APSC 1001 & CS 1010

Deep dive into Raspberry Pi with Python

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Detecting Heart Beats

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Photo: Kartik Bulusu

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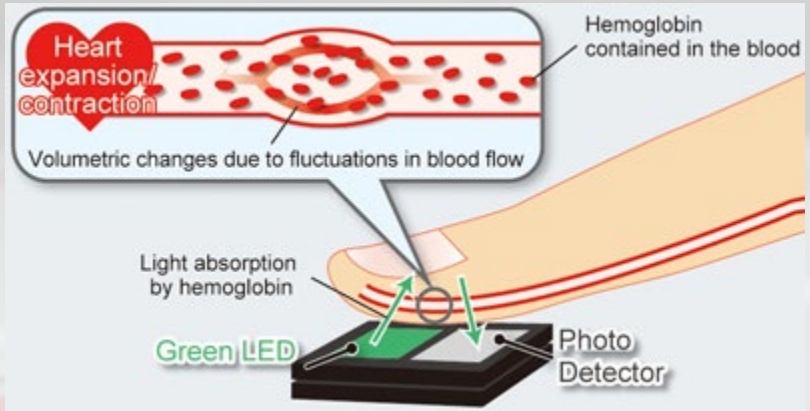
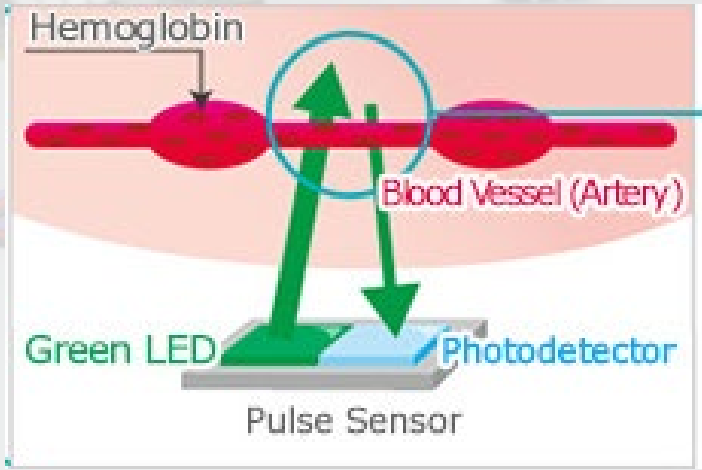
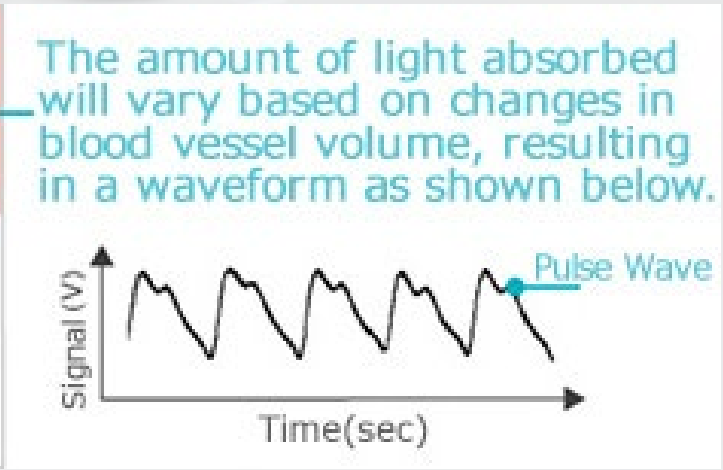
Photoplethysmogram or Pulse sensor – Explained



Green light source which has a high absorption rate in hemoglobin and less susceptibility to ambient light



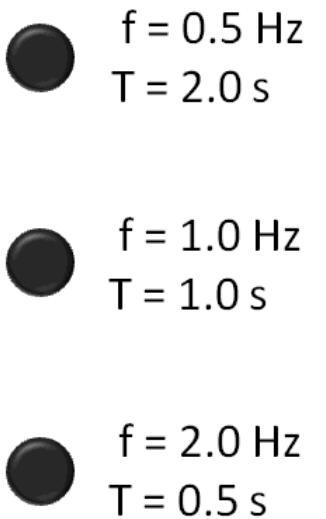


Sources:

https://pulsesensor.com/
https://www.electroschematics.com/heart-rate-sensor/
https://www.rohm.com/electronics-basics/sensor/pulse-sensor
https://www.rohm.com/sensor-shield-support/heart-rate-sensor

Frequency of signals and measurements

Frequency is the number of occurrences of a repeating event per unit **time**.



