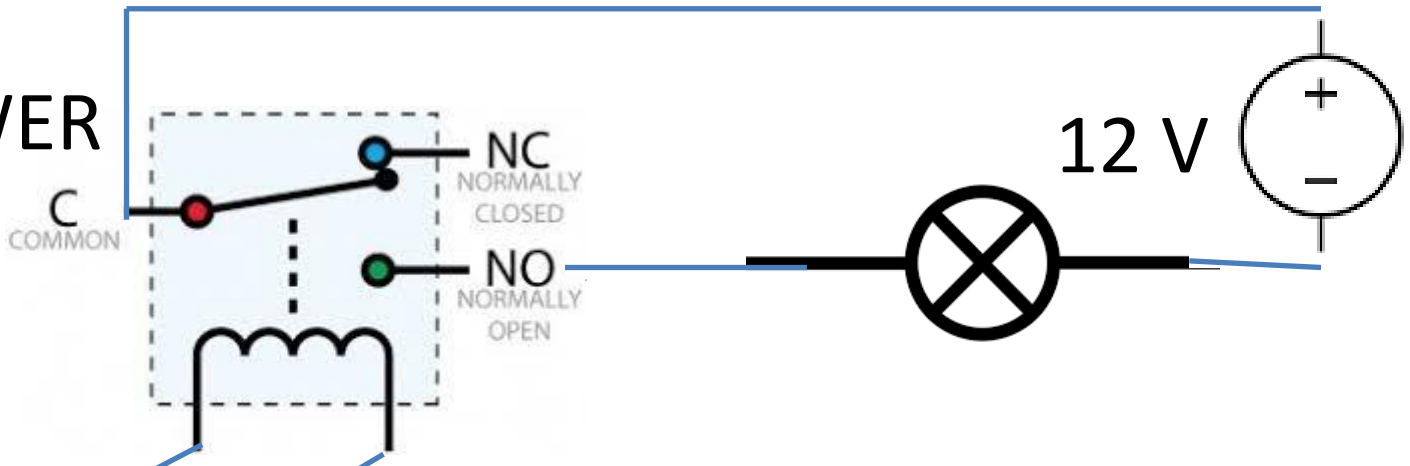
IoT Devices

- Each device has an **Internet Address = IP Address (IP = Internet Protocol)**
  - a unique string of numbers separated by periods that identifies each computer using the Internet Protocol to communicate over a network e.g., **192.168.0.1**

- Devices can be… anything! Access from Phone:
  - Cameras
  - Power Switches (Lamps, ….)
  - Coffeemachines, Refrigirators, Washing Machines
  - Alexa
  - TVs
  - Loudspeakers (Sonos), …
  - Weatherstation
  - Pet Supervions, Feeding, Activity (Laser Pointer Cat)

Circuit

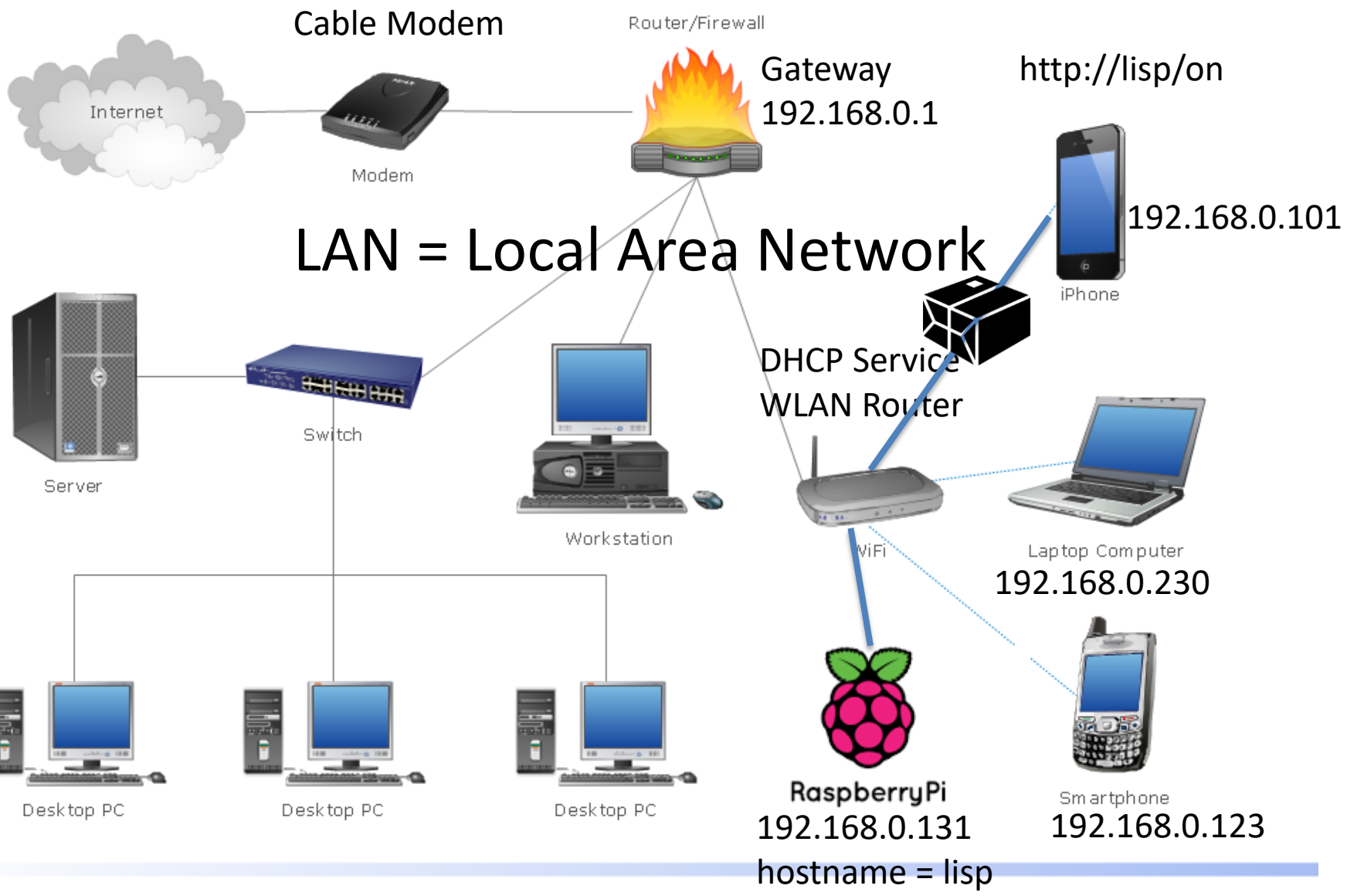
LOW-POWER RELAY



GND

PIN22

Network Diagram



Demo of Internet Lamp

- The Raspberry Pi has an IP address in the local network, assigned by the Wifi router
  - 192.168.0.xxx – assigned on sign in to WiFi, by the „DHCP“ service running on the WiFi router
  - It has a hostname, too = „lisp“. We gave it that.
  - the WiFi router remembers that 192.168.0.xxx = „lisp“
- The Wifi router „knows“ where the Pi is in the network
  - It knows how to „route“ data packages / packets to it
- The web brower on the phone issues a so-called „HTTP Request“ for the URL http://lisp/on or http://lisp/off , a „data packet / package“ is sent to host „lisp“
  - HTTP = „HyperText Transfer Protocol“ –
    the standard that „transports“ the data packets of the World Wide Web
  - The router identifies that destination = lisp = 192.168.0.xxx
  - Protocol = a list of rules and conventions for getting something done (here: data package transfer)
- The package arrives at the Pi, at a so-called „port“. Each internet protocol / application has a specific port.
  - for HTTP, the port is 80
  - On the Pi, a so-called WebServer is running – a program which always looks for incoming packages on port 80
  - Depending on the package content it receives, it does this or that
  - Here: it creates a „HTTP Response“ package which gets sent back to the phone
  - And, as a side effect, it turns on or off the lamp

Safety Considerations & Relays

- A relay can be / is used to switch a high power signal (lamp) with a low power signal (GPIO RPi output pin / port)
  - It works electromagnatically
- **There are relays for RPi that can switch 110 V**
  - **DON‘T DO THAT ALONE AT HOME**
  - **RISK OF ELECTRIC SHOCK**
  - **IF YOU WANT TO SWTICH 110 V ELECTRIC DEVICES, ALWAYS CONSULT YOUR PARENTS FIRST, DON‘T DO IT ALONE**

- **ONLY CONTROL / SWITCH LOW-POWER DEVICES (THAT HAVE AN EXTERNAL PSU) WITH RELAYS**
- **The internet lamp setup is safe, because the relay is powering an LED 12 V lamp, NOT a 110 V lamp**
- **This is only a demo – we will be using electronic low power devices (LEDs, …) exclusively in this class**

- **And: without password protection / authentication mechanism, you would never want to make a device such as our Internet Lamp accessible to the Internet (= Rest of the World)**

Pros & Cons

- Security concerns
  - Don‘t want hackers to control your thermostat
  - Don‘t want hackers to peek into your living room
  - Don‘t want criminals to know how much electricity you are using („Smart E Meters“) to infer you are on vacation
  - Don‘t want hackers to take control over the brakes in your car!! (plane, done, e-grid, …)
- You give away a lot of data AND control over the device, too:
  - Alexa from Amazon in Germany just suffered from a creepy „spontaneous laughter“ defect
  - Cheap IoT Alexa cameras send data to a cloud server in China
    - What happens if these „cloud services“ shut down for whatever reason?
    - What if you data stored there gets compromised / hacked?
  - Same with IoT power switches or lamps / lights!
    - Does it make sense if a data package travels to China and back only to turn on the light?

-> Better make you own IoT device ☺

With a „Dynamic DNS“ service and your own Domain Name, you can access it from everywhere in the world (not only local network)

Internet Terms

- Internet = all reachable devices that speak the IP protocol
- IP = Internet Protocol
  - A set of rules and conventions for data package transfer between „devices“
- IP Address = „House Address of a Computer / IoT Device“
- HTTP = Hypertext Transport Protocol
  - The transport protocol of the World Wide Web = Internet Web Browser
  - The Internet is more than the World Wide Web
    (Email, …. different Internet applications / protocols)
- Internet / Intranet / Local Network
  - Inter = „among“, Intra = „within“ (local)
- DNS (Domain Name Service) & Nameserver
  - Given a symbolic name such as www.google.com, figure out the IP address
- Router
  - Figures out how to „route“ packets from computer to computer (device to device)
- DHCP Server
  - Assigns a dynamic IP address to a device (when you sign in to WiFi)
- Gateway
  - The „gateway“ from Intranet to Internet

Building IoT Devices

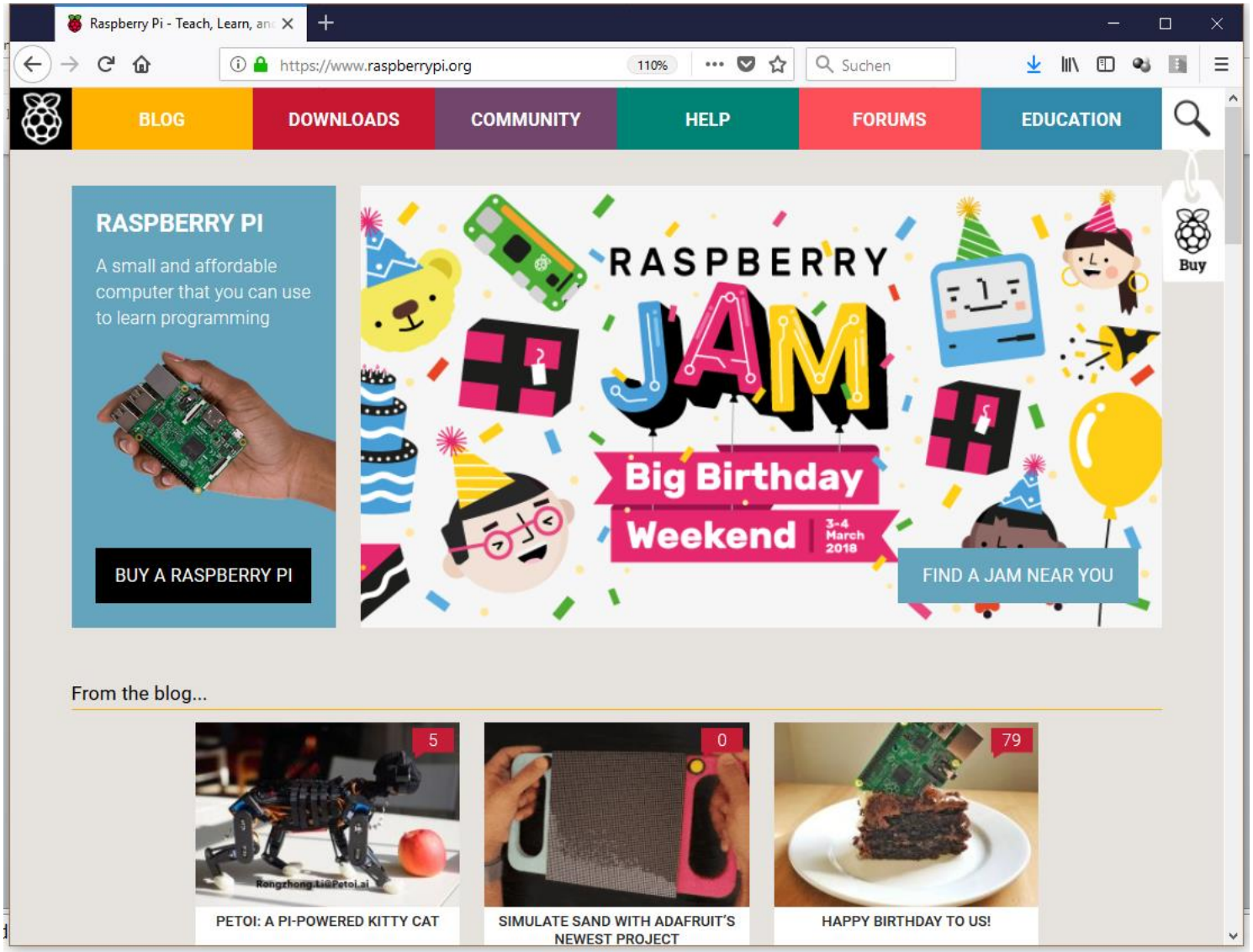
- Raspberry Pi
  - Why this one?
  - What‘s the big fuzz about it?
- What do you need to know to build a (simple) IoT device?
  - A cheap small inexpensive low-power computer (battery….) „SoC“ like Arduino, Raspberry Pi, …
  - Internet = IP capable
  - Needs to allow tinkering and connecting with little effort to hardware of your IoT device! -> „Hardware Interfaces“
  - „Software Skills“ – for us : Linux, Python
  - „Hardware Engineering Skills“ - to build the device: basic electronics
- The Raspberry Pi is the ideal platform for this!

Other Non-Hardware Projects

- Run a blog
  - Wordpress (mostly writting PhP)
  - LAMP System = Linux, Apache, MySQL, PhP
- Make a webserver
  - Other options than LAMP, also
  - We will use Python FLASK
- Make a MultiMedia player / music / video server
  - XBMC, KODI, OSMC, …
- Retro Gaming – if you don‘t own a Commodore 64…
  - RetroPi (+), RecalboxOs (++)

The Maker Community & Raspberry Pi

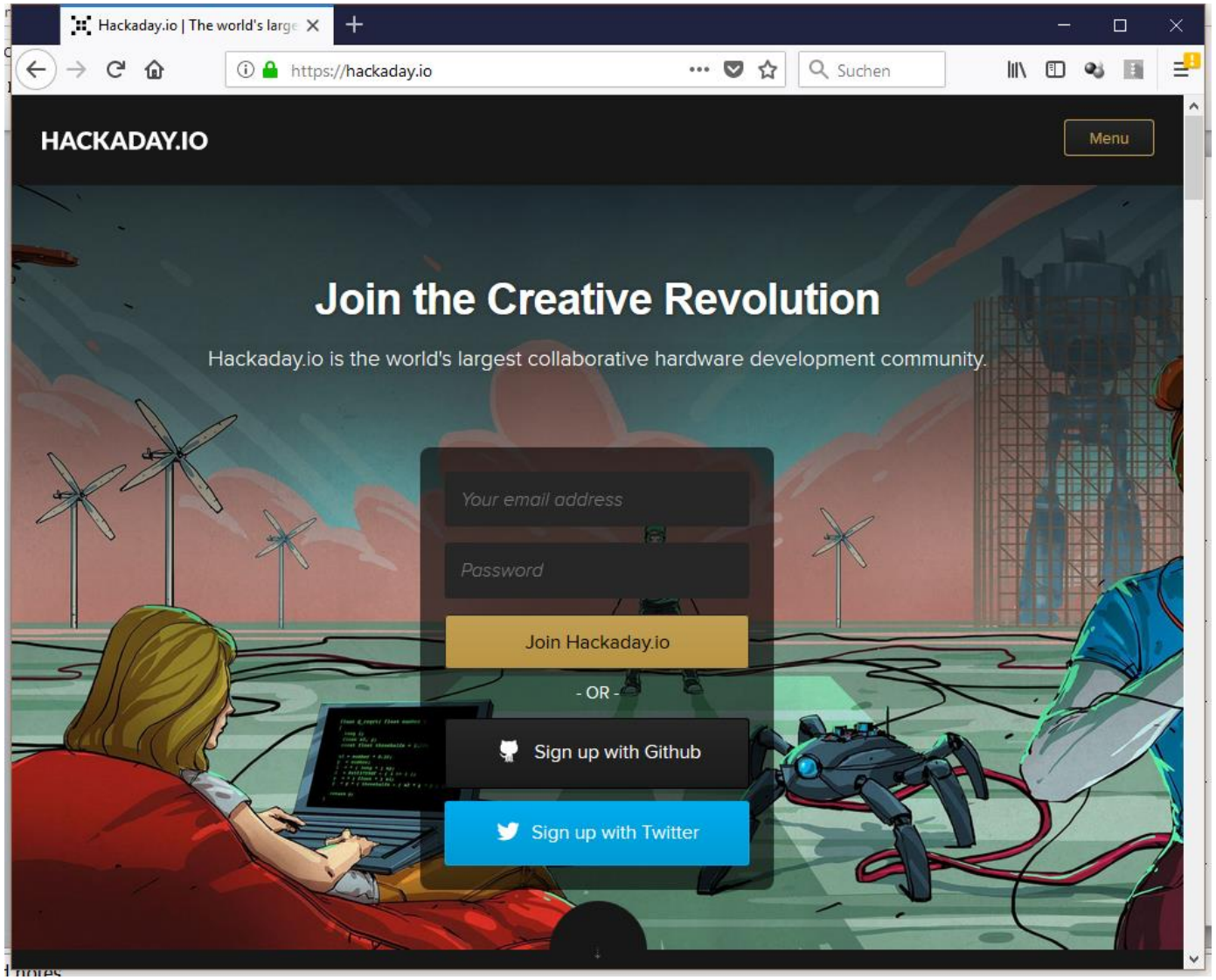
Check out http://www.raspberrypi.org



https://www.raspberrypi.org/magpi/

- Free PDF Download
- Check out www.raspberrypi.org
- Sign up for the Newsletter !

Look up IoT Projects with Rpi Here



Other Relevant Hacker / Maker Sites

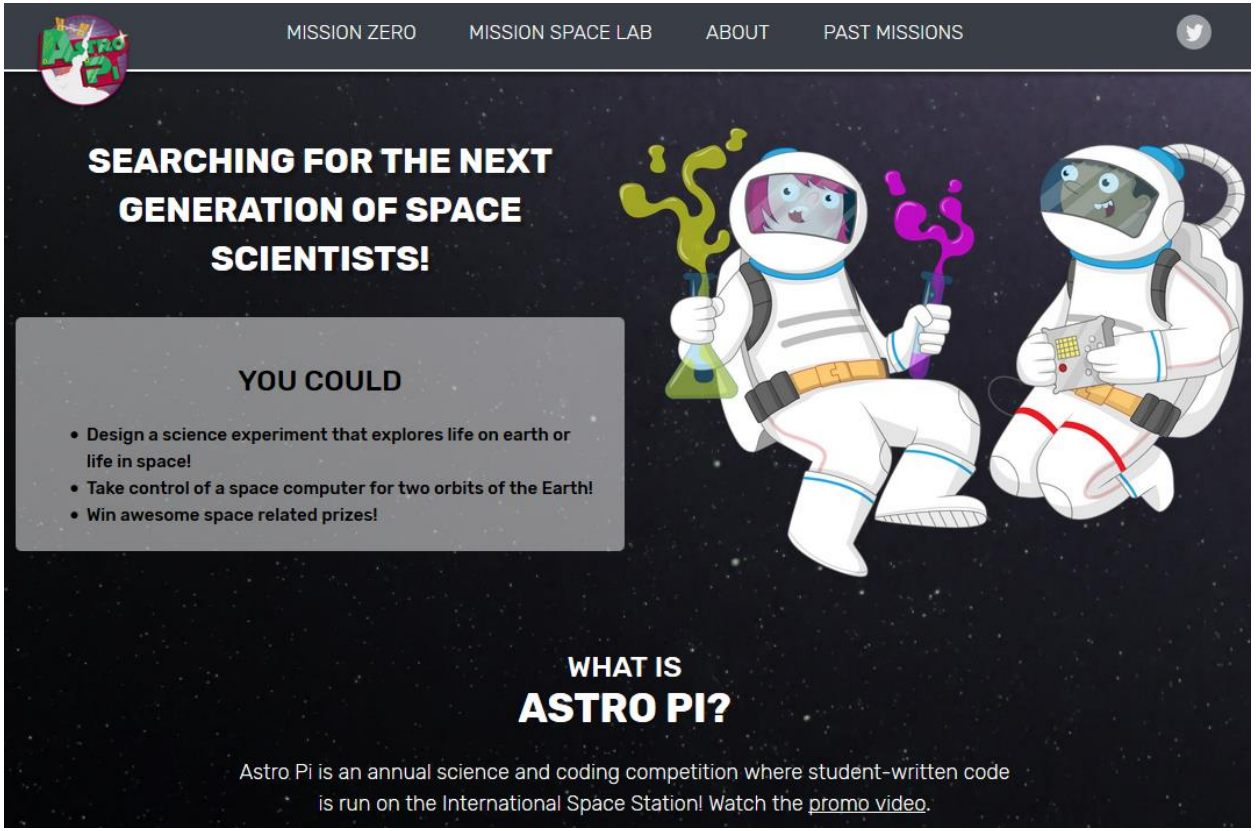
- https://makezine.com/
- https://www.instructables.com/
- https://makerfaire.com/

- https://www.adafruit.com
- https://www.sparkfun.com/
- https://www.pololu.com/

- Shopping, in addition to Adafruit, Sparkfun, Pololu:
  - https://www.jameco.com
  - Amazon
  - Ebay

AstroPi

- https://www.youtube.com/watch?v=yjll_4JY98g&feature=youtu.be



Homework Task

- Find a project on one of these sites and tell us about it next time!
  - 5 minutes
  - Why do you like it, what‘s cool about it
  - How difficult is it?
  - What do you need to know to rebuild it?
  - What would you change / improve ?

