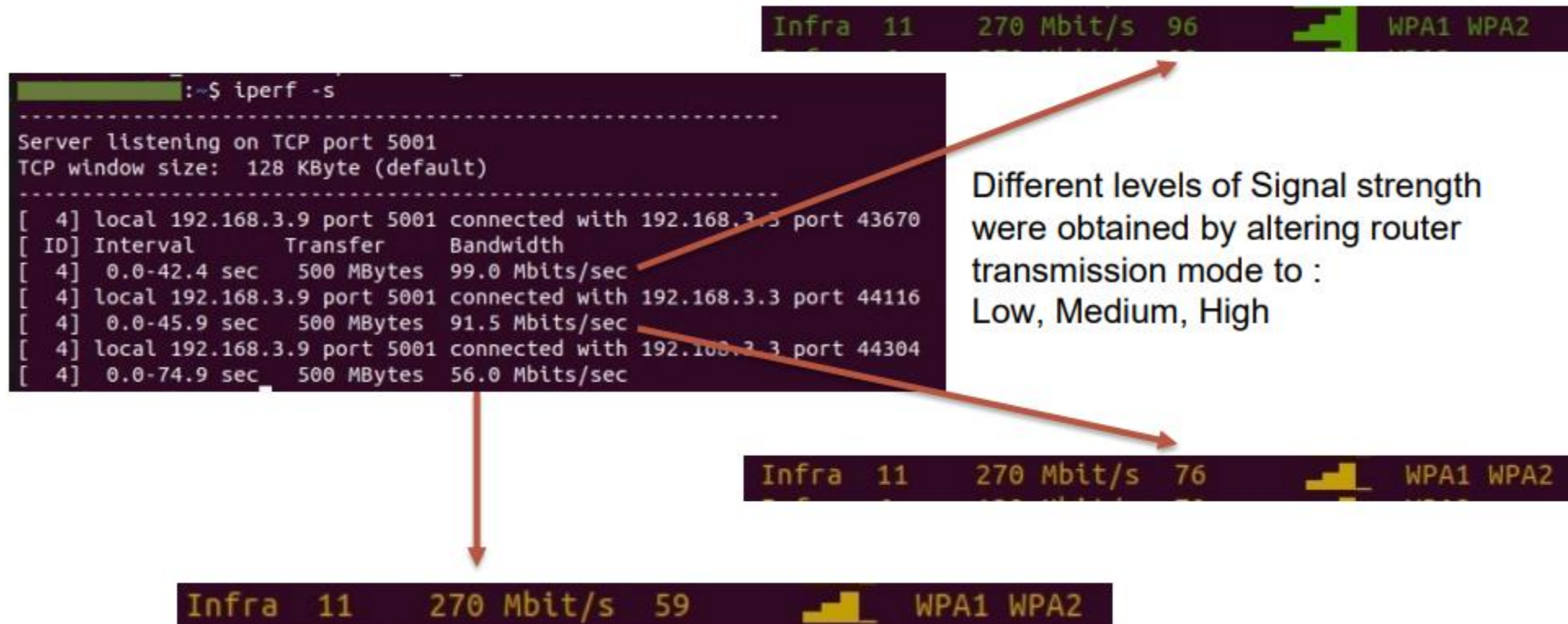


Overall, good submissions on first assignment

- 12 points on average
- Issues mostly in analysis and data presentation
 - Analysis missing or extremely limited
 - Many submissions were over 10 pages, and difficult to read
- Some confusion in what interference means.
 - Interference ~ Interfering signals, background noise
 - You were asked to measure noise level. This should have been a hint.
 - While distance may affect noise level, because there are differing levels of noise in different places, this ruins the experiment. You do not know if the effect on throughput is because of signal noise, or because of the distance.

- As the Signal strength reduces, Data transmission rate is also negatively impacted



```
-level-  
link quality: 90% (63/70)  
=====  
signal level: -47 dBm (0,02 uW)
```

< 1 meter away

```
-interface-  
wlp2s0 (IEEE 802.11), phy 0, reg: n/a, SSID: TP-LINK_F0F1  
-level-  
link quality: 80% (56/70)  
=====  
signal level: -54 dBm (3,98 nW)
```

4 meters away

```
-interface-  
wlp2s0 (IEEE 802.11), phy 0, reg: n/a, SSID: TP-LINK_F0F1  
-level-  
link quality: 69% (48/70)  
=====  
signal level: -62 dBm (0,63 nW)
```