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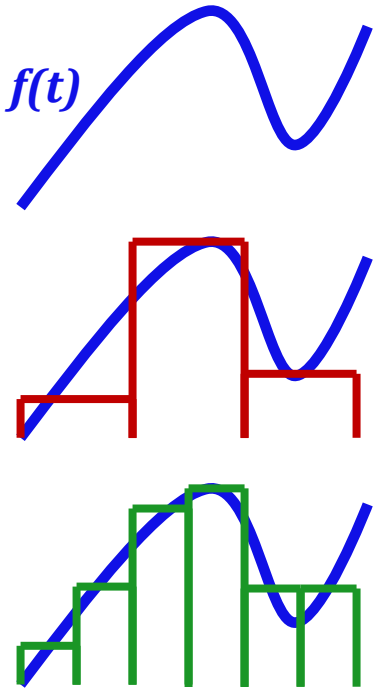
The **sampling frequency** or **sampling rate, f_s,** is the average number of samples obtained in one second (*samples per second*), thus **$f_s = 1/T$**.



The general range of hearing for young people is 20 Hz to 20000 Hz.

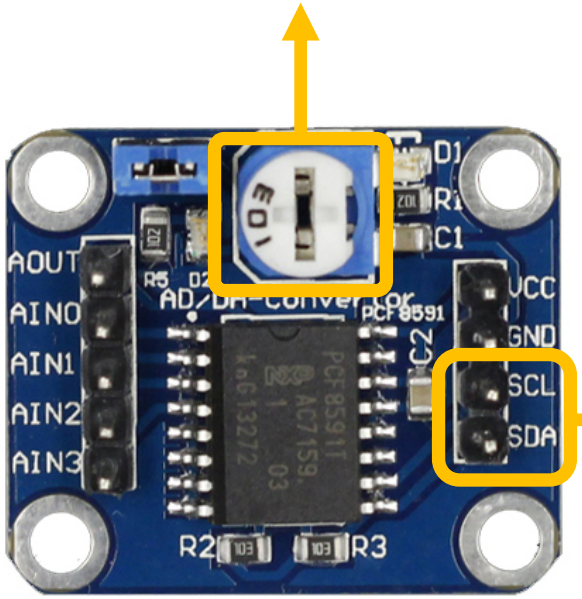
Audio CD, most commonly used with MPEG-1 audio is sampled at 44100 Hz

HD DVD (High-Definition DVD) audio tracks are sampled at 98000 Hz

The approximately double-rate requirement is a consequence of the Nyquist theorem.

Introducing the PCF8591 8-bit A/D and D/A converter

Potentiometer – to adjust the quality of the analog input signal by changing the "gain".