Very Coarse Class Outline

- Getting started with Raspberry Pi & Linux (today)
- Class 2: Basic Python and Digital IO (GPIO)
  - LEDS, Buttons, ..
- Class 3: More Python and More Digital IO
  - Bigger project (SIMON, …)
- Class 4: Analog IO and PCM, LCD Display, ..
- Class 5: IoT device
- Class 6: IoT device 2
- Class 7:

Outline for Today

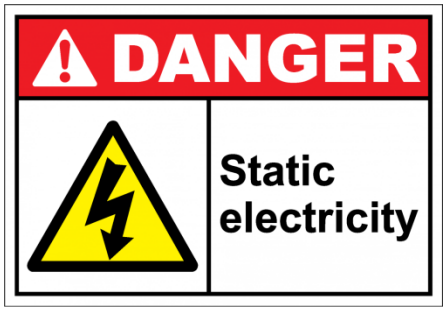
- Assemble kits
- While software installs
  - Learn about Raspberry Pi 3, Why it matters, History, …
  - Hostname Lottery

- First steps with Raspberry Pi 3
  - Change screen resolution
  - WiFi password
  - Change Password
  - Explore the Desktop
  - Some LINUX Bash commands
  - Basic RPi adminstration

Let‘s Get Started!

- Let‘s start with the assembly of our kits….
- … and monitor

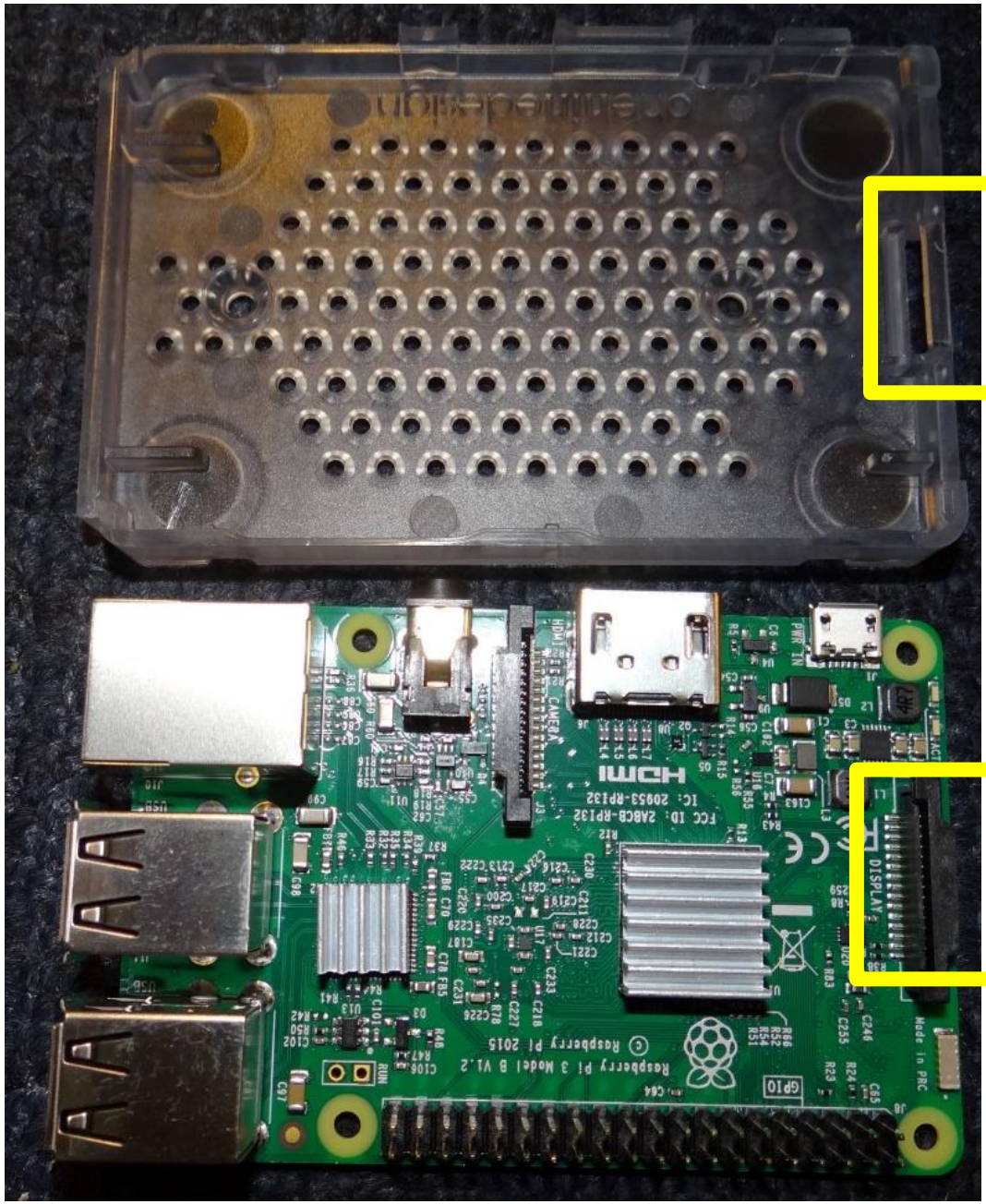
Static Electricity & GPIO Ports



- **The Raspberry Pi board has exposed circuitry and electronic components which are subject to irreparable damage or destruction by static electricity.**
- **Avoid carrying the RPi in your bare hands especially when walking across a carpeted floor. If you have to, then hold the board by the edges and discharge static from you body before setting the board down.**
- **When transporting use the anti static bag that came with your RPi. Never use a common 'zip lock' or other type of bag.**
- **Discharge static from your body by touching a grounded metal object before handling the RPi board.**
- **Also do not allow metal objects to come into contact with a powered on RPi board, especially the GPIO pins.**

HARMLESS FOR PEOPLE, BUT POTENTIALLY LETHAL FOR RPi

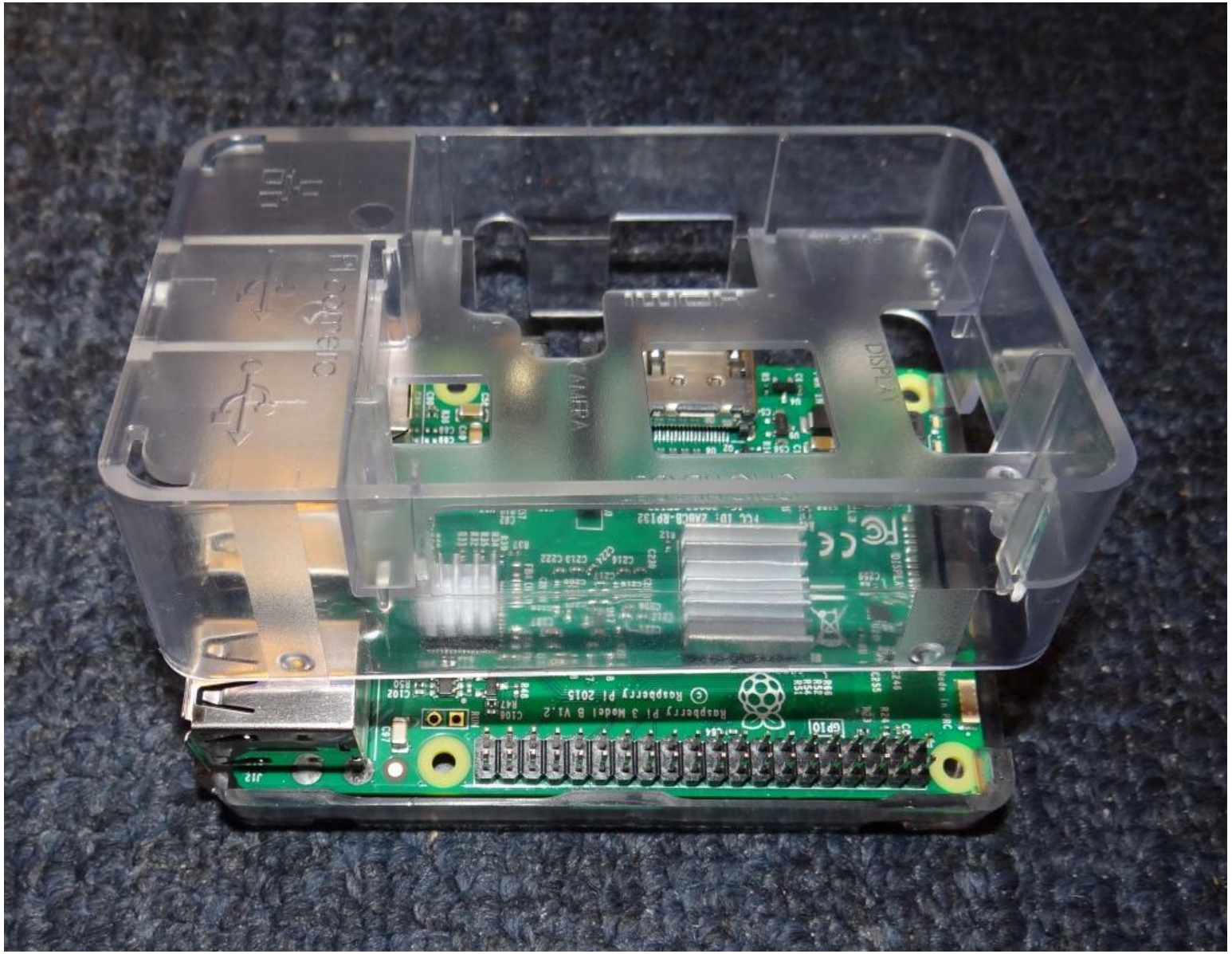
Assembly



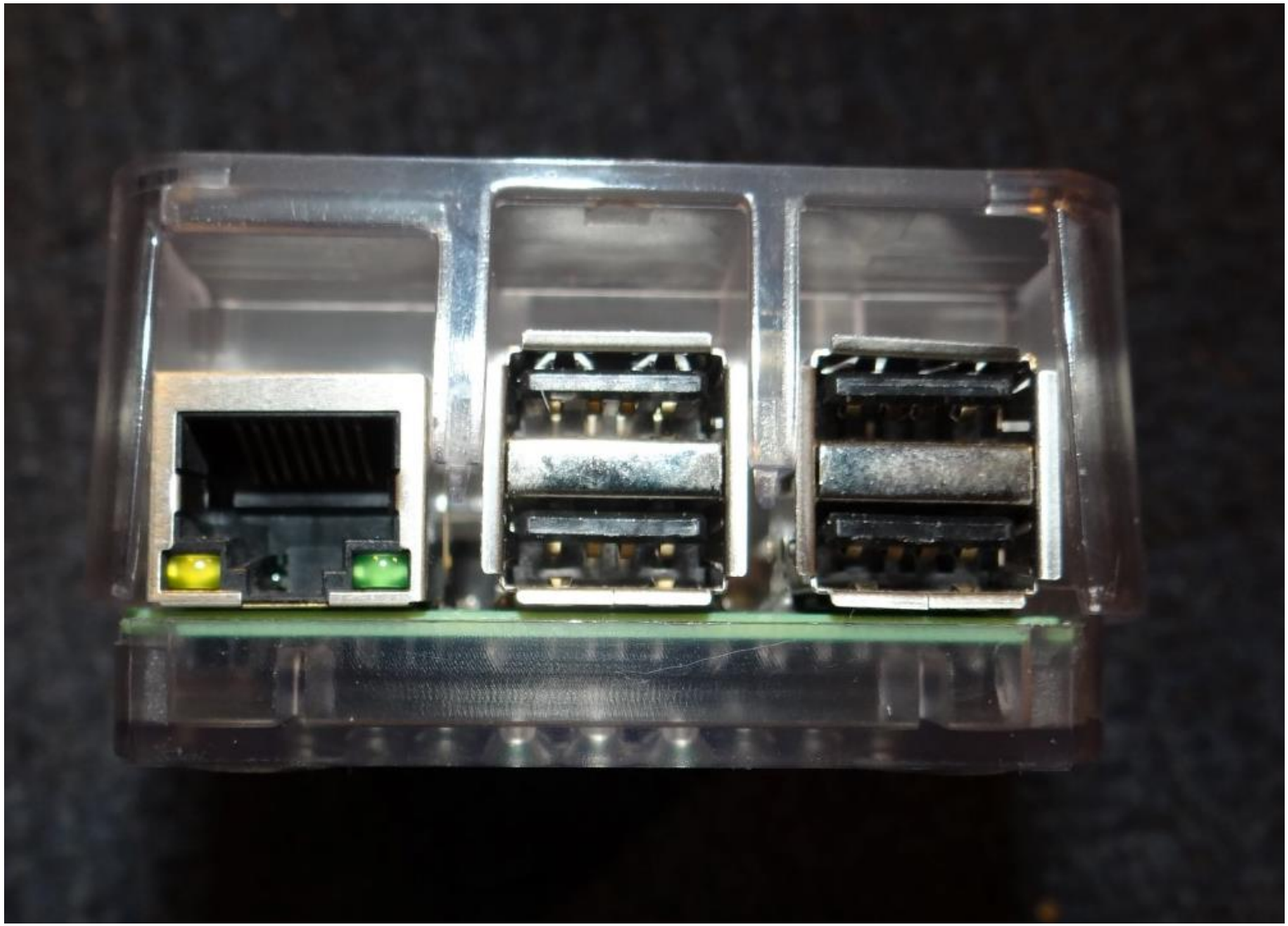
Line up correctly!

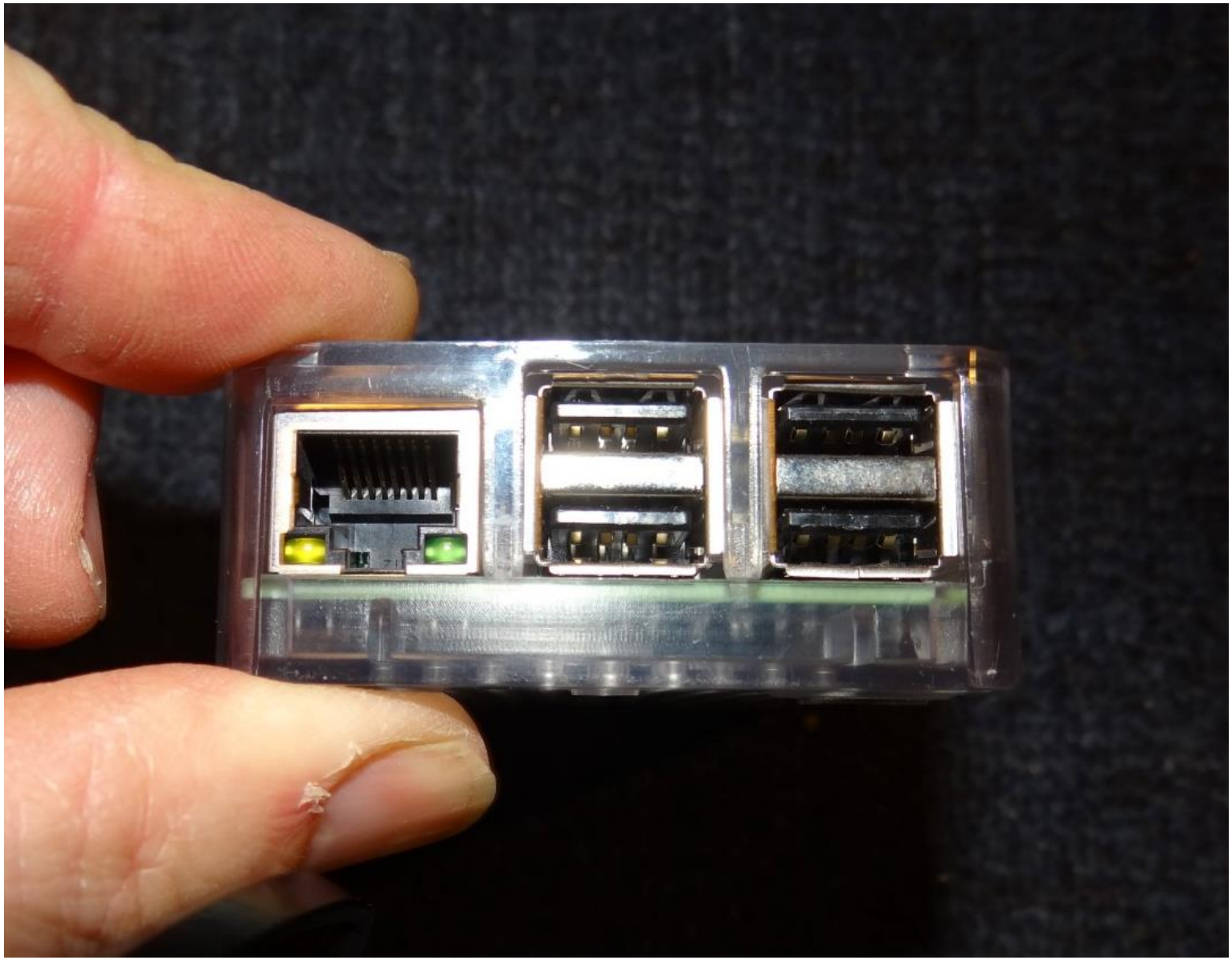

2018 03 03


2018 03 03


Raspberry Pi 3 Model B V1.2
© Raspberry Pi 2015

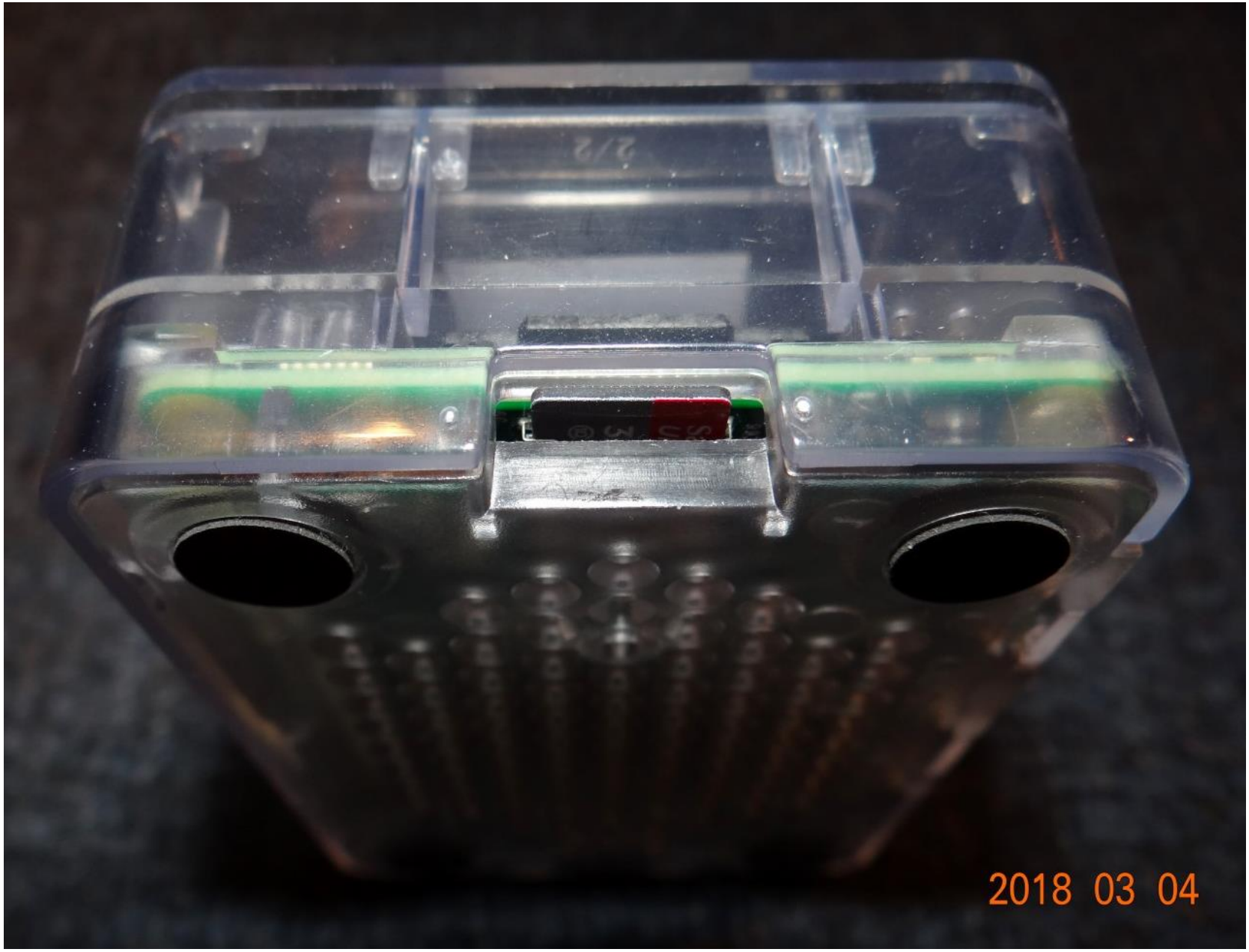

HDMI
CAMERA
A/V
GPIO HEADER






alex
GPIO HEADER
2018 03 04


Contacts Facing
Upwards
7461DVATY015
MADE IN CHINA


2018 03 04


Logitech
2018 03 04


OFF ON
Battery lifetime: keyboard off when done!
2018 03 04


You can store the USB dongle within the keyboard
2018 03 04

Next: Monitor

Optional - „RPi Workstation“ for Easy Transport

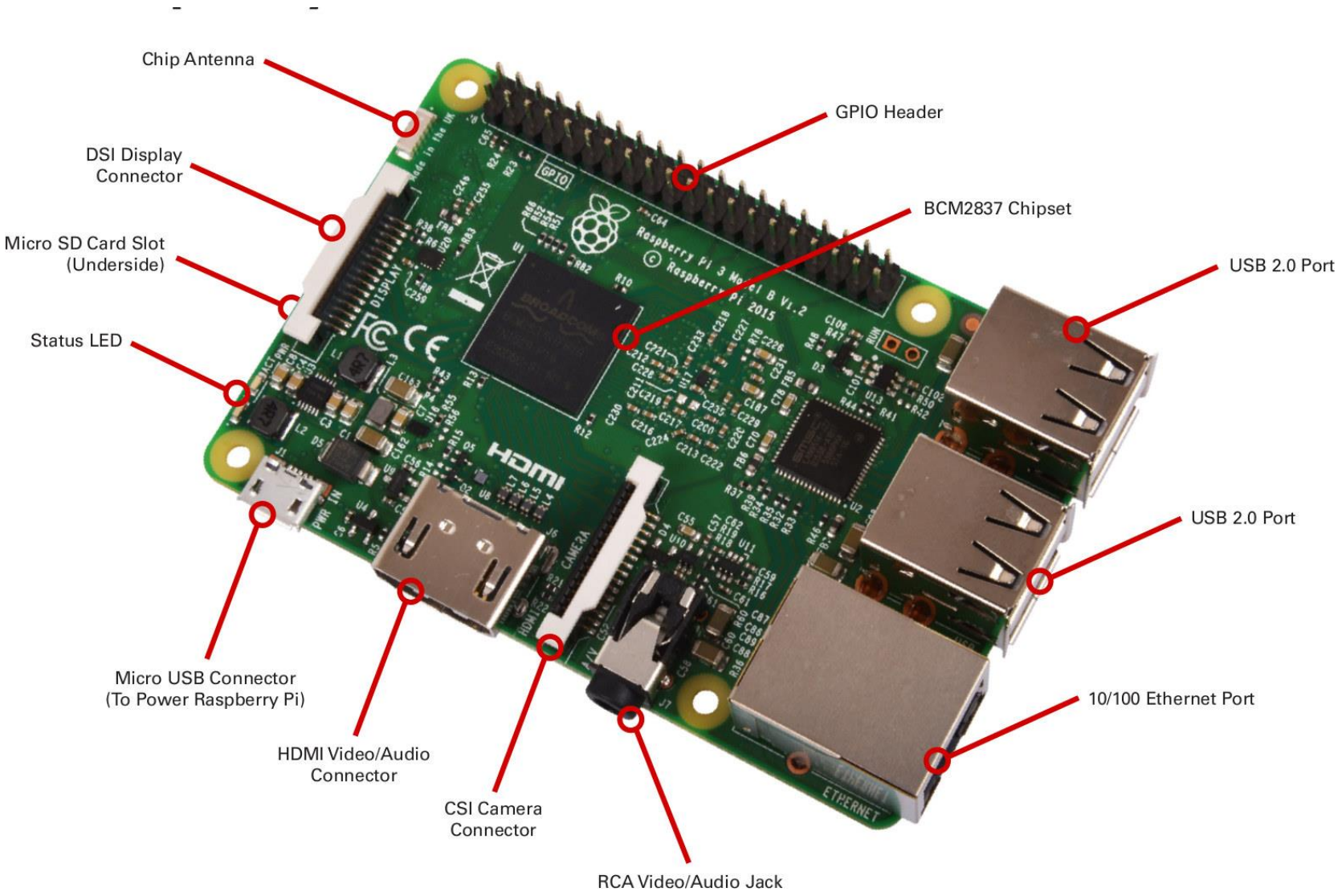
- Get an acrylic sheet from Osh!