> 5 meters away and behind a door

Analysis

- Signal strength is weaker with longer distance
- Signal strength is weaker with more obstacle density

```

-Interface-
wlp3s0 - wdev 1, phy 0, reg: DE (DFS-ETSI), SSID: SARKKI-NET2
-Levels-
link quality: 100% (70/70)
=====

signal level: -27 dBm (2,00 uW)
=====
noise level: -94 dBm (0,40 pW)

SNR:          67 dB

-Packet Counts-
RX: 296k (370,36 MiB), rate: 300.0 MBit/s MCS 15 40MHz short GI (expected: 57,3 MB)
TX: 44k (4,21 MiB), rate: 300.0 MBit/s MCS 15 40MHz short GI, retries: 2k (4,6%)
-Info-
mode: Managed, connected to: BE:4E:26:A9:8F:19, time: 38:23m, inactive: 13,1s
freq: 5180 MHz, ctrl: 5190 MHz, channel: 36 (width: 40 MHz), bands: 2
beacons: 22 371, avg sig: -42 dBm, interval: 0,1s, DTIM: 1
channel active: 45:50m, busy: 1:39m
channel rx: 1:32m, tx: 1 sec
tx power: 17 dBm (50,12 mW), power save: off
retry short/long: 7/4, rts/cts: off, frag: off
-Network-
wlp3s0 #3 (UP RUNNING BROADCAST MULTICAST)
mode: dormant, qdisc: noqueue, qlen: 1000
mac: A4:DB:30:3D:5F:1C
ip4: 192.168.68.119/24, valid: 1:21h
ip6: n/a

```

- Upstairs
- Distance from router: ~30cm

```

-Interface-
wlp3s0 - wdev 1, phy 0, reg: DE (DFS-ETSI), SSID: SARKKI-NET2
-Levels-
link quality: 69% (48/70)
=====

signal level: -62 dBm (0,63 nW)
=====
noise level: -94 dBm (0,40 pW)

SNR:          32 dB

-Packet Counts-
RX: 297k (370,52 MiB), rate: 300.0 MBit/s MCS 15 40MHz short GI (expected: 55,9 MB)
TX: 44k (4,22 MiB), rate: 300.0 MBit/s MCS 15 40MHz short GI, retries: 2k (4,6%)
-Info-
mode: Managed, connected to: BE:4E:26:A9:8F:19, time: 39:13m, inactive: 2,6s
freq: 5180 MHz, ctrl: 5190 MHz, channel: 36 (width: 40 MHz), bands: 2
beacons: 22 859, avg sig: -54 dBm, interval: 0,1s, DTIM: 1
channel active: 46:39m, busy: 1:40m
channel rx: 1:33m, tx: 1 sec
tx power: 17 dBm (50,12 mW), power save: off
retry short/long: 7/4, rts/cts: off, frag: off
-Network-
wlp3s0 #3 (UP RUNNING BROADCAST MULTICAST)
mode: dormant, qdisc: noqueue, qlen: 1000
mac: A4:DB:30:3D:5F:1C
ip4: 192.168.68.119/24, valid: 1:20h
ip6: n/a

```

- Downstairs
- Obstacles: walls, floor,
stone fireplace
- Distance: 5-7 m

```

-Interface-
wlp3s0 - wdev 1, phy 0, reg: DE (DFS-ETSI), SSID: SARKKI-NET2
-Levels-
link quality: 44% (31/70)
=====

signal level: -79 dBm (0,01 nW)
=====
noise level: -94 dBm (0,40 pW)

SNR:          15 dB

-Packet Counts-
RX: 2k (350,25 KiB), rate: 54.0 MBit/s MCS 9 40MHz (expected: 26,8 MB/s), drop: 31
TX: 384 (22,00 KiB), rate: 120.0 MBit/s MCS 11 40MHz short GI, retries: 497 (129,9)
-Info-
mode: Managed, connected to: BA:4E:26:A9:79:9C, time: 1:50m, inactive: 9ms
freq: 2447 MHz, ctrl: 2457 MHz, channel: 8 (width: 40 MHz), bands: 2
beacons: 941, avg sig: -76 dBm, interval: 0,1s, DTIM: 1
channel active: 1:37m, busy: 13 sec
channel rx: 12 sec, tx: 99 ms
tx power: 16 dBm (39,81 mW), power save: off
retry short/long: 7/4, rts/cts: off, frag: off
-Network-
wlp3s0 #3 (UP RUNNING BROADCAST MULTICAST)
mode: dormant, qdisc: noqueue, qlen: 1000
mac: A4:DB:30:3D:5F:1C
ip4: 192.168.68.119/24, valid: 1:58h
ip6: n/a