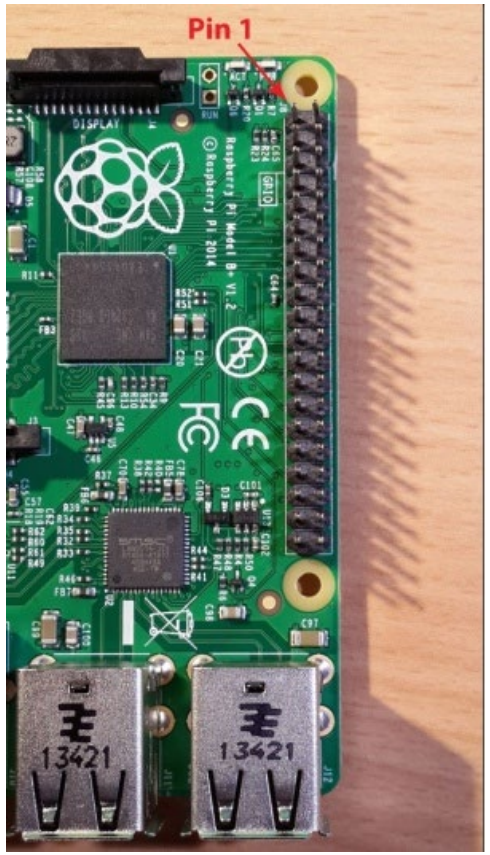
SYMBOL	PIN	DESCRIPTION
AIN0	1	analog inputs (A/D converter)
AIN1	2	
AIN2	3	
AIN3	4	
A0	5	hardware address
A1	6	
A2	7	
V_{SS}	8	negative supply voltage
SDA	9	I^2C-bus data input/output
SCL	10	I^2C-bus clock input
OSC	11	oscillator input/output
EXT	12	external/internal switch for oscillator input
AGND	13	analog ground
V_{REF}	14	voltage reference input
AOUT	15	analog output (D/A converter)
V_{DD}	16	positive supply voltage

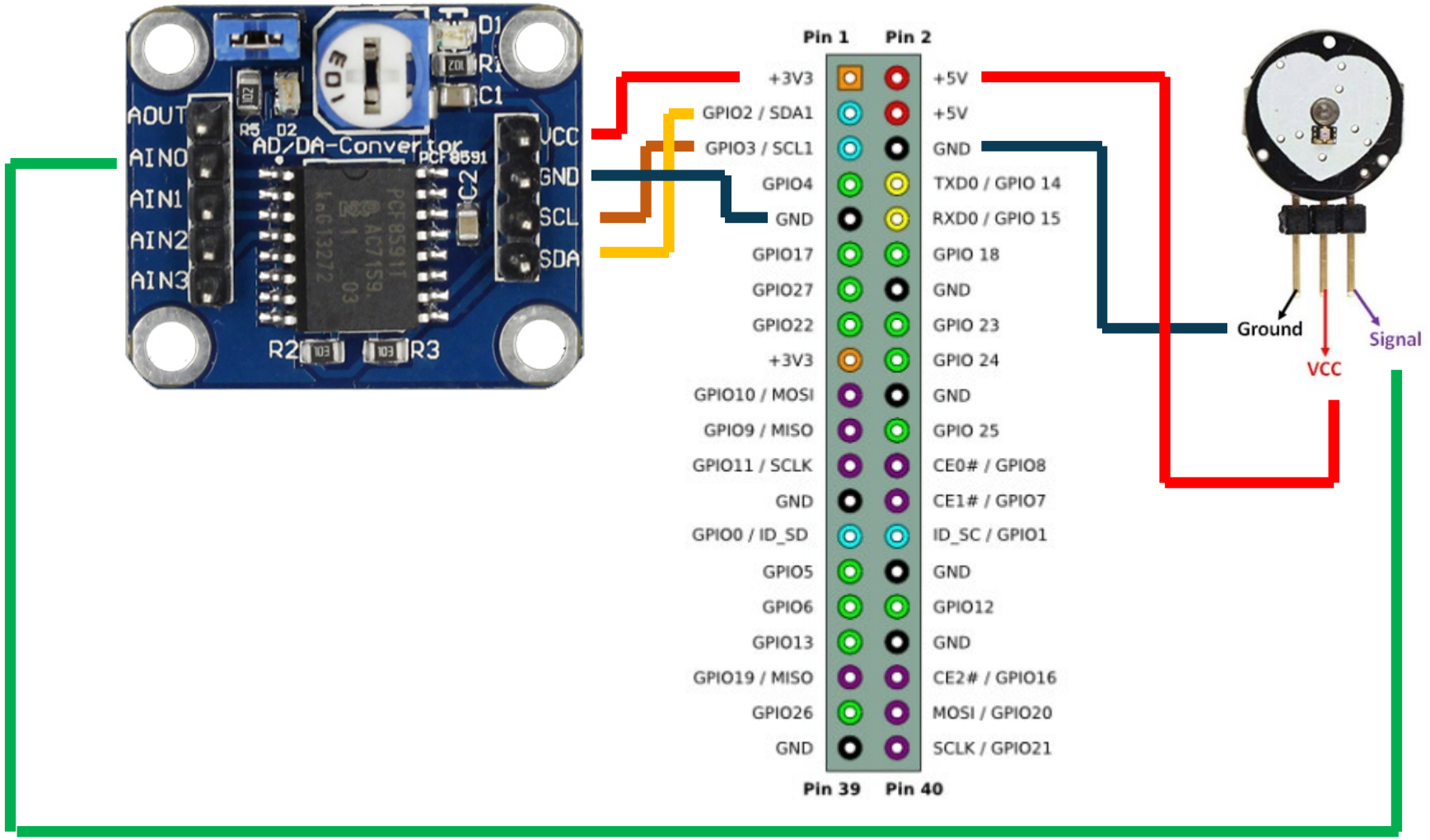
I^2C (Inter-Integrated Circuit, *eye-squared-C*), alternatively known as **I2C** or **IIC**, is a synchronous, multi-master, multi-slave, packet switched, single-ended, serial communication bus invented in 1982 by Philips Semiconductors.