- Double Sided *Really Strong* Tape, e.g., M3 Mounting Tape (not simple transparent Scotch double sided)
- Get a magnifier glass if your eyes are as bad as mine (GPIO labels are small)

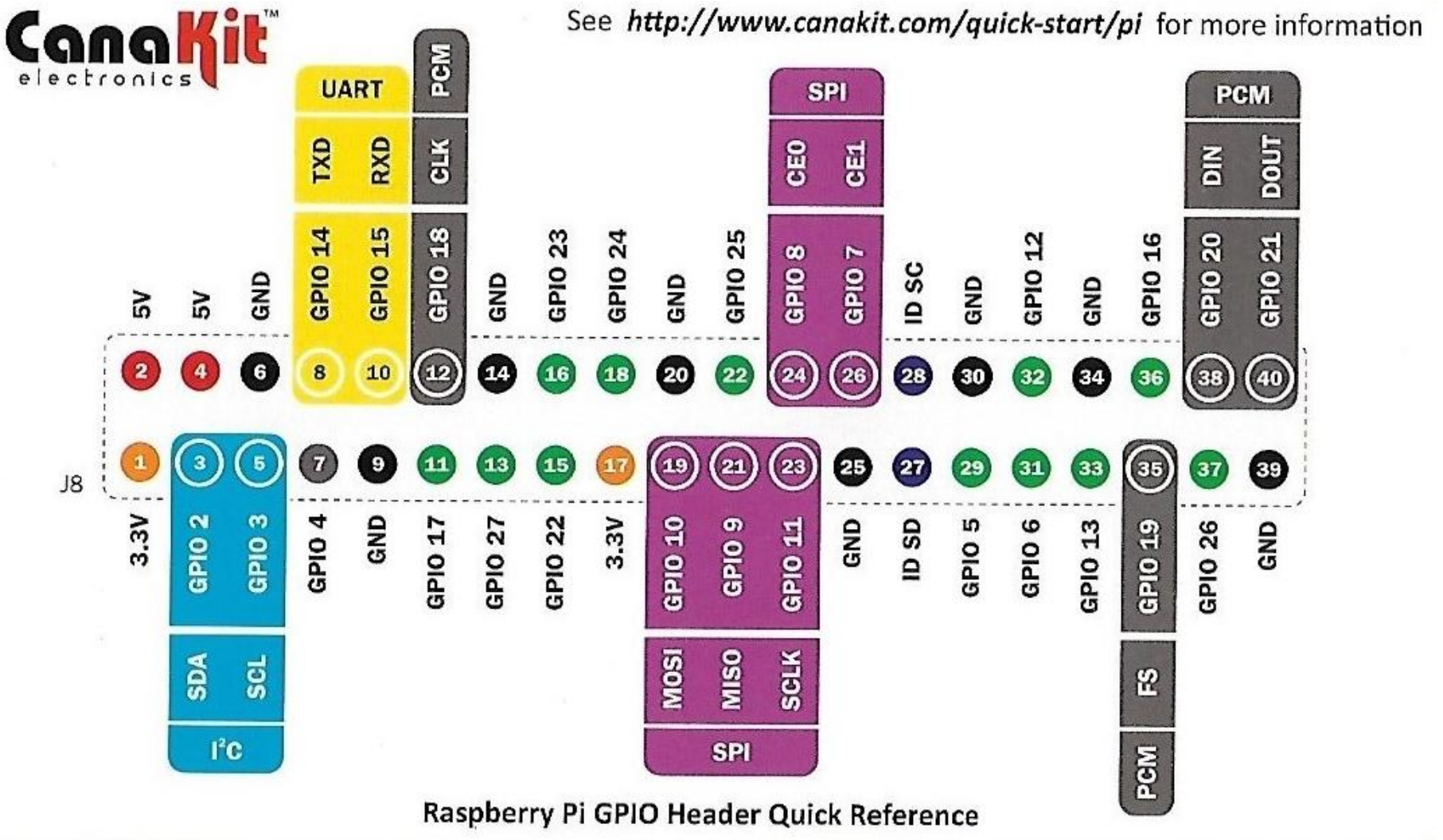
Software Installation

- Some talking which it installs… interrupt me when it is done!

Raspberry Pi 3 Model B



GPIOs https://pinout.xyz/#



Key Features

- **GPIOs**
  - **40 pin**
  - **Digital in and out**
  - **PWM „Pulse Width Modulation“**
  - **SPI, I2C: Indutry Standards Serial Protocols**
    - **Serial Peripheral Interface (SPI) – for Sensors, …**
      - **3 or 4 wires**
      - **Multiple devices with „select device“ signal**
      - **One master only**
      - **Full duplex**
      - **Longer ranges**
    - **I2C = I Squared C = I Two C = IIC = I^2C (Inter-Integrated Circuit)**
      - **2 wires only**
      - **Multiple devices on same bus, with chip addresing**
      - **Multiple masters possible**
      - **Cheaper**
      - **Half duplex**
  - **I2C more flexible, SPI faster**
  - **GPIOs need to be treated with care though; can be damaged by static electricity!**
- **However, no ANALOG inputs / outputs (unlike Arduino)**
- **Compared to Arduino:**

Key Features – 1

- RPi is a true Linux computer!
  - Complex applications easier possible
  - more versatile, much more powerful and more flexible than Arduino
    Minecraft, Python, Java, Internet, Word Processings, Games, Video, …
  - Arduino doesn‘t have an operating system – it runs ONE program that you will have to write
  - RPi: Webservers, Cloud Storage, WordPress, Databases, …. easily possible
  - However, this can also be a drawback (e.g., RobotControl, …)
- GPIO etc. easy to program (Python libraries)
- Inexpensive
  - Not worries if it breaks, get a new one ~ 30 $
- For web server / IoT applications
  - Low Power consumption
  - IoT server is „on“ all the time
- „Maker & Haker Infrastructure“
- Many products (books, magazine, extensions, ..)

Raspberry Pi 0

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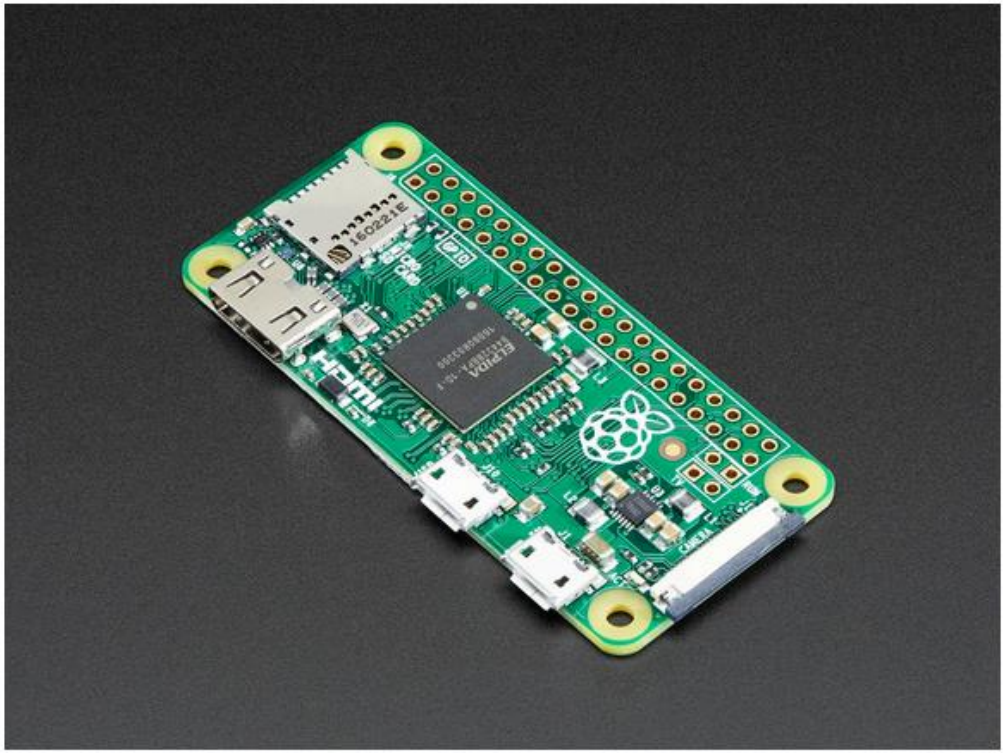
RASPBERRY PI / COMPUTERS / RASPBERRY PI ZERO - VERSION 1.3








Raspberry Pi Zero - Version 1.3

PRODUCT ID: 2885

$5.00

IN STOCK

MAX PER CUSTOMER: 1

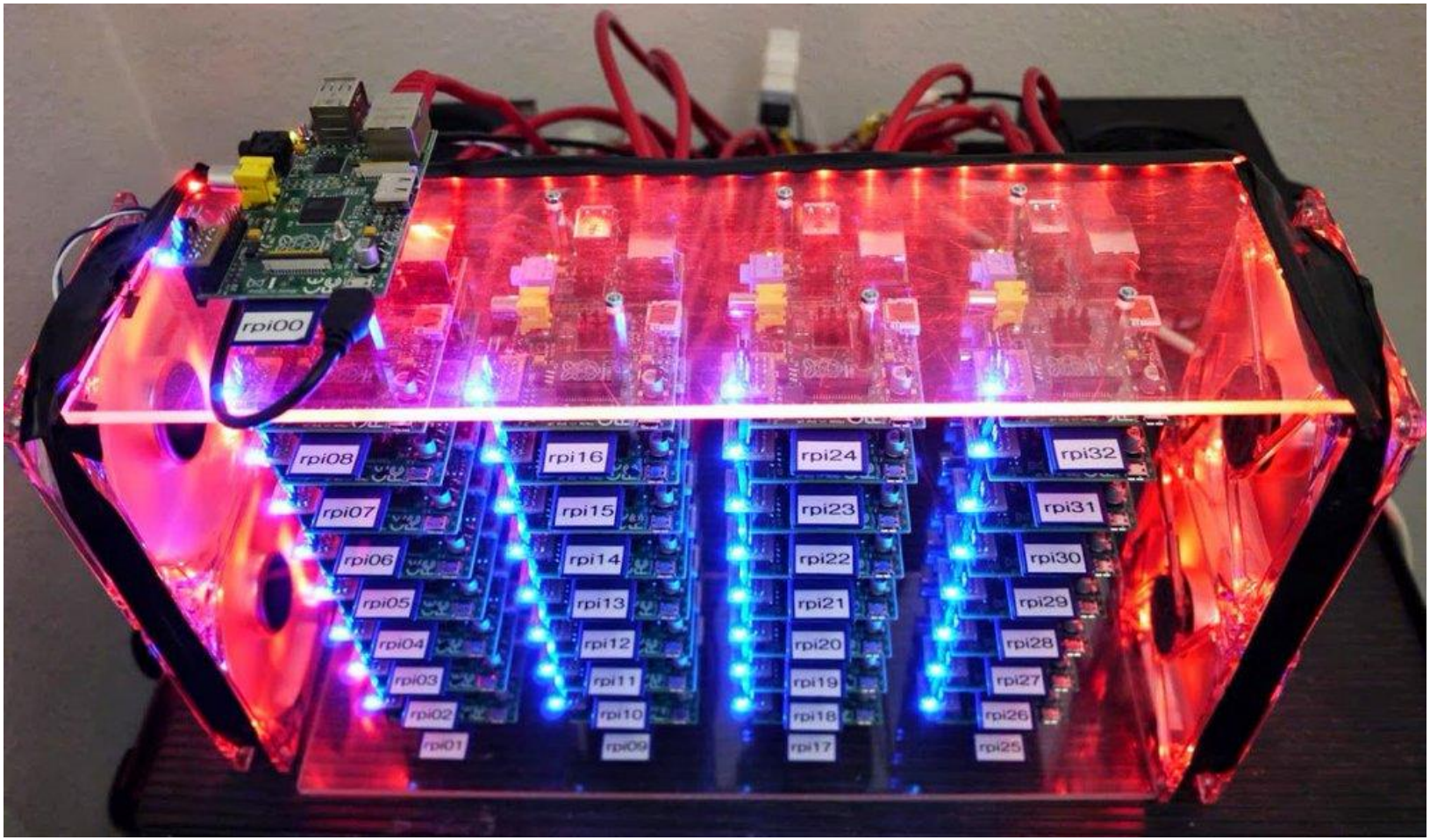
1 ADD TO CART

- ☐ **Also include 1 x Raspberry Pi Zero v1.3 Camera Cable ($5.95)**
- ☐ **Also include 1 x Adafruit Pi Protector for Raspberry Pi Model Zero ($4.95)**
- ☐ **Also include 1 x USB OTG Host Cable - MicroB OTG male to A female ($2.50)**
- ☐ **Also include 1 x Break-away 0.1" 2x20-pin Strip Dual Male Header ($0.95)**
- ☐ **Also include 1 x Tiny OTG Adapter - USB Micro to USB ($2.95)**
- ☐ **Also include 1 x Mini HDMI Plug to Standard HDMI Jack Adapter ($2.95)**
- ☐ **Also include 1 x Mini HDMI to HDMI Cable - 5 feet ($5.95)**

A Toy Computer?

- Hmmm… but wait

Beowulf Cluster RPI 2B: < 2.000 $
Joshua Kiepert @ Boise State



Los Alamos – 750 RPI3 – Saves 250 Millions $ Investment

RPi 3 B – ~ 35 $

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RASPBERRY PI / RASPBERRY PI B+, PI 2, & PI 3 / RASPBERRY PI 3 - MODEL B - ARMV8 WITH 1G RAM

Raspberry Pi 3 - Model B - ARMv8 with 1G RAM

PRODUCT ID: 3055

$35.00

IN STOCK

1 ADD TO CART

Also include 1 x Aluminum Heat Sink for Raspberry Pi 3 - 15 x 15 x 15mm ($1.95)

ADD TO WISHLIST

DESCRIPTION

TECHNICAL DETAILS

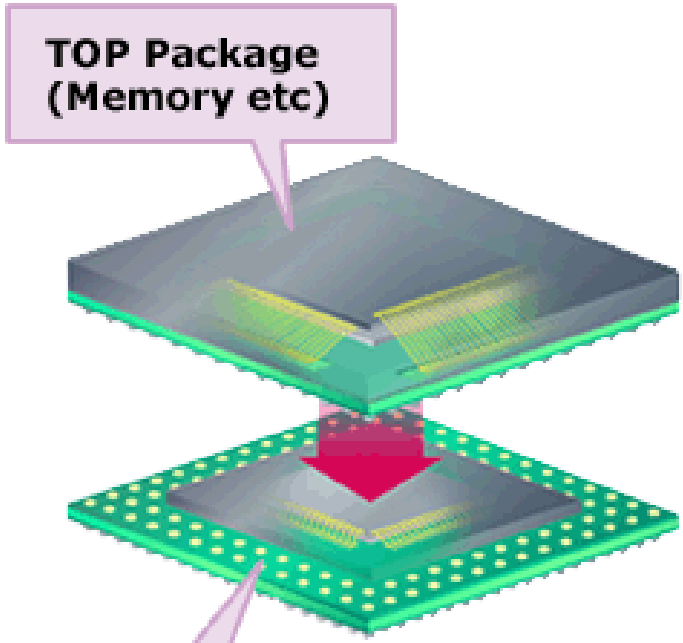
LEARN

Raspberry Pi 3 Model B Specs

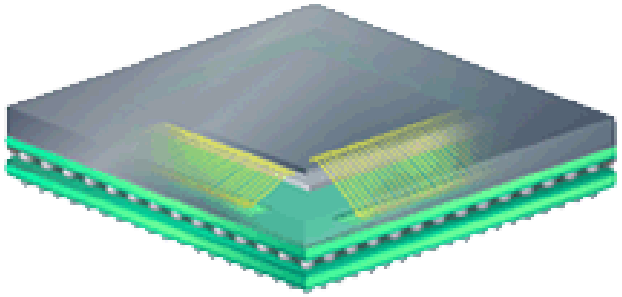
- System on a chip = SoC = CPU + GPU + 1 GB RAM Memory „on Top“
  - CPU = Central Processing Unit („The Brain“)
  - GPU = Graphics Processing Unit („Graphics Card“)
  - Same in phones, tablets, …
  - Broadcom „Video Core“ series of SoC‘s
- Pi 3:
  - CPU: ARMv8 @ 1.2 GHz (A53 cluster) / BCM2837Broadcom
  - Quad Core 64 bit
  - 1 GB RAM DDR2 @ 900 MHz – „Package on Package (POP)“ on SoC
  - WiFi, Bluetooth built in
  - **50 % faster than Pi 2 SoC !**
- Pi 2:
  - CPU: ARMv7 @ 900 MHz / BCM2867 Broadcom
  - Quad Core 32 bit
  - 1 GB RAM DDR2 @ 450 MHz – „Package on Package (POP)“ on SoC
  - No WiFi / no Bluetooth
- Where is the hard disk??
- Compared with recent PC or MacBook, RPI3 is slow, but fast enough as you will see

… It is pronounced S - O - C

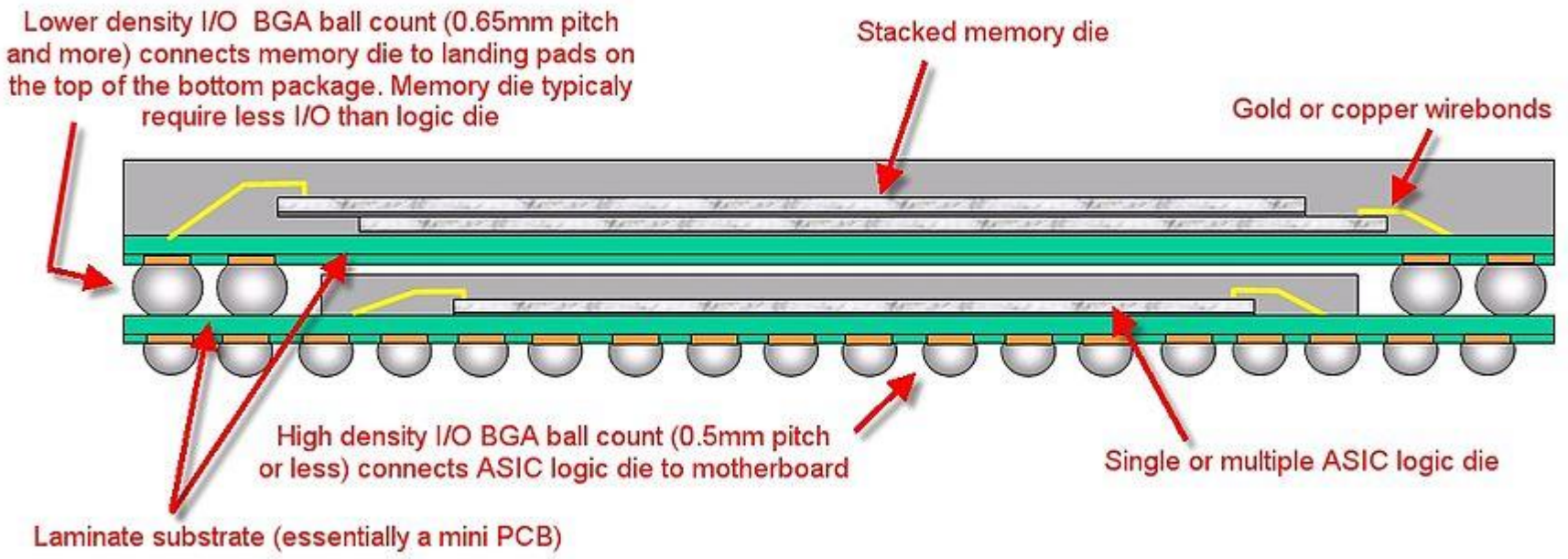
Stacking of Memory on Top of SoC



- Rich variation of built-in chips
- Stacking chosen packages increases yields



PoP „Package on Top“



Specs

- CPU / GPU: ARMv8 Quad Core 64bit 1.2 GHz

BCM2837

This is the Broadcom chip used in the Raspberry Pi 3, and in later models of the Raspberry Pi 2. The underlying architecture of the BCM2837 is identical to the BCM2836. The only significant difference is the replacement of the ARMv7 quad core cluster with a quad-core ARM Cortex A53 (ARMv8) cluster.