```

- Outside, next to mailbox
- Obstacles: outer wall, car,
garage
- Distance: 10-15 m

```

-Interface-
wlp3s0 - wdev 1, phy 0, reg: DE (DFS-ETSI), SSID: SARKKI-NET2
-Levels-
link quality: 86% (60/70)
=====

signal level: -50 dBm (0,01 uW)
=====
noise level: -94 dBm (0,40 pW)

SNR:          44 dB

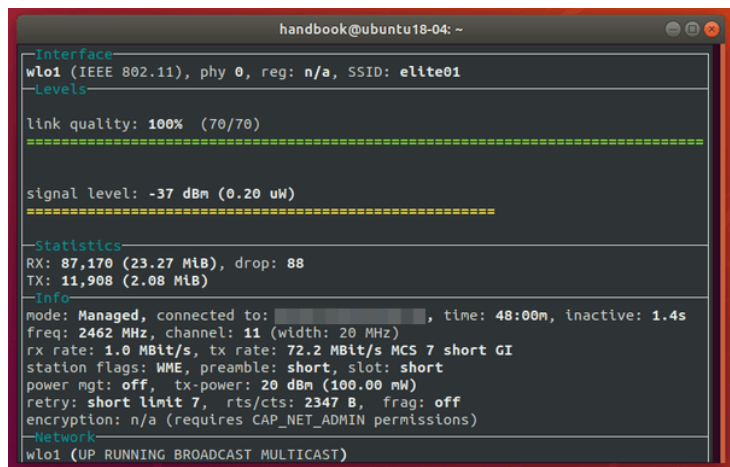
-Packet Counts-
RX: 8k (1,36 MiB), rate: 216.0 MBit/s MCS 13 40MHz (expected: 55,9 MB/s), drop: 40
TX: 221 (27,53 KiB), rate: 216.0 MBit/s MCS 13 40MHz, retries: 83 (37,6%), failed1
-Info-
mode: Managed, connected to: BE:4E:26:A9:8F:18, time: 6:40m, inactive: 0,7s
freq: 2447 MHz, ctrl: 2457 MHz, channel: 8 (width: 40 MHz), bands: 2
beacons: 3 652, lost: 1, avg sig: -56 dBm, interval: 0,1s, DTIM: 1
channel active: 8:20m, busy: 1:20m
channel rx: 1:06m, tx: 136 ms
tx power: 16 dBm (39,81 mW), power save: off
retry short/long: 7/4, rts/cts: off, frag: off
-Network-
wlp3s0 #3 (UP RUNNING BROADCAST MULTICAST)
mode: dormant, qdisc: noqueue, qlen: 1000
mac: A4:DB:30:3D:5F:1C
ip4: 192.168.68.119/24, valid: 1:53h
ip6: n/a

```

- Downstairs, next to microwave oven
- Microwave turned on, Chromecast
streaming HD video

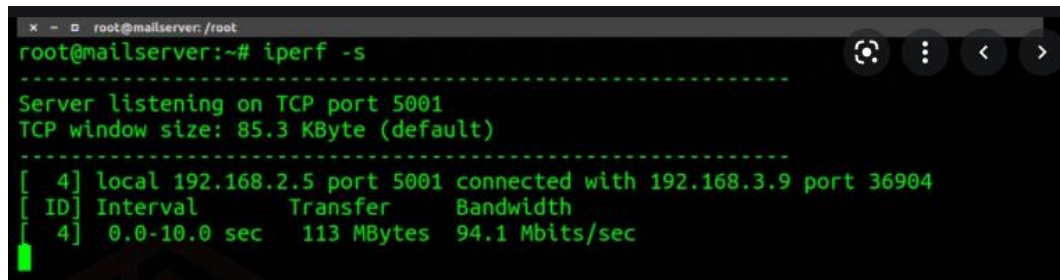
How to show what tools you used, while presenting data neatly:

- Signal Strength measured using Wavemon:



```
handbook@ubuntu18-04: ~  
-Interface-  
wlo1 (IEEE 802.11), phy 0, reg: n/a, SSID: elite01  
-Levels-  
link quality: 100% (70/70)  
=====  
signal level: -37 dBm (0.20 uW)  
=====  
-Statistics-  
RX: 87,170 (23.27 MIB), drop: 88  
TX: 11,908 (2.08 MIB)  
-Info-  
mode: Managed, connected to: [redacted], time: 48:00m, inactive: 1.4s  
freq: 2462 MHz, channel: 11 (width: 20 MHz)  
rx rate: 1.0 MBit/s, tx rate: 72.2 MBit/s MCS 7 short GI  
station flags: WME, preamble: short, slot: short  
power mgt: off, tx-power: 20 dBm (100.00 mW)  
retry: short limit 7, rts/cts: 2347 B, frag: off  
encryption: n/a (requires CAP_NET_ADMIN permissions)  
-Network-  
wlo1 (UP RUNNING BROADCAST MULTICAST)
```

- Throughput measured using iperf:



```
root@mailserver: /root  
root@mailserver:~# iperf -s  
-----  
Server listening on TCP port 5001  
TCP window size: 85.3 KByte (default)  
-----  
[  4] local 192.168.2.5 port 5001 connected with 192.168.3.9 port 36904  
[ ID] Interval      Transfer    Bandwidth  
[  4] 0.0-10.0 sec   113 MBytes  94.1 Mbits/sec
```

Distance from router	Signal Strength	Throughput
1 Meter	-40 dBm	100 Mbps
5 Meters	-50 dBm	90 Mbps
5 Meters + Wall (concrete, 35 cm)	-62 dBm	50 Mbps
10 Meters	-80 dBm	30 Mbps

Analyze the impact of distance on the signal strength