It is widely used for attaching lower-speed peripheral ICs to processors and microcontrollers in short-distance, intra-board communication.

Sources:
https://en.wikipedia.org/wiki/I%C2%B2C
http://wiki.sunfounder.cc/index.php?title=PCF8591_8-bit_A/D_and_D/A_converter_Module

Pulse sensor + A/D converter





Sources:

https://how2electronics.com/pulse-rate-bpm-monitor-arduino-pulse-sensor/

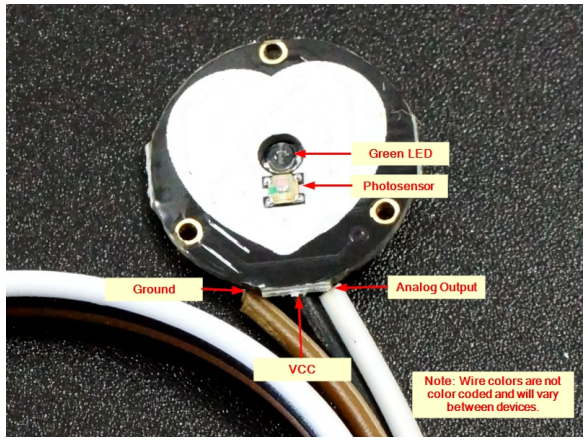
https://medium.com/@sarala.saraswati/connecting-to-your-raspberry-pi-console-via-the-serial-cable-44d7df95f03e

http://wiki.sunfounder.cc/index.php?title=PCF8591_8-bit_A/D_and_D/A_converter_Module