The ARM cores run at 1.2GHz, making the device about 50% faster than the Raspberry Pi 2. The VideoCore IV runs at 400MHz.

Also see the Raspberry Pi 2's chip BCM2836 and the Raspberry Pi 1's chip BCM2835.

History of the ARM CPU

- ARM = „Acorn RISC Machine“
- ARM = „Advanced RISC Machine“
- Originally developed in Cambridge, England by the company Acorn Ltd., ~ 1987 -
  - Developer: Roger / Sophie Wilson
  - ARM RISC Instruction Set
- The first RISC CPU – 1987:
  „fastest micro in the world“
- ARM and Cell Phones are from the 80ies! ☺

Ancient Predecessor of the IPhone

Acorn Archimedes

From Wikipedia, the free encyclopedia

The **Acorn Archimedes** is a family of personal computers designed by Acorn Computers Ltd in Cambridge, England and sold in the late-1980s to mid-1990s, their first general purpose home computer based on their own ARM architecture (then the CPU and architecture was known as Acorn RISC Machine, or ARM, that later became one of the most widely used CPU architectures in the world,[1] used in most smartphones among many other uses). The first Archimedes was launched in 1987.

ARM's RISC design, a 32-bit CPU (using 26-bit addressing), running at 8 MHz, was stated as achieving 4.5+ MIPS,[2] which provided a significant upgrade from 8-bit home computers, such as Acorn's previous ones. Claims of being the fastest micro in the world and running at 18 MIPS were also made during tests.[3]

The models in the family either omitted the Acorn or Archimedes part of the name, with the first models named "BBC Archimedes", while the name "Acorn Archimedes" is commonly used to describe any of Acorn's contemporary designs based on the same architecture. While the computers are no longer sold, computers such as the Raspberry Pi can still run its operating system, RISC OS (at least later versions), as they use ARM chips that are (mostly) compatible.

Acorn Archimedes

Archimedes 400/1 series computer. The function keys on the keyboard are the standard grey; on BBC branded models, the function keys were red

Example applications of ARM cores [edit]

Main article: List of applications of ARM cores

ARM cores are used in a number of products, particularly PDAs and smartphones. Some computing examples are Microsoft's first generation Surface and Surface 2, Apple's iPads and Asus's Eee Pad Transformer tablet computers, and several Chromebook laptops. Others include Apple's iPhone smartphone and iPod portable media player, Canon PowerShot digital cameras, Nintendo Switch hybrid and 3DS handheld game consoles, and TomTom turn-by-turn navigation systems.

In 2005, ARM Holdings took part in the development of Manchester University's computer SpiNNaker, which used ARM cores to simulate the human brain.[60]

ARM chips are also used in Raspberry Pi, BeagleBoard, BeagleBone, PandaBoard and other single-board computers, because they are very small, inexpensive and consume very little power.

ARM

- ARM is also in VexRobotics Cortex Controller
  - ARM CORTEX M3
  - inexpensive ARM CPU for „realtime applications“ (~ 3.40 $)

BBC Micro

From Wikipedia, the free encyclopedia

The **British Broadcasting Corporation Microcomputer System**, or **BBC Micro**, is a series of microcomputers and associated peripherals designed and built by the Acorn Computer company for the *BBC Computer Literacy Project*, operated by the British Broadcasting Corporation. Designed with an emphasis on education, it was notable for its ruggedness, expandability, and the quality of its operating system. An accompanying 1982 television series "*The Computer Programme*" featuring Chris Serle learning to use the machine was also broadcast on BBC 2.

BBC Micro

BBC Micro Model A/B (standard configuration)

Sophie Wilson, ARM „Inventor“

Acorn BBC Micro Team

Motivation for the Raspberry Pi

- Eben Upton, father of the Pi (2006)
  - Computer Scientist
    PhD @ Cambridge / England
  - Director of student admissions
    for computer science (CS)
  - Realized decline in admission
    numbers for CS ~ 2000 and CS knowledge
    - „Children are not digital natives“
    - They know about the internet and games etc. from PCs, but they do not know enough about the underlying digital technology
    - Unlike kids of the early 1980
    - Upton learned BASIC on the BBC Micro
    - Why is this, he asked? How can we make it better?
  - Later, worked for Broadcom
  - First Raspberry Pi in 2012, but developed the idea in 2006
  - Speaks at Maker Fair in San Mateo ocasionally

Video Eben Raspberry Pi

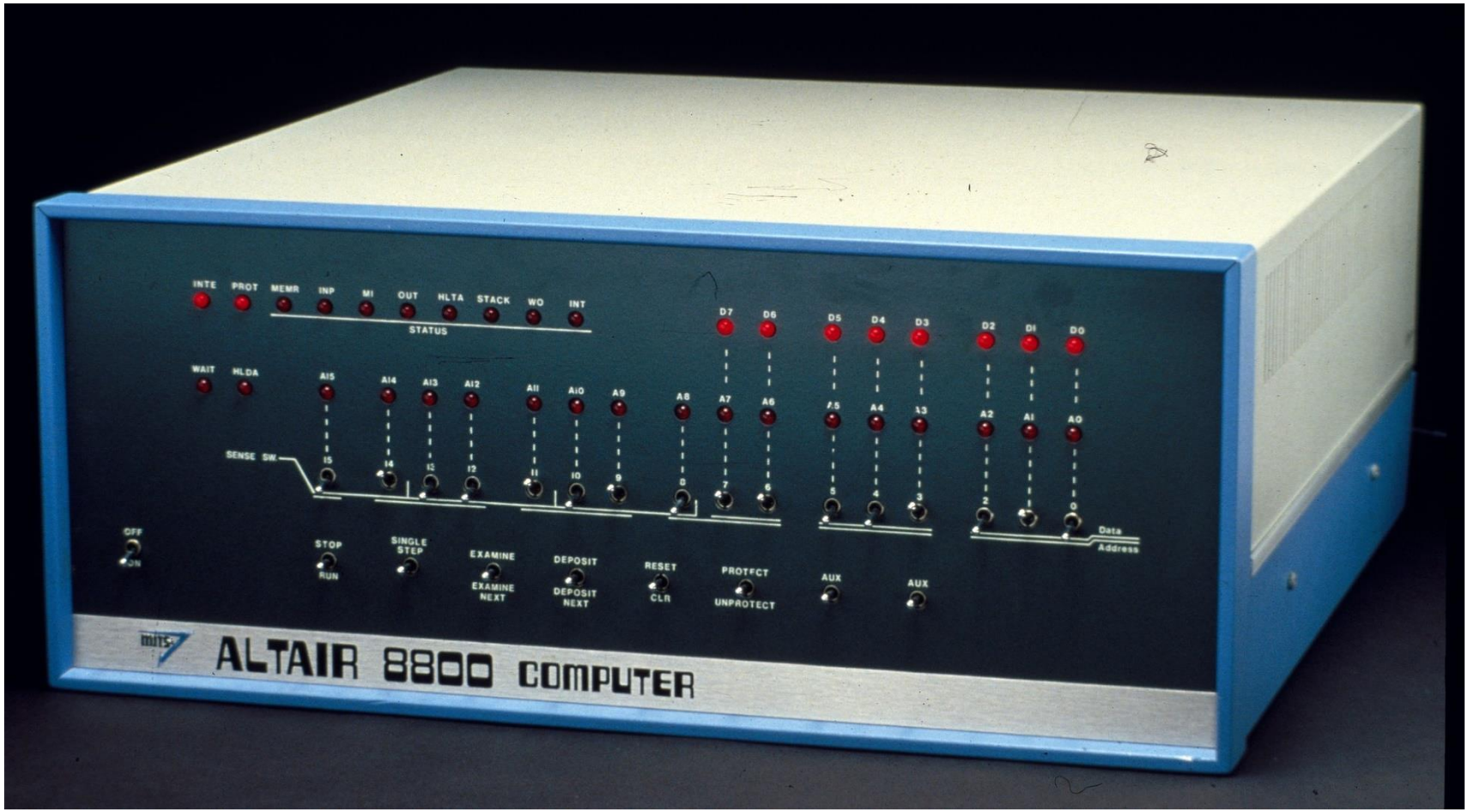
Homework, if you have time:

- https://youtu.be/6xFzVuxldqs
- https://youtu.be/UCt6d0SCxO4

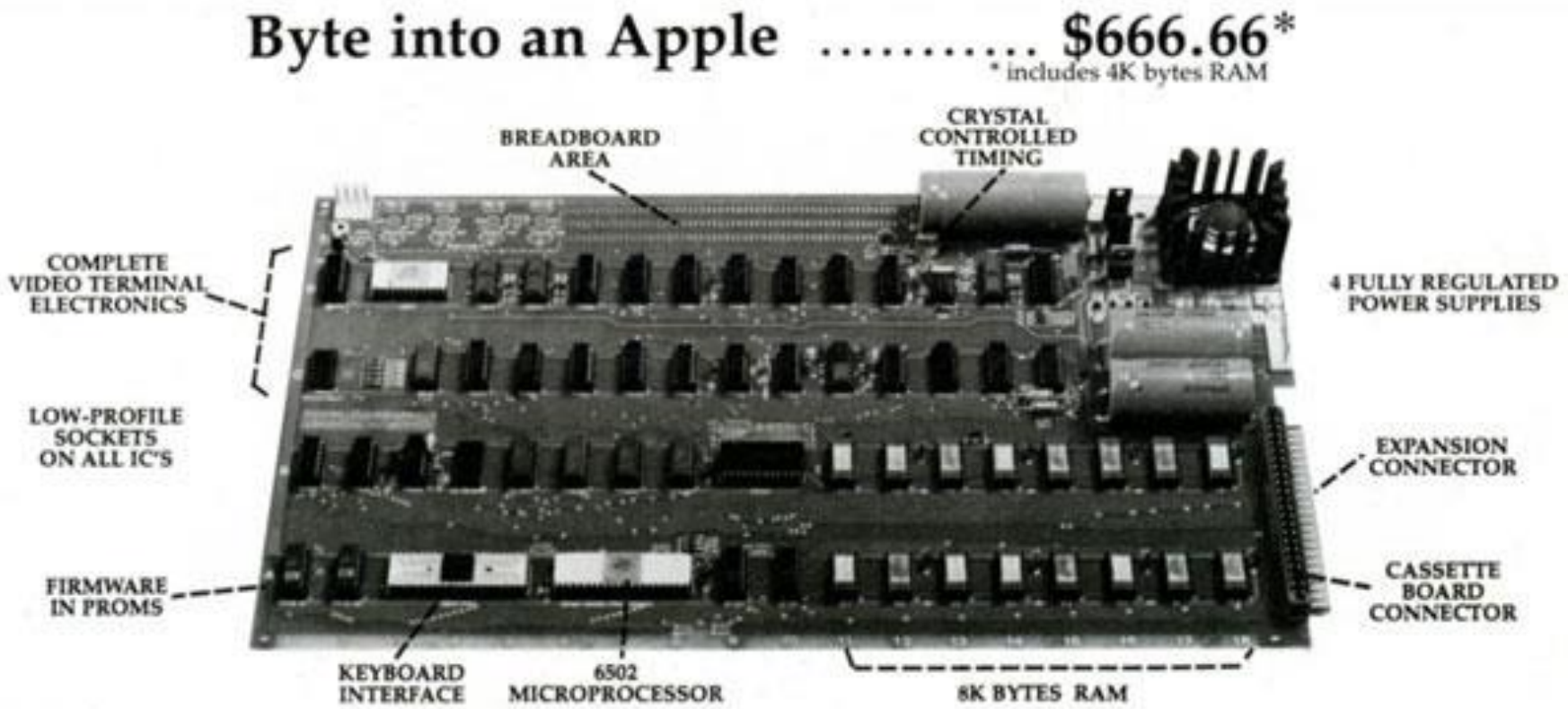
Computing in the 1980s

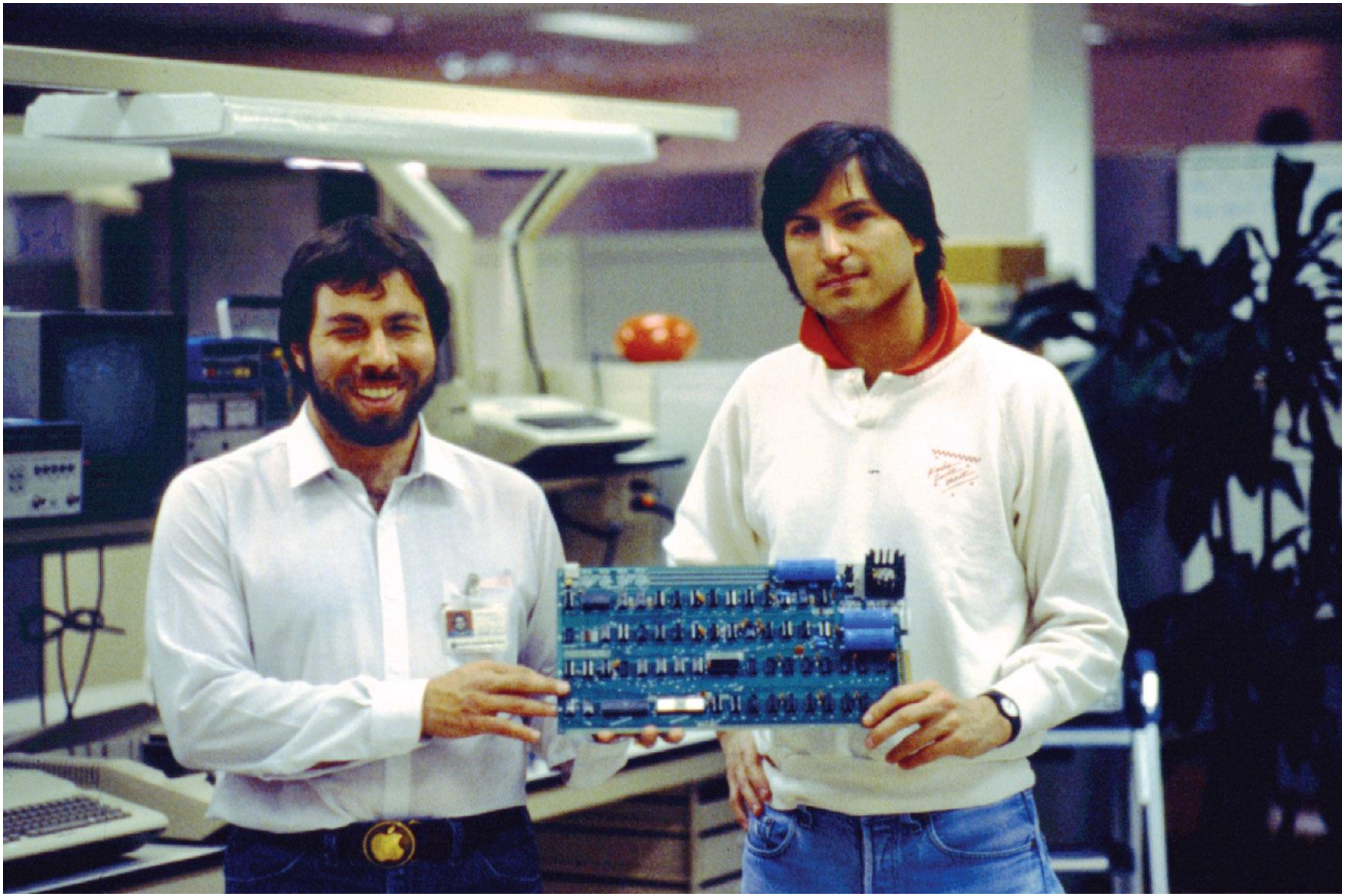
- Early 80is:
  - build your own Microcomputer
- Later
  - get a Commodore 64
  - BBC Micro
  - ….
- What was better about the home computers of the 80is?
  - Understandable
  - You HAD to program to achieve something
  - Not so much software, no multi-media „to consume“
  - More „make“ than „consume“ culture
  - LOTS of hobby / maker projects!
  - Expansion ports – build your own hardware extensions was easier!
    - More „hands on“ tinckering possible with these old machines
- **Go to the Computer History Museum in Mountain View !!!**

Altair 8800, 1974
Bill Gates: BASIC for Altair (punched tape)



Apple 1 – October 1976



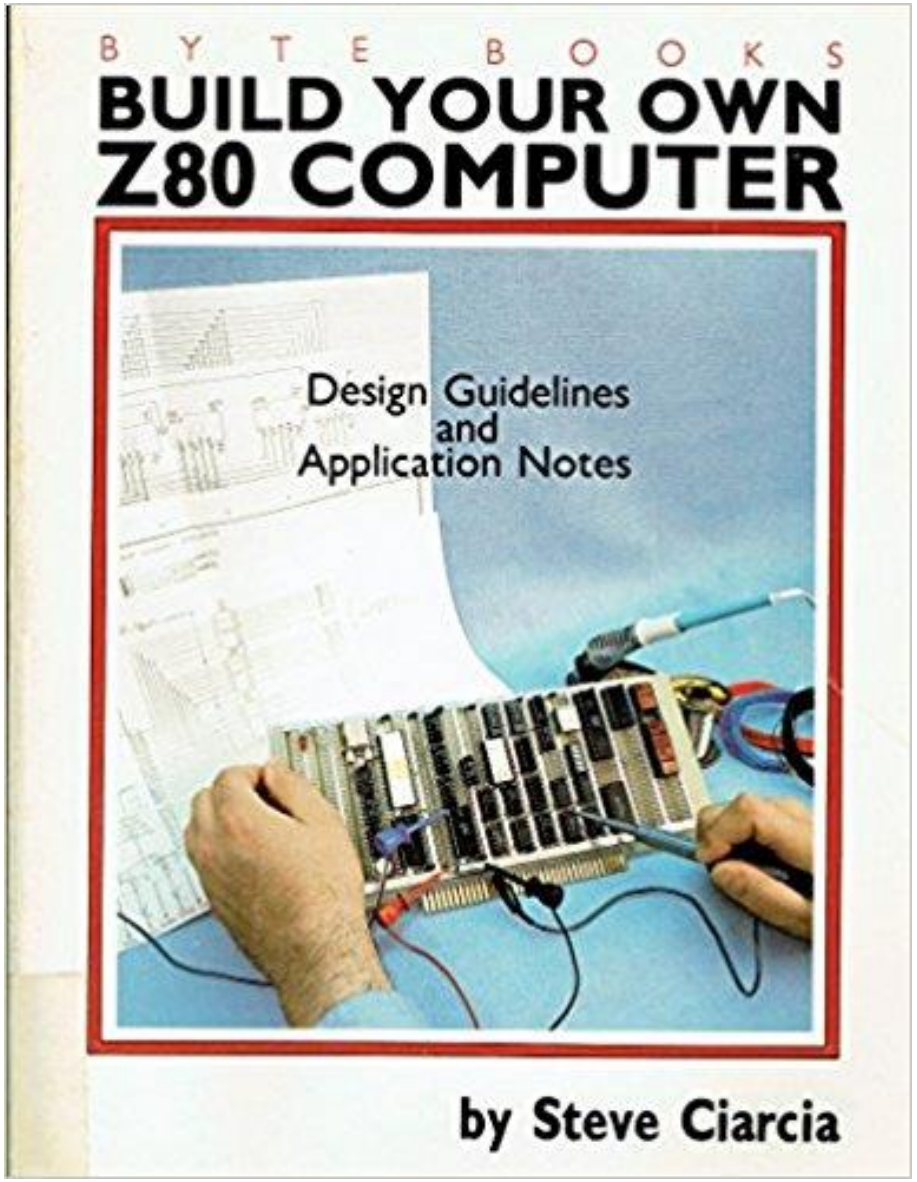


Trinity 1: Commodore PET 1977 – CBM

Trinity 2: TRS („Trash“) 80
1977 – Tandy / Radio Shack

Trinity 3: Apple II
1977 – Apple Computers

1981


BYTE BOOKS
BUILD YOUR OWN
Z80 COMPUTER
Design Guidelines
and
Application Notes
by Steve Ciarcia

Commodore 64 – 1984 - The Bread Bin

The best selling computer ever – 17 Millions !
Guinness Book of Records

Messing with Computers

- Interview with Upton in MIT Technology Review
  http://www2.technologyreview.com/tr35/profile.aspx?trid=1307

  "To judge by the applicants Upton was looking at, however, kids had lost interest. ***They were still messing around on computers, but they weren't messing around with them. They weren't writing programs and taking apart circuit boards.*** They were the kinds of kids who played World of Warcraft and exchanged cat pictures on Facebook. ***They had changed from active hackers to passive consumers.***"

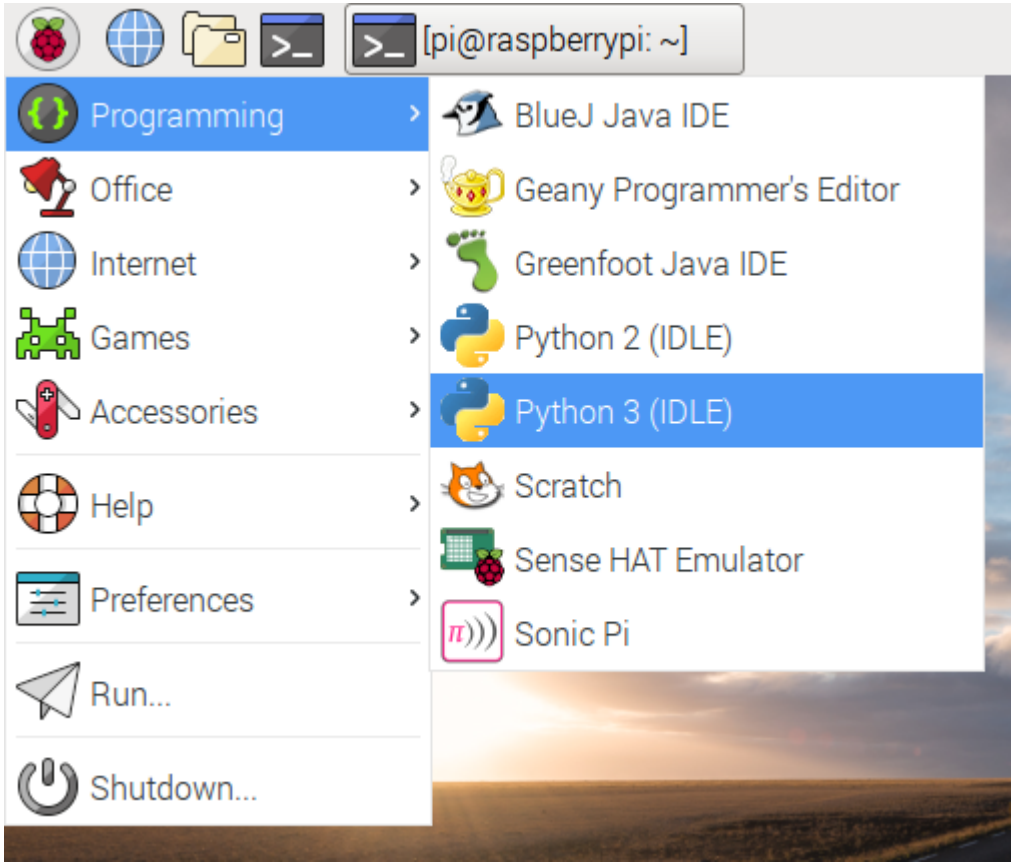
Raspberry Pi Allows This!

