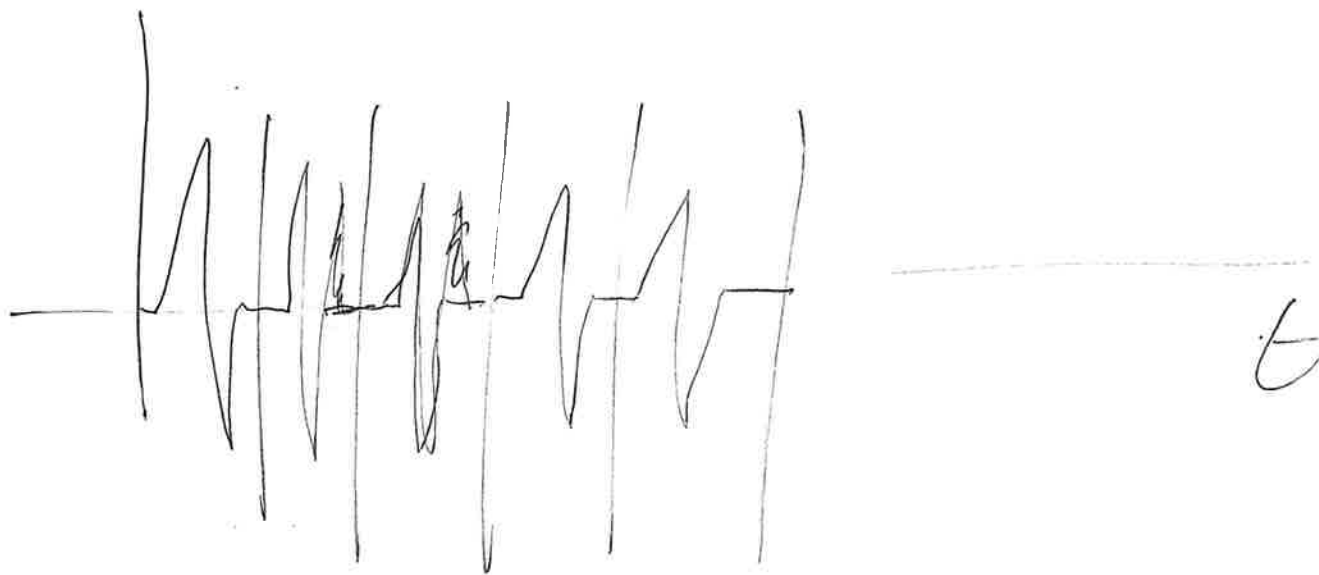


Exercise 1

You have heard that hummingbirds are amazing birds. You want to study them, in particular you would like to monitor their heart rate. For this, you design a heart rate monitor. How often should this heart rate monitor collect data?



Maximum heart rate: 1200 bpm

The key to sampling is that ②
the sampling frequency should be
at least twice the frequency
in the signal:

$$f_{\text{sampling}} \geq 2 \times f_{\text{signal}}$$

$2 \times 1200 \text{ bpm}$

$$f_{\text{sampling}} > 2400 / \text{min}$$

When we speak about frequency,
we always refer to points / second.

$$f_{\text{signal}}: 1200 \text{ bpm} = 20 / \text{second} = 20 \text{ Hz}$$

$$f_{\text{sampling}} 2400 / \text{min} = 40 / \text{second} = 40 \text{ Hz}$$

Exercise 2: We have a heart rate monitor that gets points at the frequency of 6 Hz.

Is this heart rate monitor good enough to monitor:

- a) Dog: 70 - 120 bpm
- b) Elephant: 25 - 35 bpm
- c) Pigeon: 250 - 300 bpm
- d) Hamster: 300 - 600 bpm

Nyquist:

$$f_{\text{sampling}} > 2 \times f_{\text{signal}}$$

$$6 > 2 \times f_{\text{signal}}$$

$$f_{\text{signal}} < 3 \text{ Hz}$$

a Dog: $120 \text{ bpm} = 2 \text{ Hz} < 3 \text{ Hz}$ (4)
The heart rate monitor is adequate.

• Elephant: $35 \text{ bpm} = \frac{35}{60} < 3 \text{ Hz}$
The heart rate monitor is adequate.

• Pigeon $300 \text{ bpm} = 5 \text{ Hz}$ not $< 3 \text{ Hz}$
The heart rate monitor won't work.

• Hamster: $600 \text{ bpm} = 10 \text{ Hz}$ not $< 3 \text{ Hz}$
The heart rate monitor does not work.

• Cat $100 - 180 \text{ bpm}$
 $= 3 \text{ Hz} < 3 \text{ Hz}$ No.

Exercise 3: Two guards are standing in front of a cave. You know that the cave contains a treasure (This treasure can be one of copper, gold, silver, platinum, diamonds, or rubies).

Guard 1 lies when guarding copper, gold, or silver, and tells the truth otherwise.

Guard 2 lies when guarding platinum, diamonds or rubies, and tells the truth otherwise.

Guard 1: The treasure is either gold or copper.

Guard 2: I hate chocolate.

Option:

Treasure	S1	check
Copper	(T)	X
Gold	(T)	X
Silver	F	OK
Platinum	(F)	X
Diamonds	(F)	X
Rubies.	(F)	X

Therefore the cave contains silver. Since ⑥
Guard 2 tells the truth when there is silver,
(s/he does not like chocolate.

Exercise 4 You arrive in a strange
place called Subtenea. You can't look
at the sky to find out if it is day or night.
You are told that there are only knights
in that place, but 2 types of knights:

Day Knight (DK): tells the truth during the day
and lies at night time.

Night Knight (NK): tells the truth at night time
and lies during day.

You meet John and Sally:

John: Sally is a DK and it is day

Sally: We are both NK.

Options:

⑦

Time of day	John	Sally	S ₁	S ₂	Check:
D	DK	DK	T	F	X
D	DK	NK	F	F	X
D	NK	DK	T	F	X
D	NK	NK	F	T	X
N	DK	DK	F	F	
N	DK	NK	F	F	X
N	NK	DK	F	F	X
N	NK	NK	F	T	X

Conclusion : Both are days bright and it is a night.