Goal of the lab segment

Co-work
- Observe, ask and try in groups

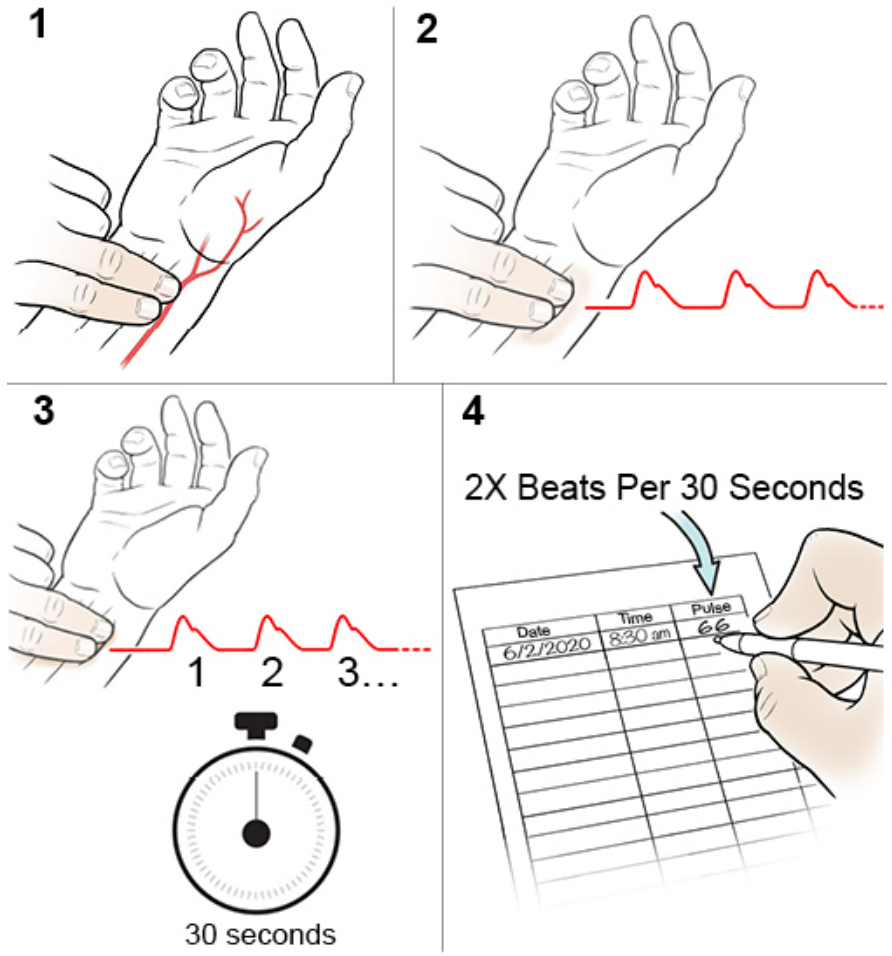
Make
- Build-a-hack
- Pulse sensors, A/D converter and Raspberry Pi 3B+



Analyze data using Python

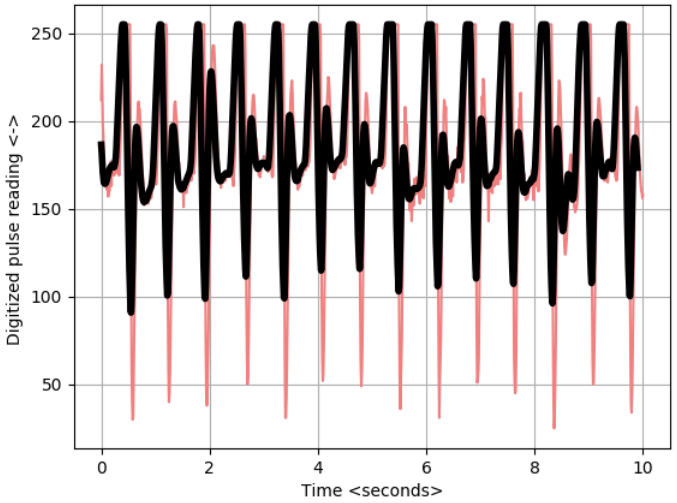
Record
- Challenges, Opportunities, Gaps and Surprises

Record your pulse at your wrist

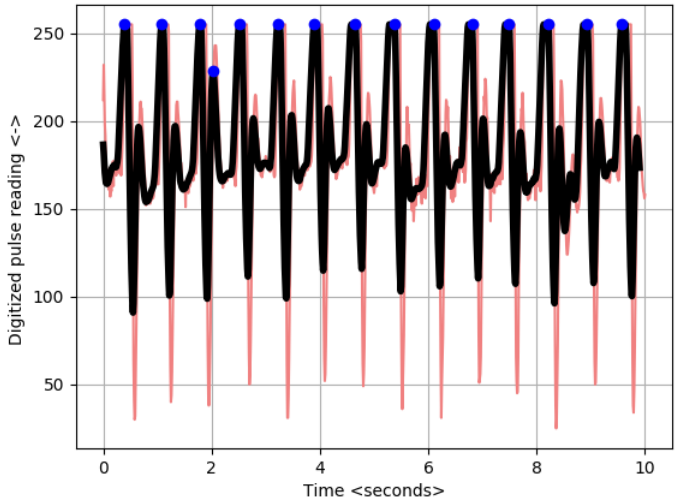


Sources:
https://www.spectrumhealthlakeland.org/lakeland-ear-nose-and-throat/ent-health-library/Content/3/90852/
https://protosupplies.com/product/pulsesensor-heart-rate-sensor-module/