- Messing WITH computers AND programming AND tinkering are important if you want to beome and engineer or „digital native“
  - It is cheap (35 $)
    - No worries if you break something – just get a new one ☺
    - Break your MacBook is a different story… Mom & Dad will be angry!
  - It invites programming
  - It has GPIOs
- Similar with BotBall, VexRobotics, …
  - **You have to MAKE something in order to become an engineer**
  - And mess with circuits if you want to become a hardware engineer ☺
- Energy consumption
  - Running a webserver on the Pi is cheap!
    5 Watts for RPi over 150 Watts for a „real“ webserver server
  - Much more affordable

Commodore 64 – No Desktop!

Same with Raspberry Pi …

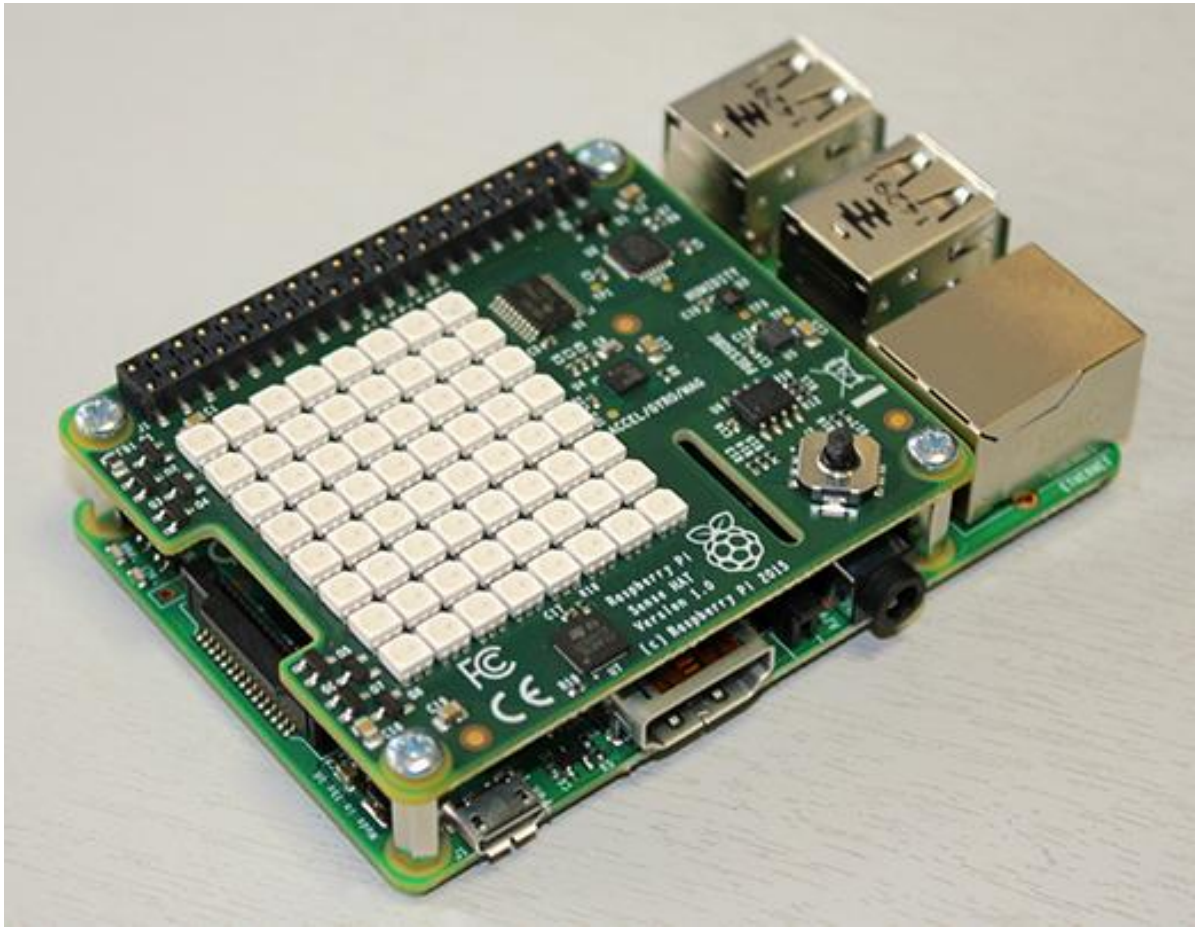
- … no need to install programming languages!



Raspberry Pi HAT Demos

- HAT = „Hardware Attached on Top”
  - An extension port that goes on top
  - Can also come with required driver software that gets loaded automatically
  - Get a SenseHat if you only get one HAT! (but pricey…)
    - **Not required for our class!**
    - LED Matrix
    - 5-way Joystick
    - Sensors: Gyroscope, Accelerometer, Magnetometer, Barometer, Temperature, Humidity
    - We will be using the SenseHAS Simulator
    - See AstroPi
  - Many many other cool HATs
    - Real Time Clock (RTC), Unicorn LED Matrix HAT HD, Sound Cards, Robot HAT for controlling DC motors and servos, …

RPi SenseHAT



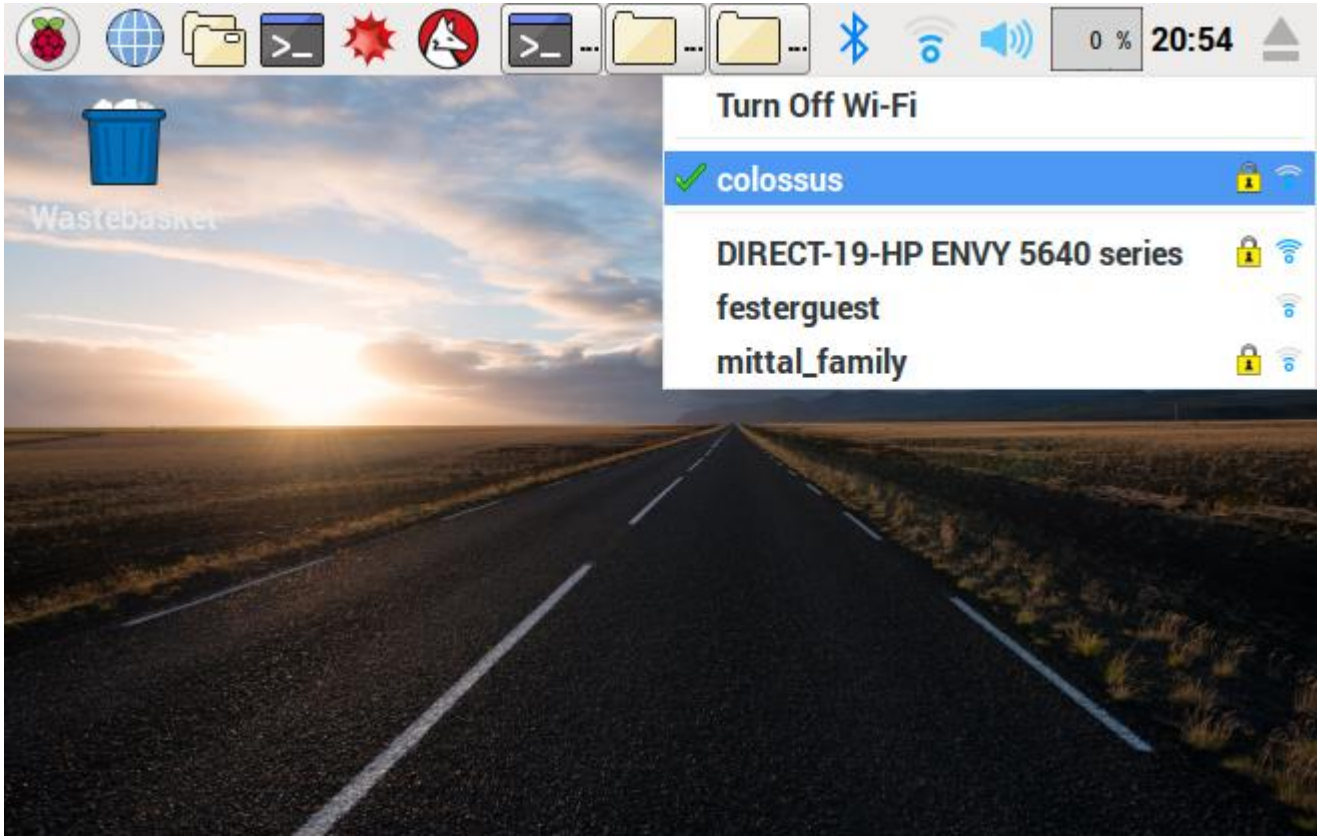
Are we ready now?

- Let‘s start our RPi experience!

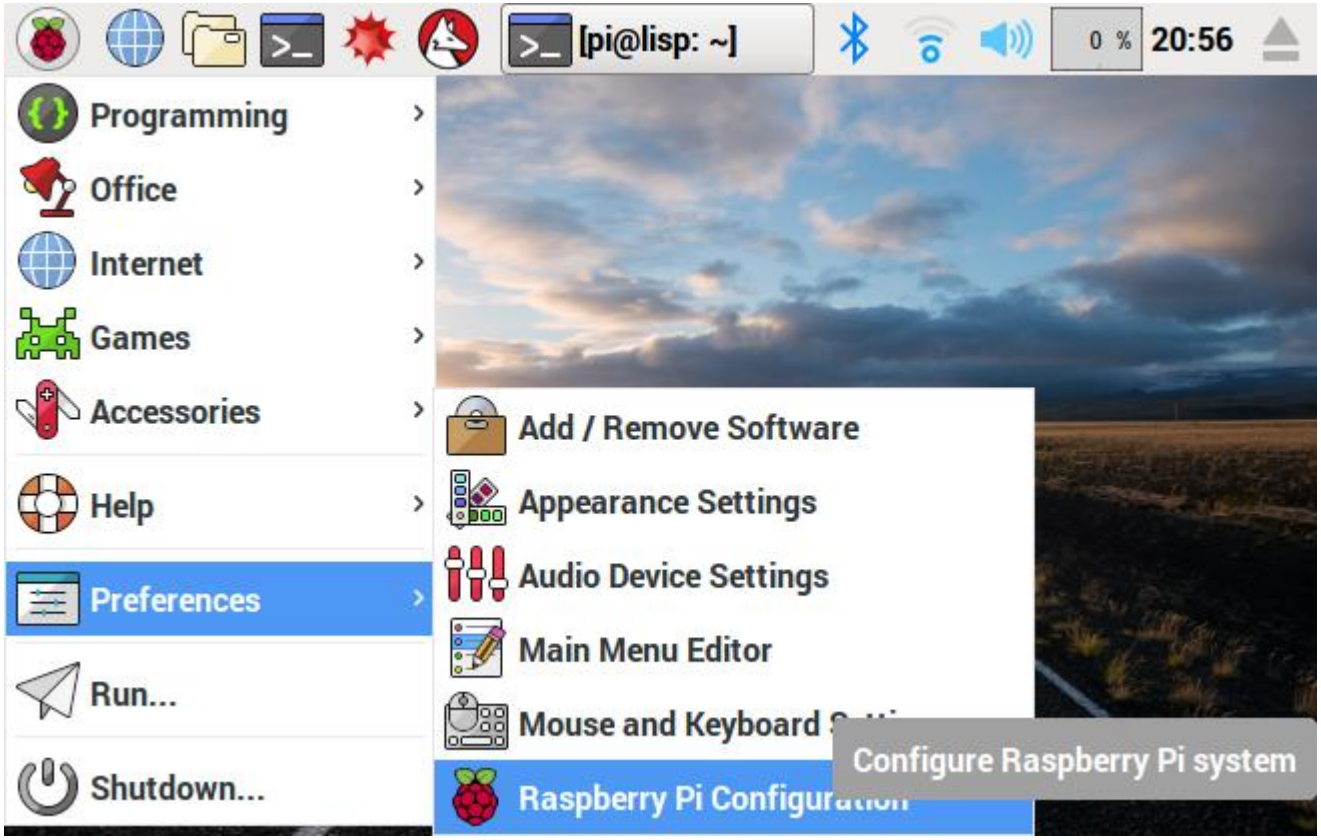
Configuration

- Screen resolution
- Internet WiFi
- Password
  - Default user: **pi** (not need to change)
  - Default password: **raspberry** – let‘s change that!
  - Super user login disabled, but **sudo**
- Set Hostname from Lottery
  - Use clear tape for stickers
  - 1 on RPi case, 1 under keyboard
  - Leave the keyboard dongles plugged in all the time to avoid confusion

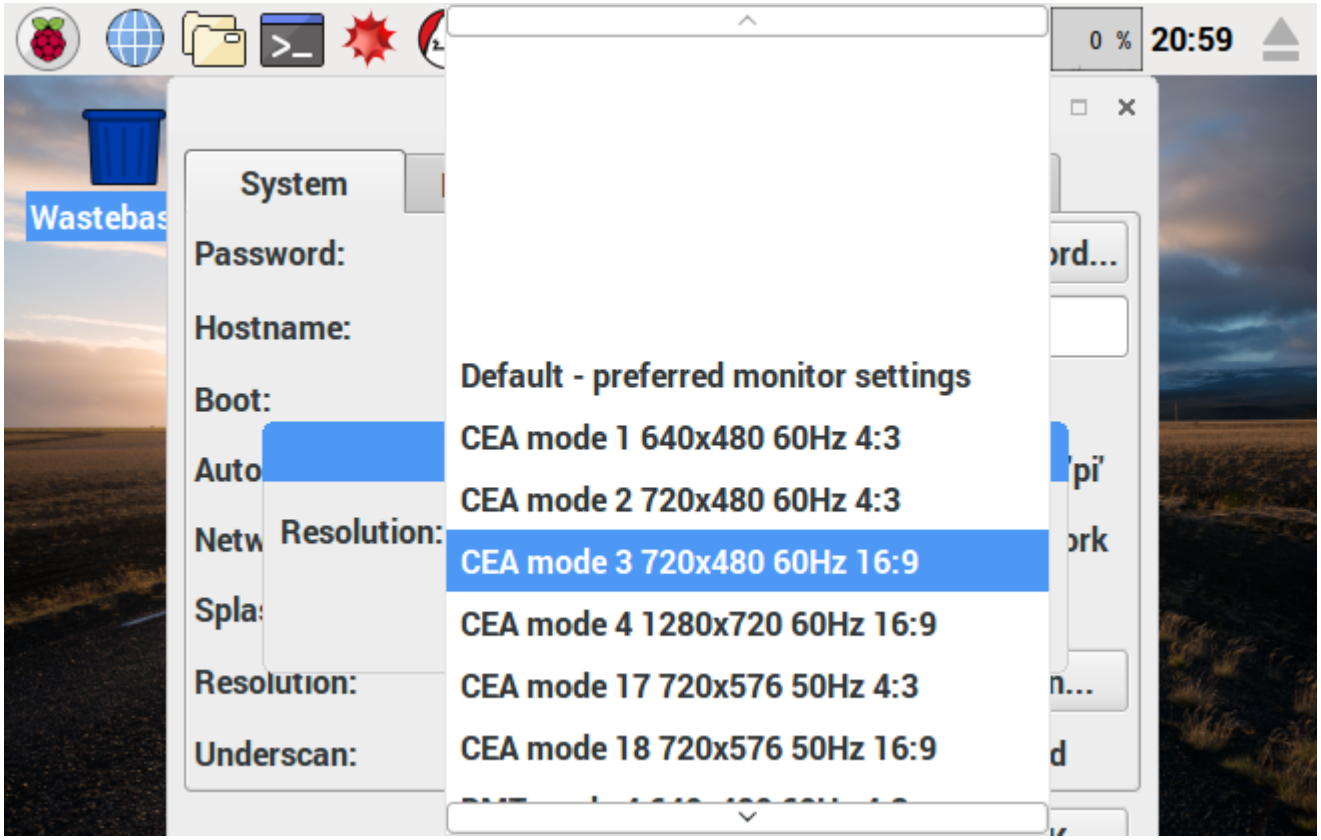
Wifi Configuration
Wifi Password is ….



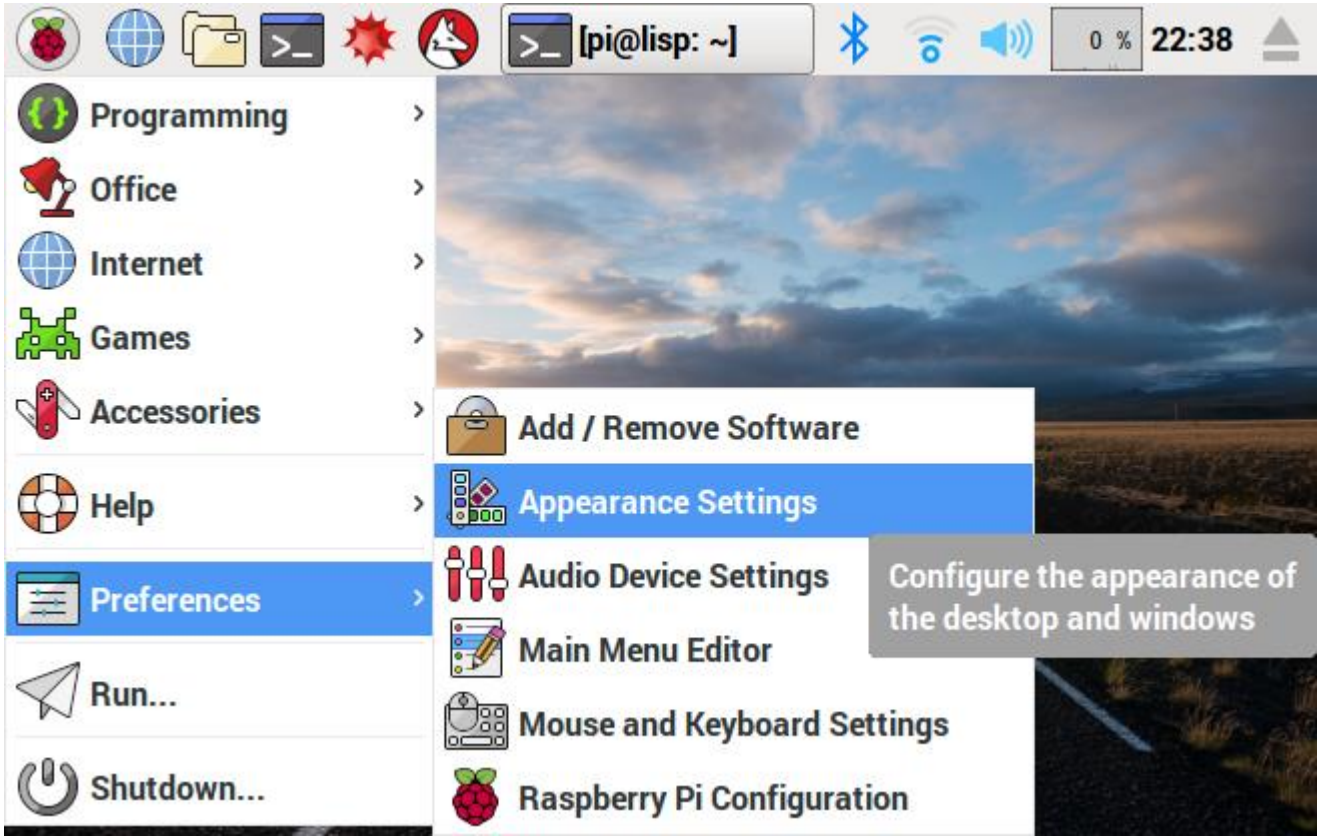
Screen Resolution



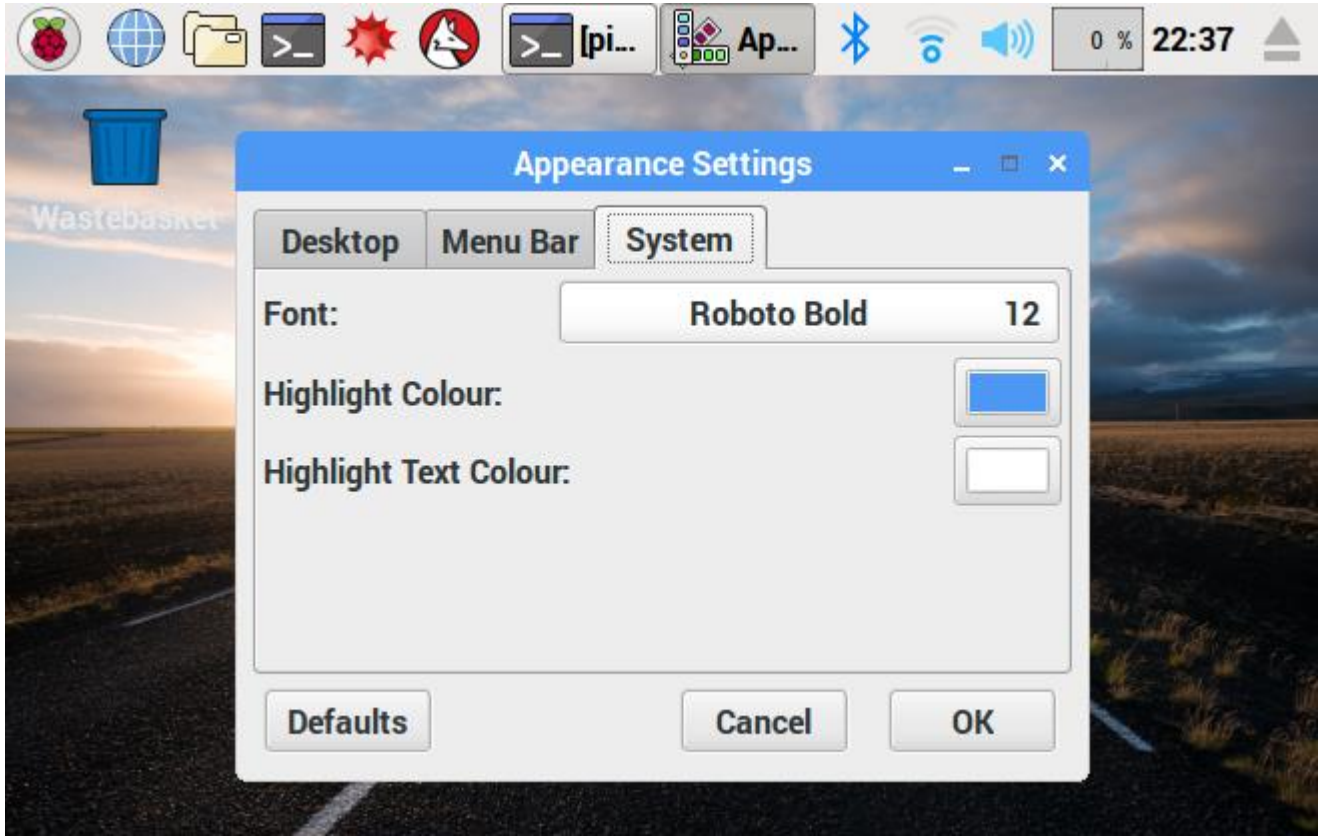
Screen Resolution



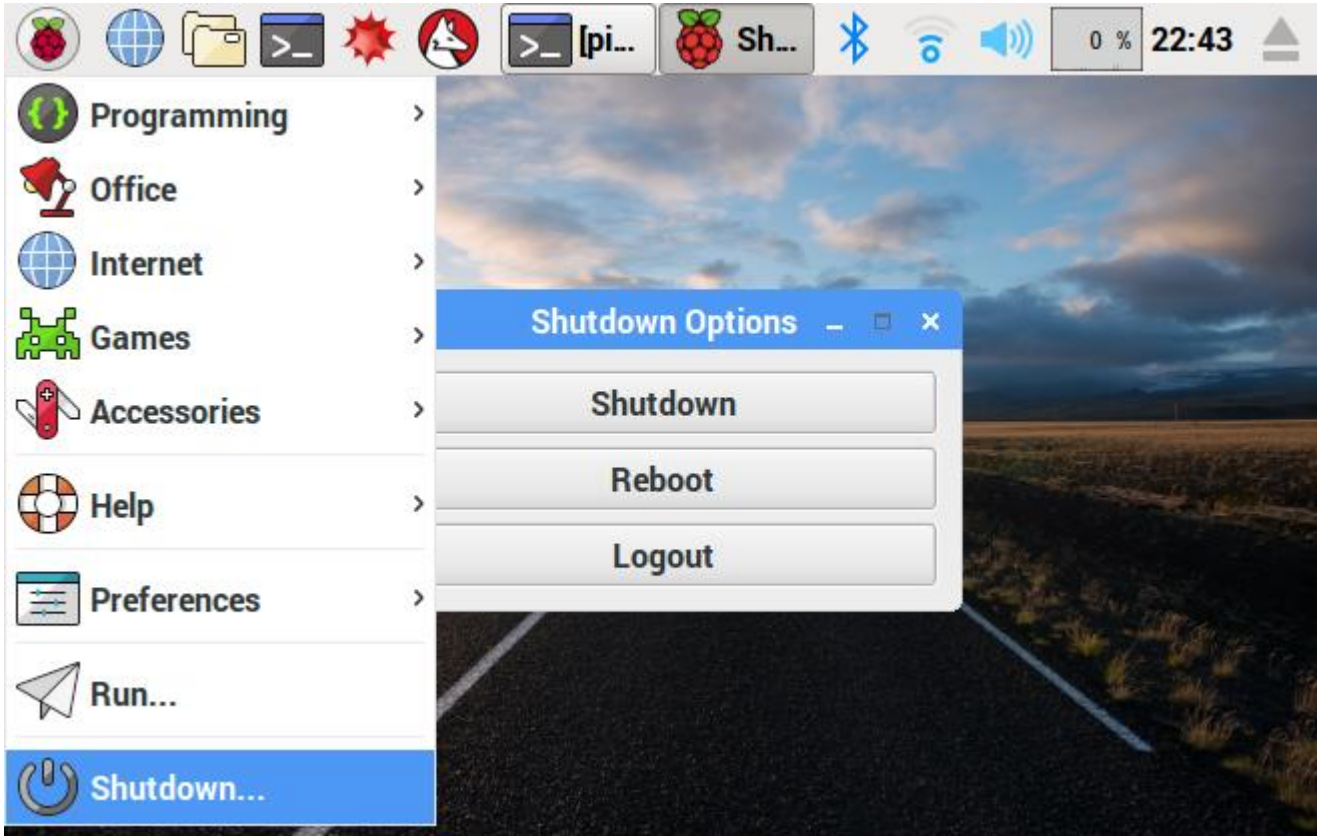
Increase Font Size



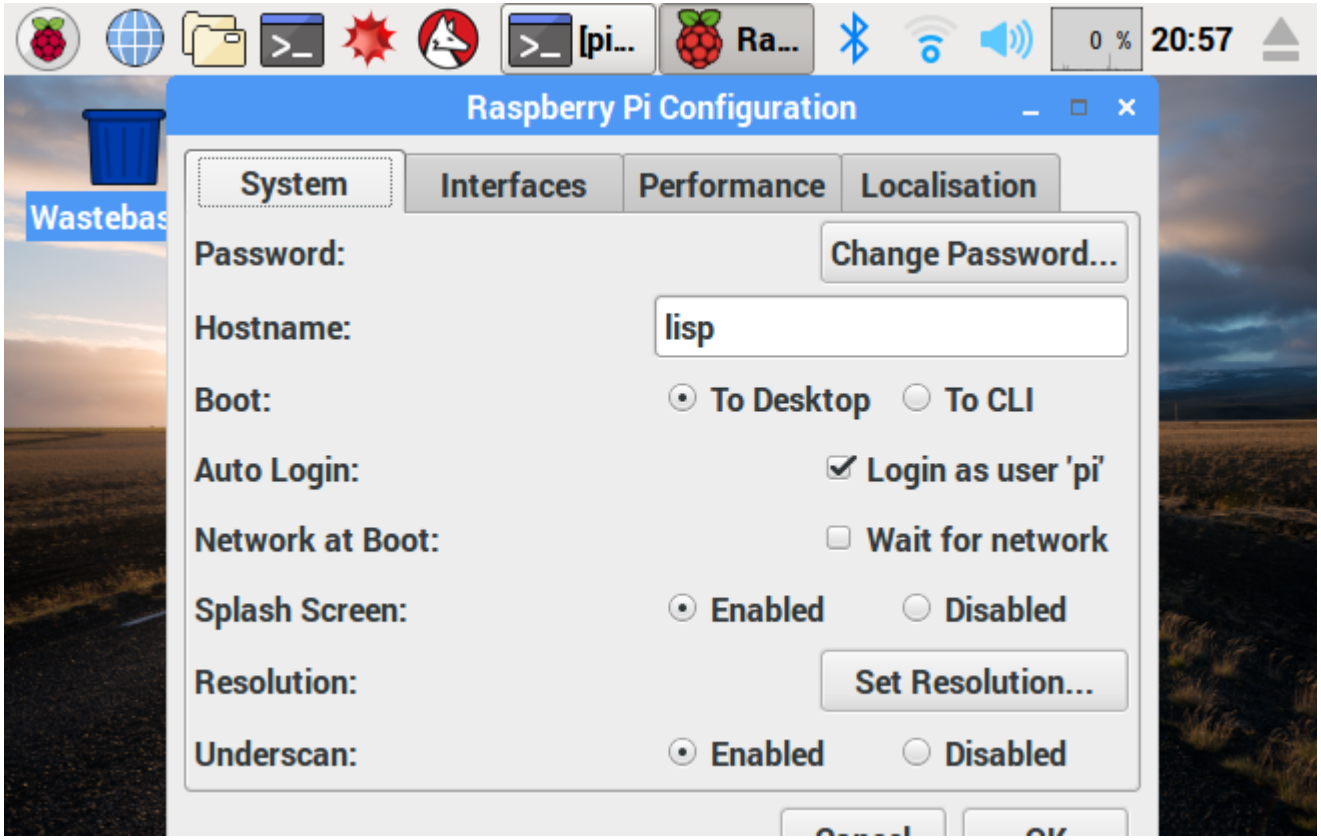
Increase Font Size – 2



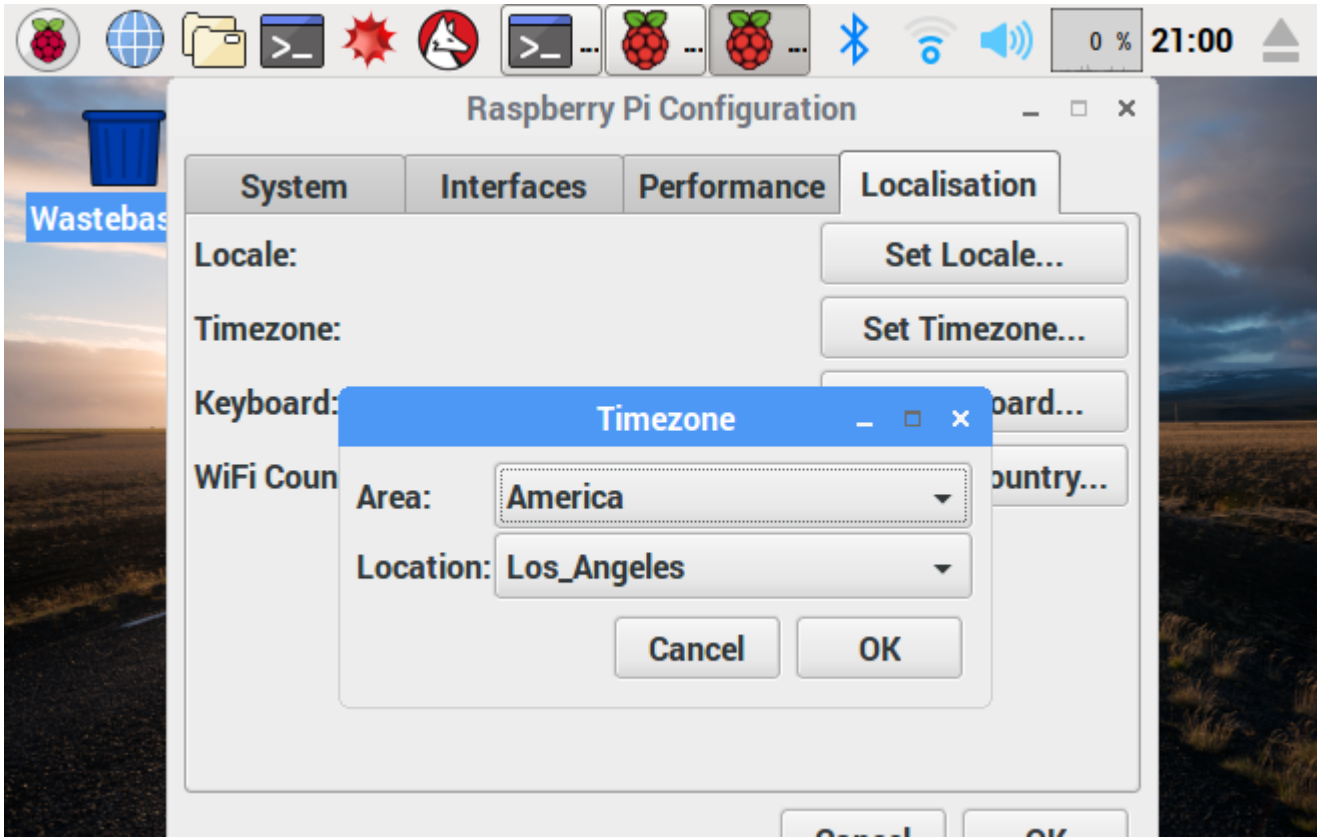
Reboot -
Never Just Unplugg Your RPi!



Password & Hostname from Lottery



TimeZone / Localization for Clock



Exporing PIXEL

- PIXEL =
  '*Pi* Improved XWindow Environment, Lightweight‘
- Show File Browser
- Take a screenshot
  - FN + Delete = „Print Screen“
- TouchPad
  - Use 2 Finger Scrolling
  - Right Mouse Button for Mac Users ☺
- Browser
  - Chromium
  - Flash
  - YouTube works also!

Explore PIXEL Desktop & Apps

- Explore programs
  - Calculator
  - Editor
  - File Manager
  - Task Manager
  - No Minecraft (yet) ☺
    - For the break, ok?

PIXEL Keyboard Shortcuts

- Window not showing all content?
  Use maximize button!
  - Also minimize, close
- Switch / cycle between windows: Alt-tab
- Close window Ctrl-w
- Use Ctrl-Esc for „Start Menu“

Class Wordpress and File Host

- http://motherpi/ Class Wordpress – open in Web browser
- Downloads http://motherpi/downloads/class<x>/

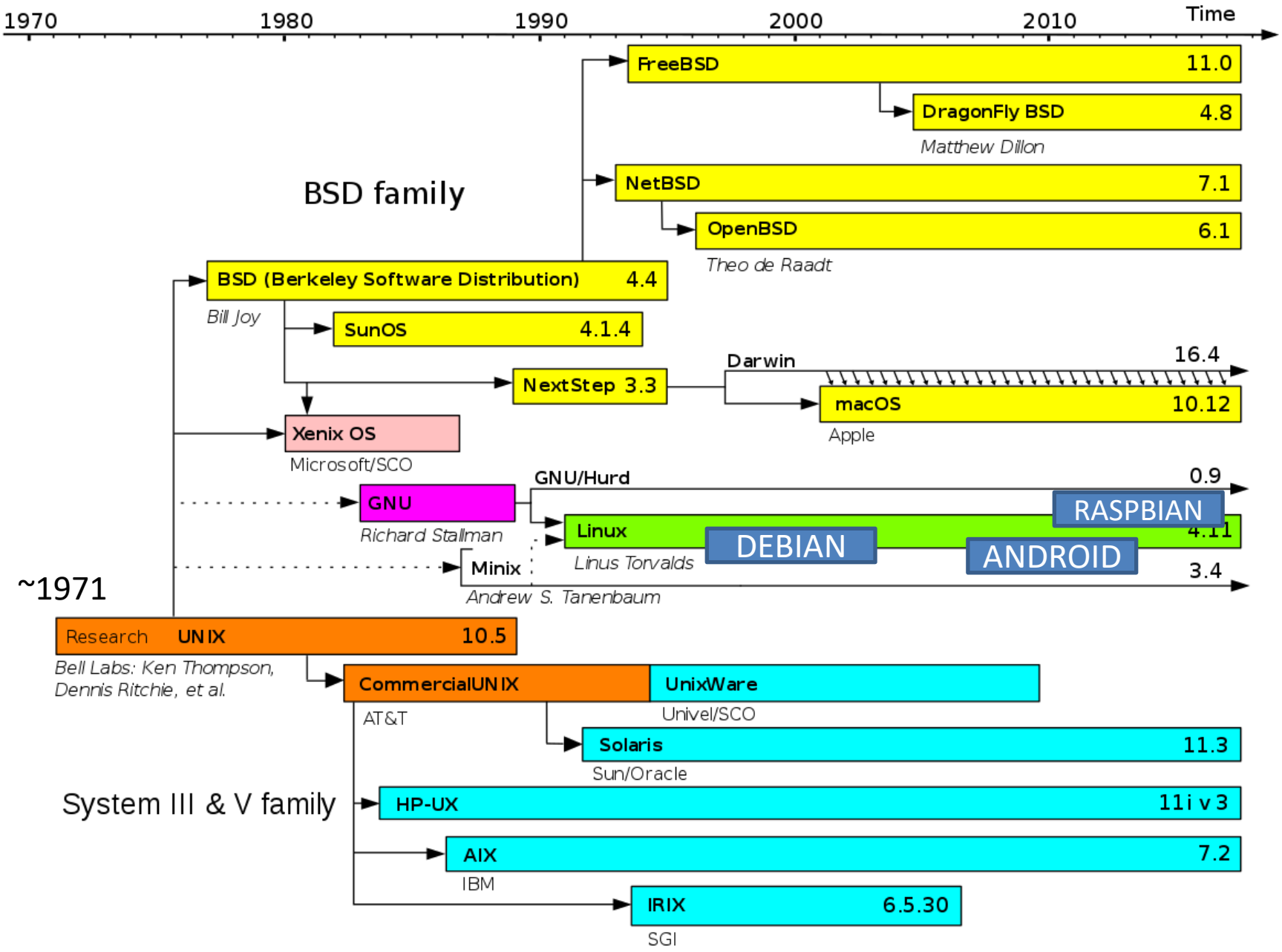
- Structure of a **URL = Uniform Resource Locator**
  - protocol:// e.g. **http://...** mailto://... sftp://…
  - Domain / HostName: **motherpi** = „Name of Computer“
    - resolves to IP address -> nslookup motherpi
      sudo apt-get install dns-utils (!)
  - Then: resource / directory on that serve: /class<x>/ …
  - There can also be a **port**: motherpi:**80**/downloads/….
    - Port 80 = Port for HTTP / HTML World Wide Web protocol
    - Different services „on the server“ have different ports

Linux Basics

- Some History
- Command Shell / BASH / „Terminal“ / Console
  - the „command post“ of every Unix computer
- Why not do everything from the desktop?
  - The shell is much more powerful and versatile
  - Allows „scripting“
  - Most things can ONLY be done from the shell
  - True hackers don‘t use the desktop ☺

Download Slides from motherpi

- Use the „File Manager“ with the provided URL (http://...)!
- Frequently, we will use the shell aka console aka BASH aka terminal
  - Open the „Terminal“ program (single click is sufficient!)
  - Type in
    cd Desktop/
    mkdir class1
    cd class1
  - Now, from the Terminal, type in
    wget <url of file you wish to download>
    after each download, type
    ls –a
    to see it has worked
  - Download all the content you can find there, using wget
  - **When done, quit terminal using „exit“ or „Ctrl-d“, or „Ctrl-Shift q“**
  - Go to the Desktop, and see „class1“ folder there, click to open, verify everything is there
  - Launch the PDFViewer program and open the PDF slides

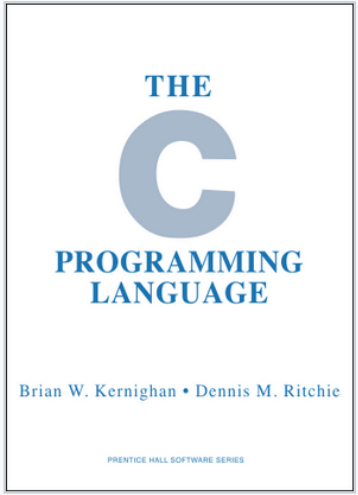

1970
1980
1990
2000
2010
Time
FreeBSD 11.0
DragonFly BSD 4.8
Matthew Dillon
BSD family
NetBSD 7.1
OpenBSD 6.1
Theo de Raadt
BSD (Berkeley Software Distribution) 4.4
Bill Joy
SunOS 4.1.4
Darwin
16.4
NextStep 3.3
macOS 10.12
Apple
Xenix OS
Microsoft/SCO
GNU/Hurd
0.9
GNU
Richard Stallman
RASPBIAN
Linux
4.11
DEBIAN
ANDROID
Linus Torvalds
Minix
3.4
Andrew S. Tanenbaum
~1971
Research UNIX 10.5
Bell Labs: Ken Thompson,
Dennis Ritchie, et al.
CommercialUNIX
UnixWare
AT&T
Univel/SCO
Solaris 11.3
Sun/Oracle
System III & V family
HP-UX 11i v3
AIX 7.2
IBM
IRIX 6.5.30
SGI

Influential Hackers

Ken Thompson and Dennis Ritchie, principal developers of Research Unix

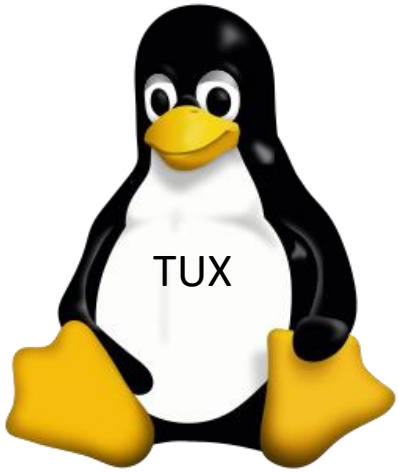
Ken Thompson (sitting) and Dennis Ritchie working together at a PDP-11

K&R C –
„The C Bible“



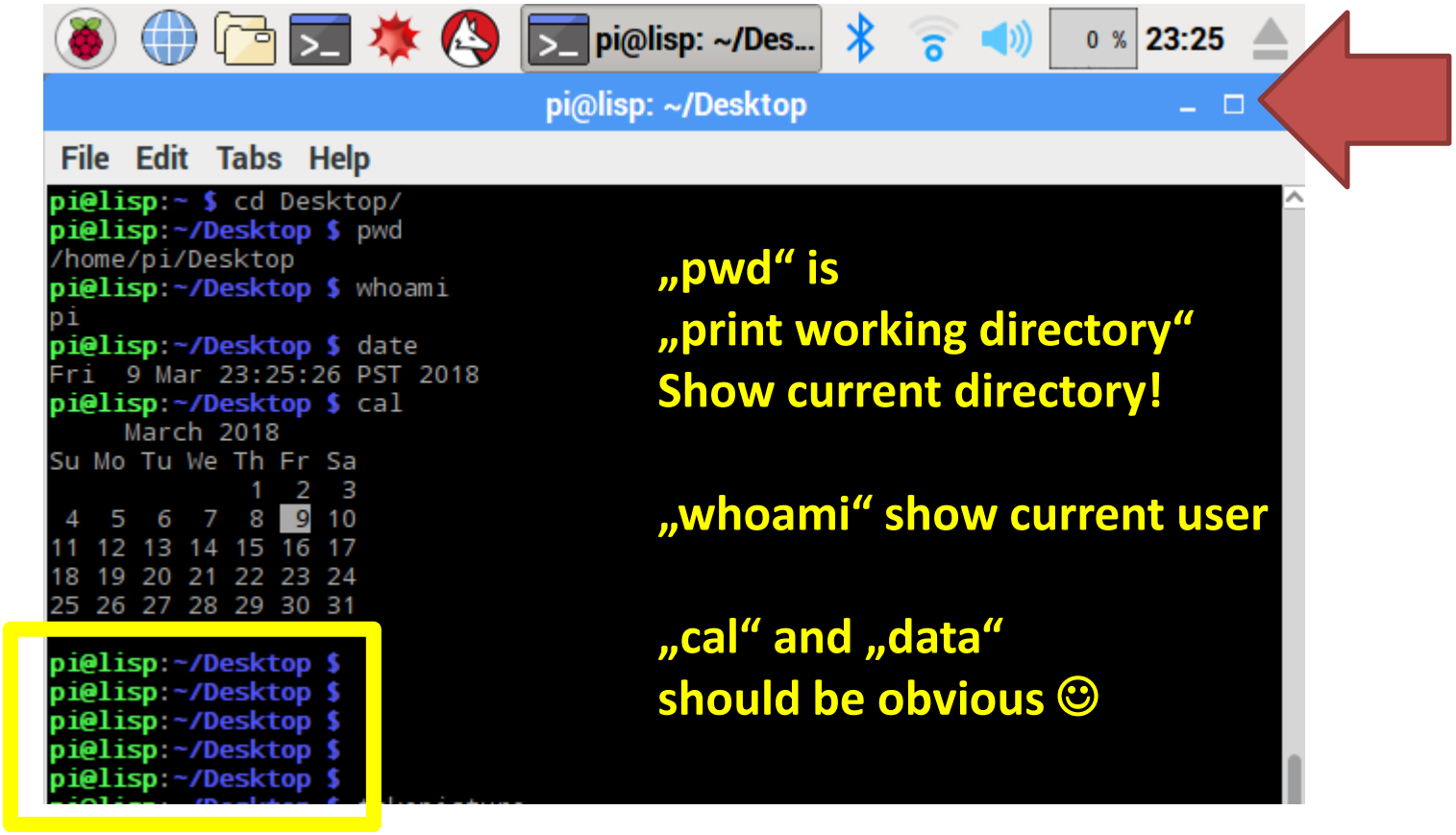
The cover of the book, *The C Programming Language*, first edition by Brian Kernighan and Dennis Ritchie