Recorded pulse signal

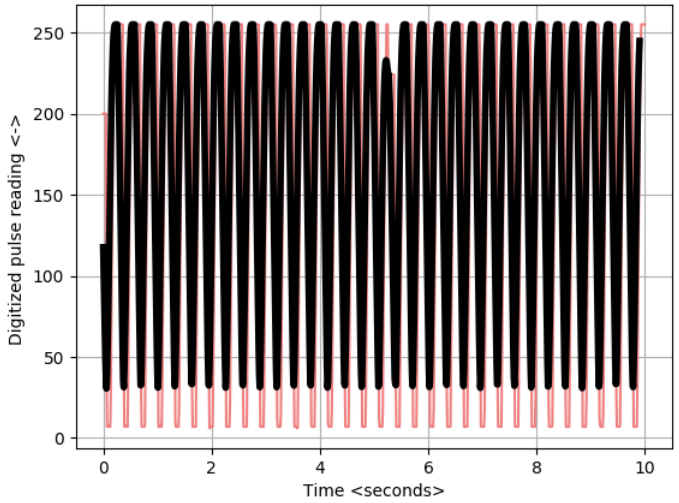


Pulse signal peaks detected by the Raspberry Pi 3B+ system

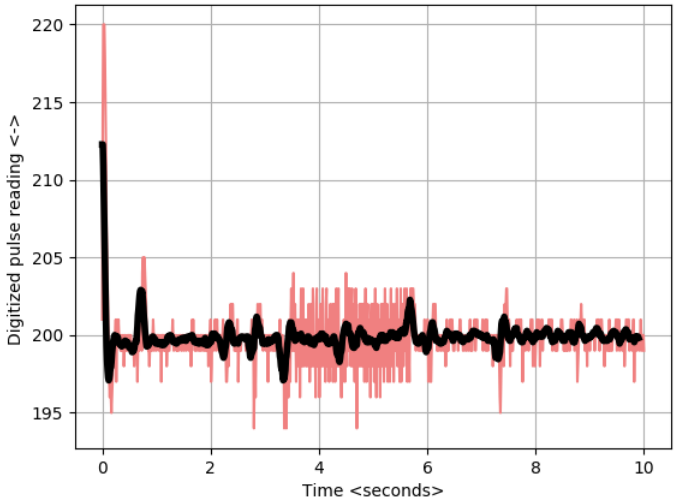


Signals generated by the heart rate measurements system after adjusting the potentiometer settings

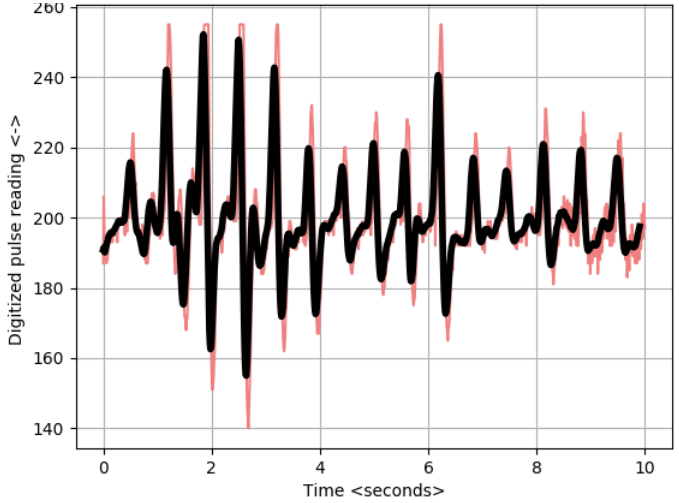
Pulse signal with high gain setting



Pulse signal with low gain setting



Typical pulse signal with optimal gain setting



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APSC 1001 Introduction to Engineering for Undeclared Majors
CS 1010 Computer Science Orientation