Linus Torvalds
Linux = Linus‘ Unix



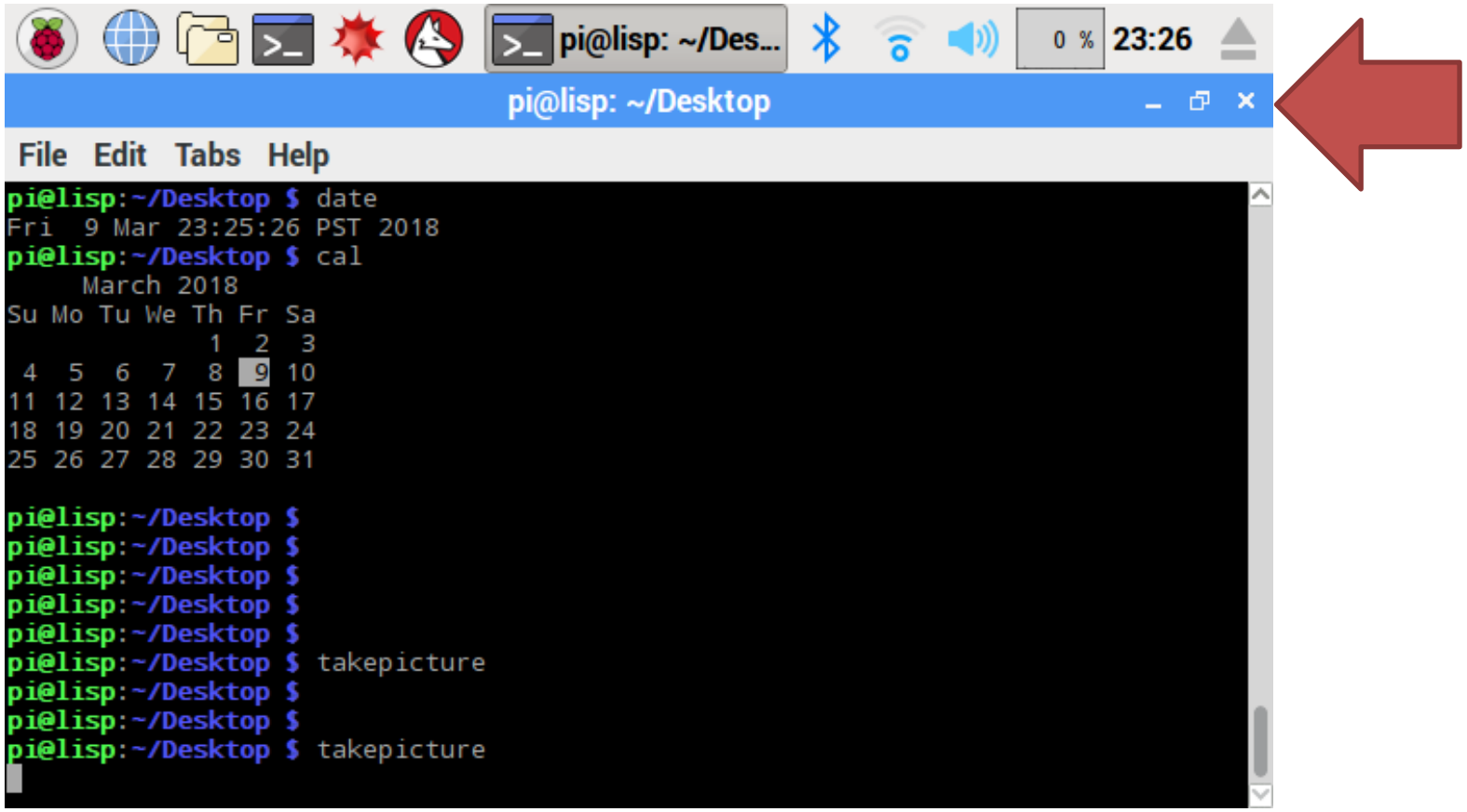
Command Shell / BASH / Terminal / Console / Command Line Interface (CLI) …

PROMPT = <username>@<hostname>: <current directory>



Last line not visible => maximize the window!

Notice: Minimize, Maximize, Close



All lines visible now – notice the icon changed

Files, Directories, and Trees

- Files = clear, right? Like in MacOS, Windows, …
  - Files can be „hidden“
    (start with a „period“, eg., „.alias“)
  - Files CAN have an extension, eg., „.txt“ for „text file“
  - Files are OWNED by a user („pi“ or „root“):
    - Privacy, Security (Access Rights)
    - You cannot delete or rename or move files from owner „root“, for examples
  - Files can be created with the File Manager
  - Or from the BASH shell!
- Directories = like folders
  - Can also be hidden, have owners, …
  - Directories can contain other directories

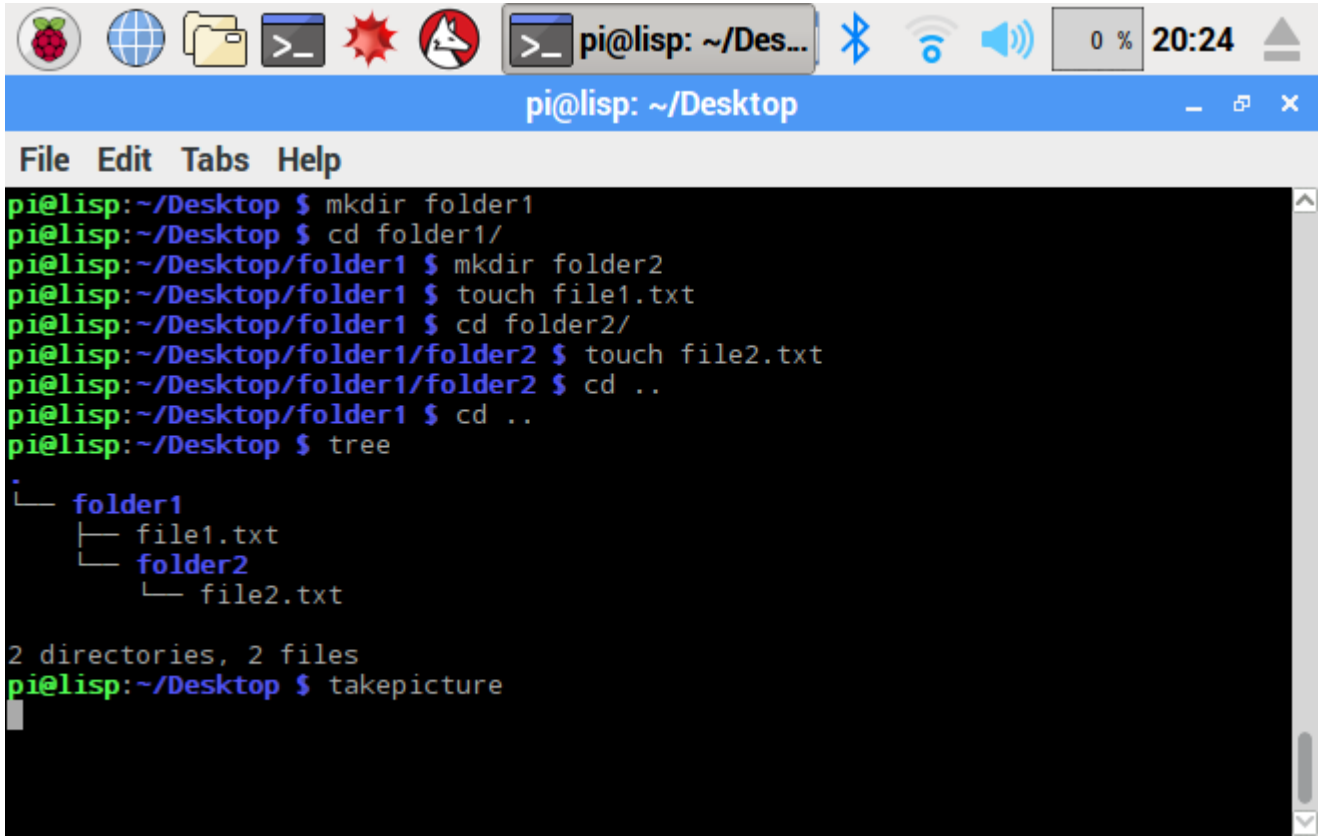
  -> „Tree structure“

Files, Directories, and Trees - 2

- Each file is contained in SOME directory

~/Desktop/folder1/file1.txt = FILE PATH

/home/pi/Desktop/folder1/ = DIR. PATH

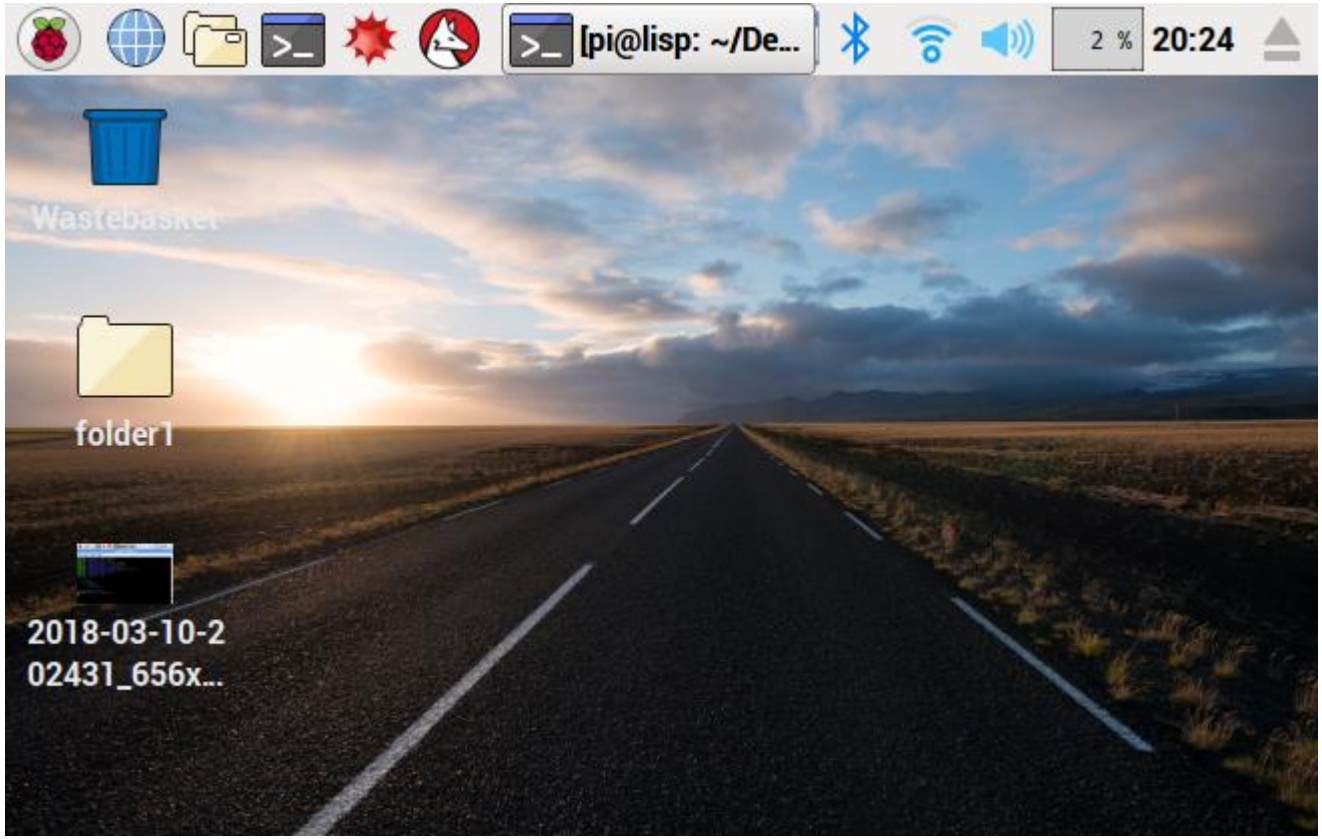


„mkdir“ is „make directory“ Guess what it does?!

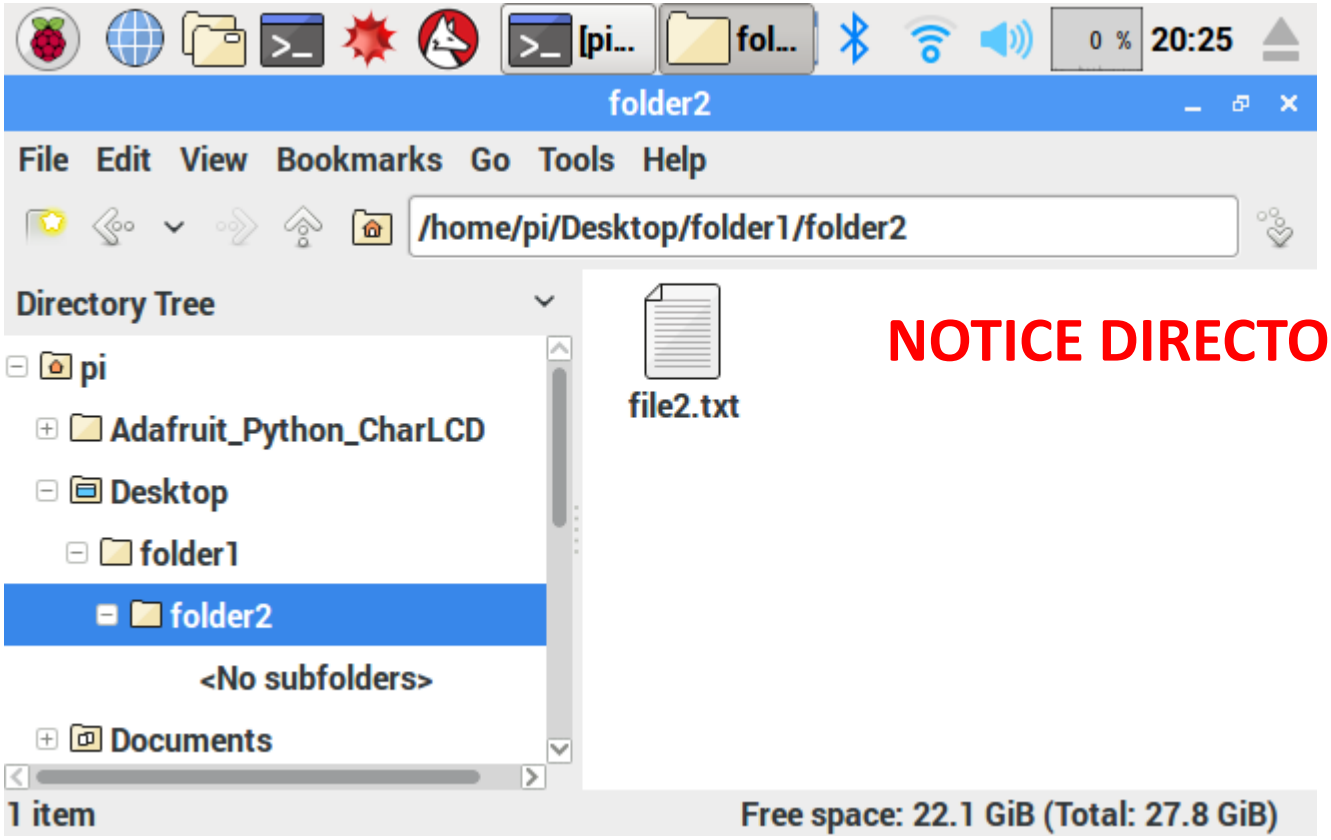
„cd“ changes the current directory

„touch“ creates an empty file

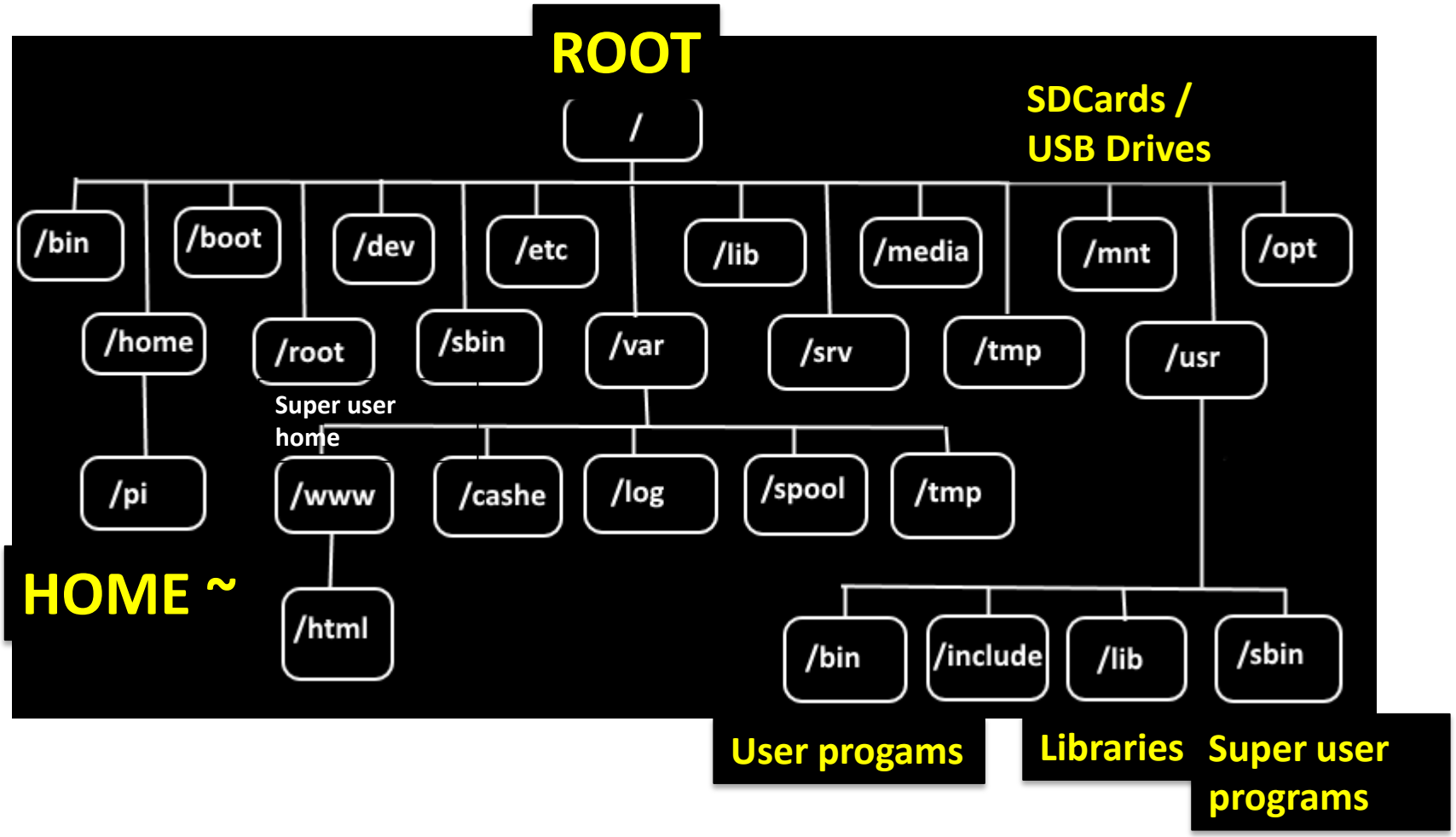
We created a folder on the desktop!



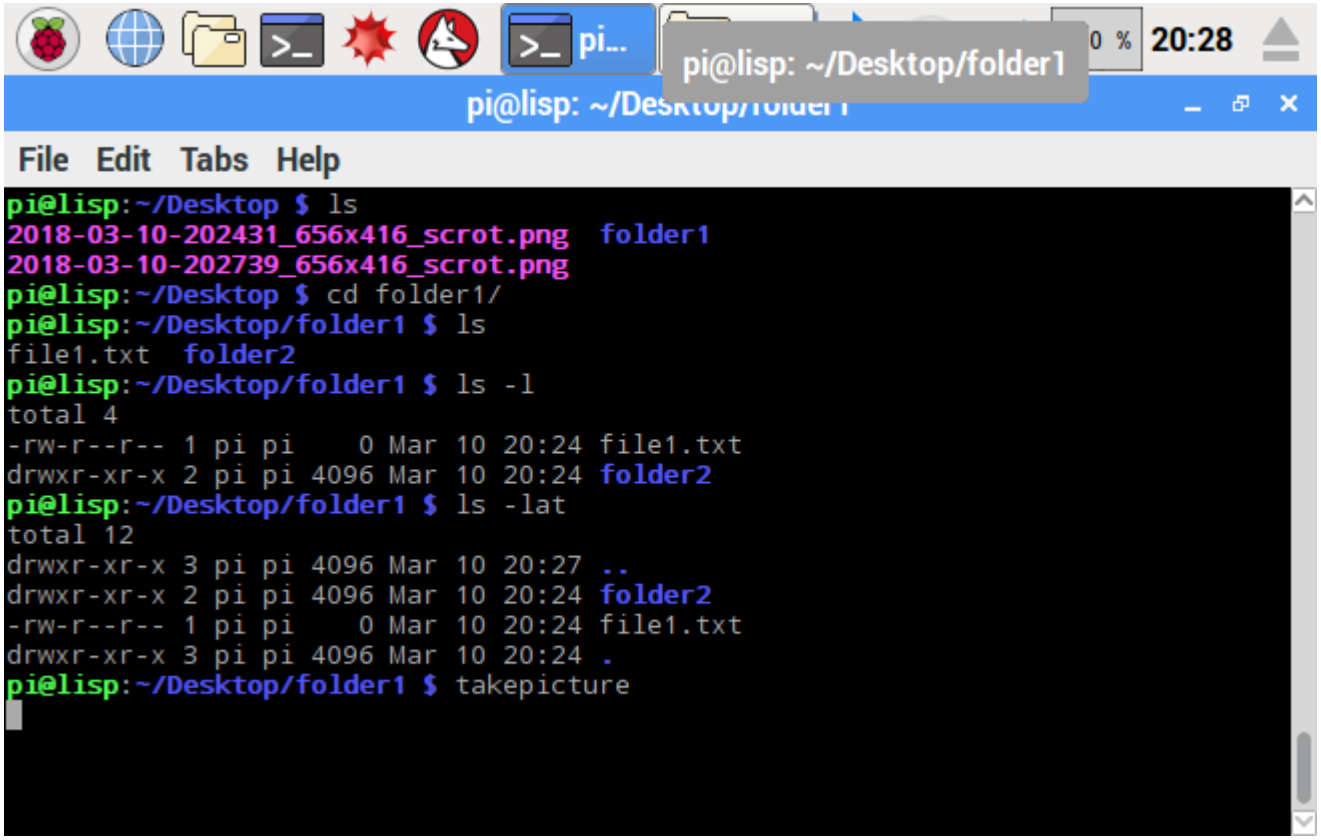
Let‘s look inside with the File Manager



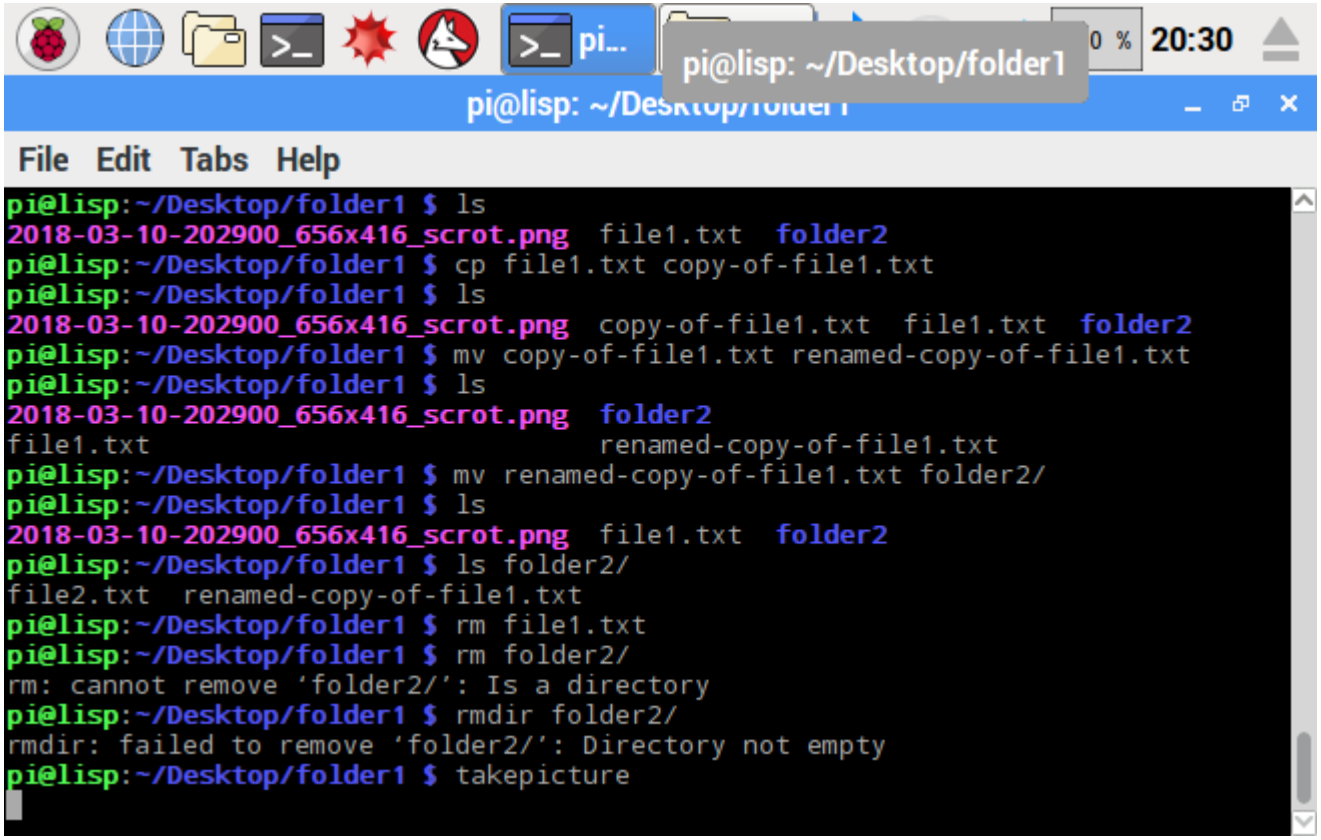
Raspbian Filesystem Tree



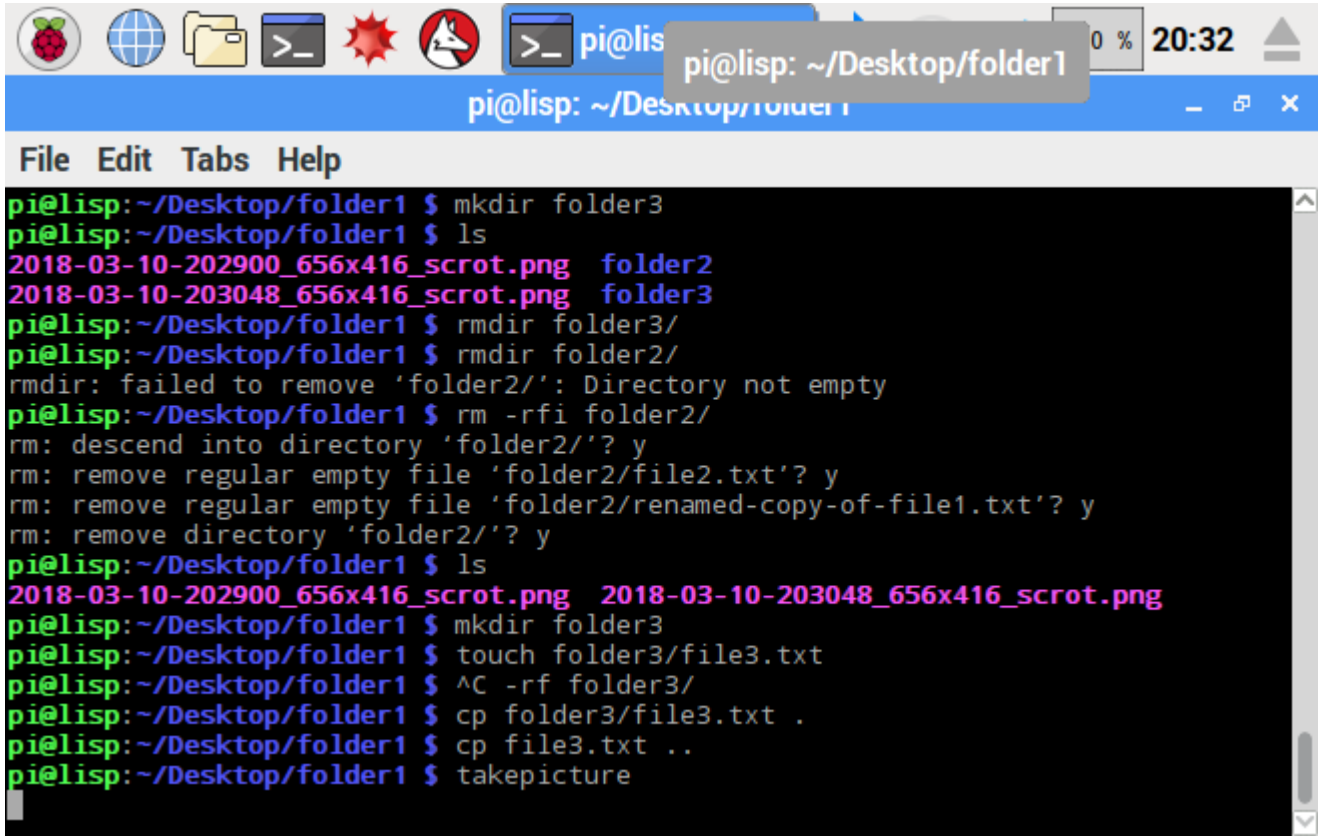
What‘s in a directory?
„ls“ to „list files“ – Files have Attributes



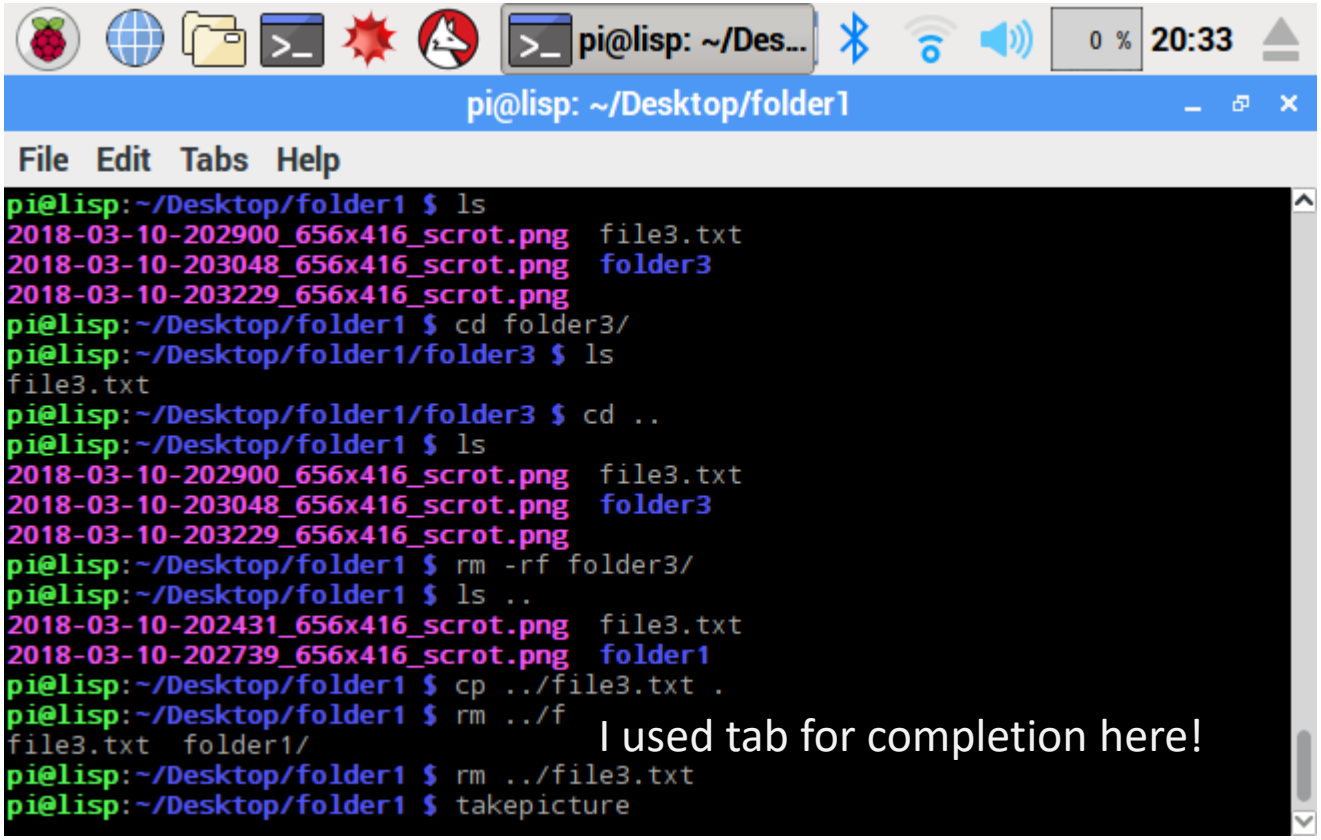
copy (cp), move (mv), remove (rm), remove directory (rmdir)



Deleting directories – „rmdir“ and „rm –rfi“

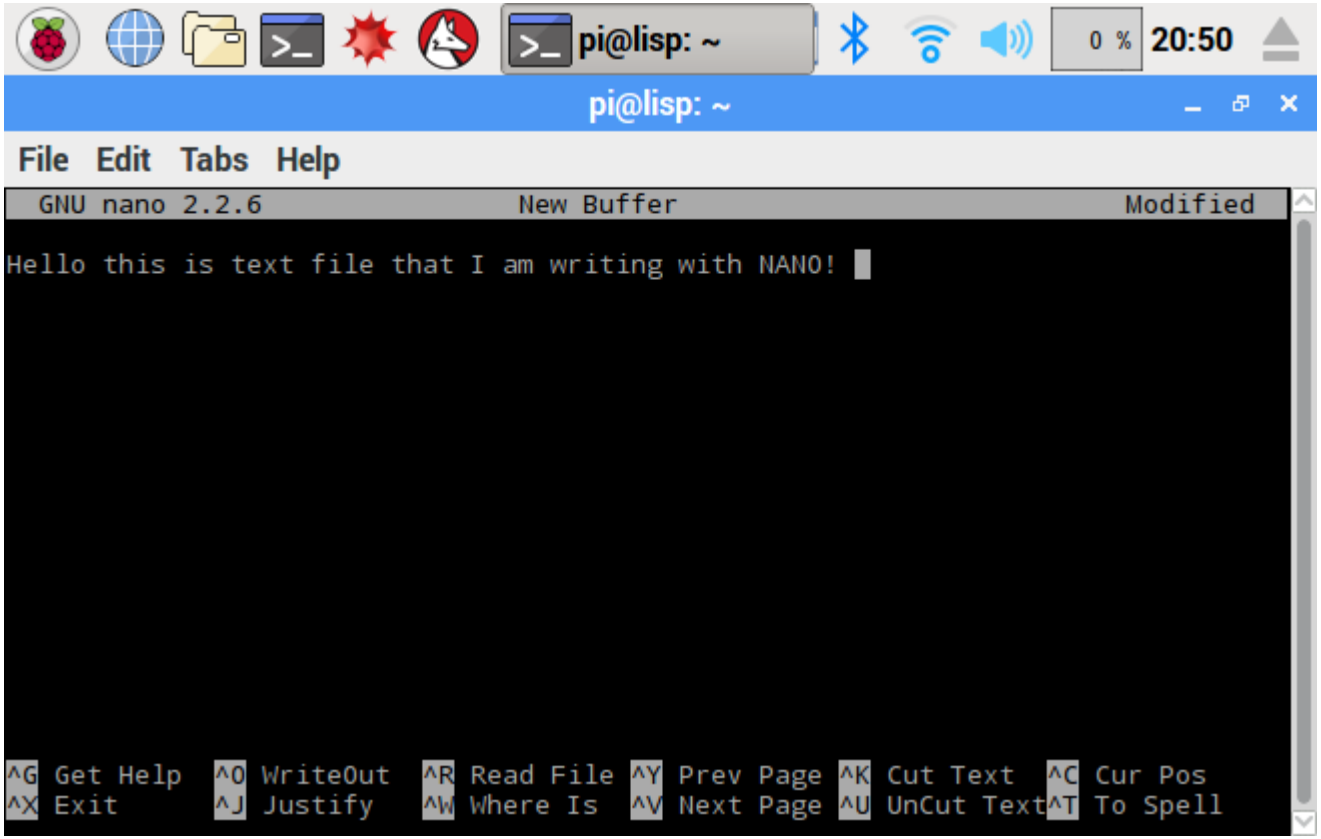


Using „.“ and „..“ in commands



NANO Text Editor

- Start with „nano“ – from the Shell
- Important key bindings: Ctrl-X, etc. See below:



BASH Basic Commands 1

- cd = change (current) directory
  - „relative“ from the current directory, e.g., if current directory contains „Desktop“, then „cd Desktop“ changes into „Desktop“ directory
  - or „absolute“ – give „path“ of destination directory
    Eg, cd /home/pi/Desktop/ takes you to the Desktop directory, no matter what the current directory is
- pwd = print working directory
  - Same as in the BASH prompt, but FULL path shown
- User‘s home directory is under /home/pi (for user pi)
- The user‘s home directory is also known by ~

Two Special Directories – „.“ and „..“

- . = current directory
  - For what is that useful?
    „cd .“ does *nothing*
  - However, „cp ~/Desktop/file1.txt .“ copies the file in subdirectory „Desktop“ to current directory „.“
    - otherwise, error message in „cp“
- .. = parent directory – the directory that contains the current directory
  - E.g., parent directory of „Desktop“ is „~“ (home)
  - „cd ..“ changes current directory to parent directory
  - „go up one level“

BASH Basic Keyboard Shortcuts

- Use „clear“ in the console to clear content
  - However, HISTORY is still available
  - And you can also scroll back
- Make a new „tab“ with Ctrl-Shift-t
- Close a tab with with Ctrl-Shift-w
- Close a shell / BASH with Ctrl-Shift-q
- To get control back over the BASH, use Ctrl-c to interupt / cancel any currently running command
  - Show „top“ process managment program
  - „q“ or „Ctrl-c“ to quit it

BASH Navigation

- Use tab key to complete filenames in current directory!
  - type: cd ~
  - type: cd De<tab> -> completes to cd Desktop/
- Use up/down arrows for history of commands
- Use Ctrl-r for „reverse search“, enter search string
  - Use Ctrl-c to cancel
  - Enter to re-use that command from history

Basic Network Commands

- Important hosts:
  - localhost – try „ping localhost“
  - 192.168.0.1 = localhost
  - Usually, the local network is in the range 192.168.xxx.yyy
- nslookup <hostname>
- hostname
- hostname –I
- ping <hostname or ip-address>
- whois <domain-name>, e.g. michael-wessel.info
- ifconfig
- Let‘s also see all hosts in the local network with nmap…
- Download the chat.py program!

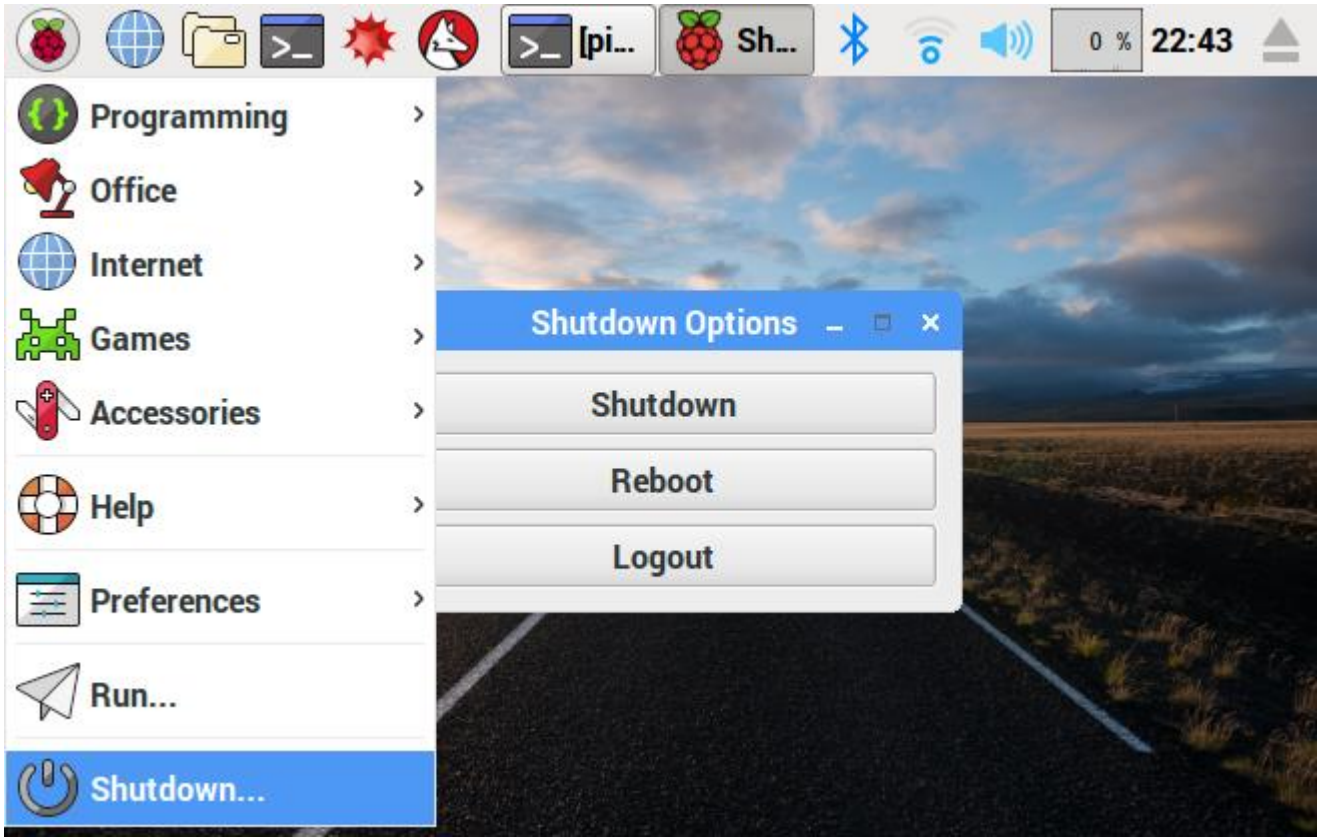
Other Useful Commands

- Space free on disk:
  df –h
- Look at a text file:
  cat file1.txt
  Better: use more if more than one screen! Use „q“ to quit more
- List connected USB devices:
  lsusb
- List running „processes“:
  top
- Run a program as „super user = root“:
  sudo <command here>
  E.g., to reboot or halt RPi:
  sudo restart, sudo halt
- sudo also needed for Raspberry Pi updates!

This is only the beginning…

- There is much more to Unix / Linux
  - Processes
  - (symbolic) links
  - File and directory permissions
  - User Groups
  - Adminstration
  - BASH scripting
- … But it should be sufficient for out purposes!

Always shutdown RPi cleanly!



Homework

- Maybe make assembly more transportable (acrylic sheet, double sided 3M mounting tape)
- Lookup IoT projects from Maker Scene
- Watch Eben Upton video
- Connect to home WiFi and update Rpi:
  - From terminal /BASH (note: sudo = super user do)
    sudo apt-get update
    sudo apt-get upgrade
- Important - make a backup !
  - Get an extra MicroSDCard
  - Under Accessories, use the „SDCard Copier“
  - This only takes 5 minutes
  - I suggest to run this after *every class* because that way you won‘t loose any work in case of crash
- Have fun with your RPi !

Idea for Setup