Signal Processing - 1 by One

Sibi Raj B. Pillai
Dept of Electrical Engineering
IIT Bombay

Access Details

EE229 Signal Processing

http:/www.ee.iitb.ac.in/~bsraj/courses/ee229/

email: srbpteach@gmail.com, or bsraj@ee.iitb.ac.in

Google Classroom: Class Code **?????**

Google Meet: **https://meet.google.com/ipo-oksm-pud**

Please raise your comments/criticisms at the classroom page

Modus Operandi

1) GnuRADIO Assignments : 10 marks (gnuradio.org)

(GnuRADIO Tutorials, Materials will be given)

2) Quiz : $12.5 \times 2 = 25$ marks (September xx, yy:zz am)

3) Midsem : 25 marks

4) Endsem : 35 marks

(Topup Bonus, SAFE tool, 68 marks for BB)

Biggest Obstacle in Learning Signals

Courtesy: clipart-library.com

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What is there to learn?

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Biggest Obstacle in Learning Signals

What is there to learn?

It took 150years to unravel the mysteries behind Fourier's conviction

Courtesy: clipart-library.com

Signals: Analog and Digital

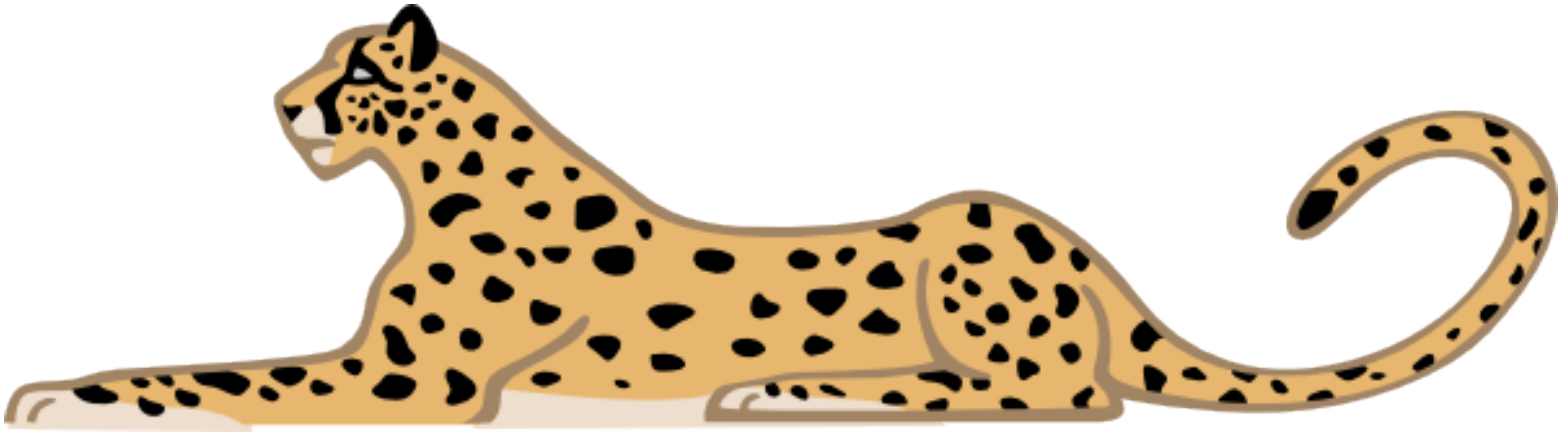

Figure: Leona the Leopard

Signals: Analog and Digital

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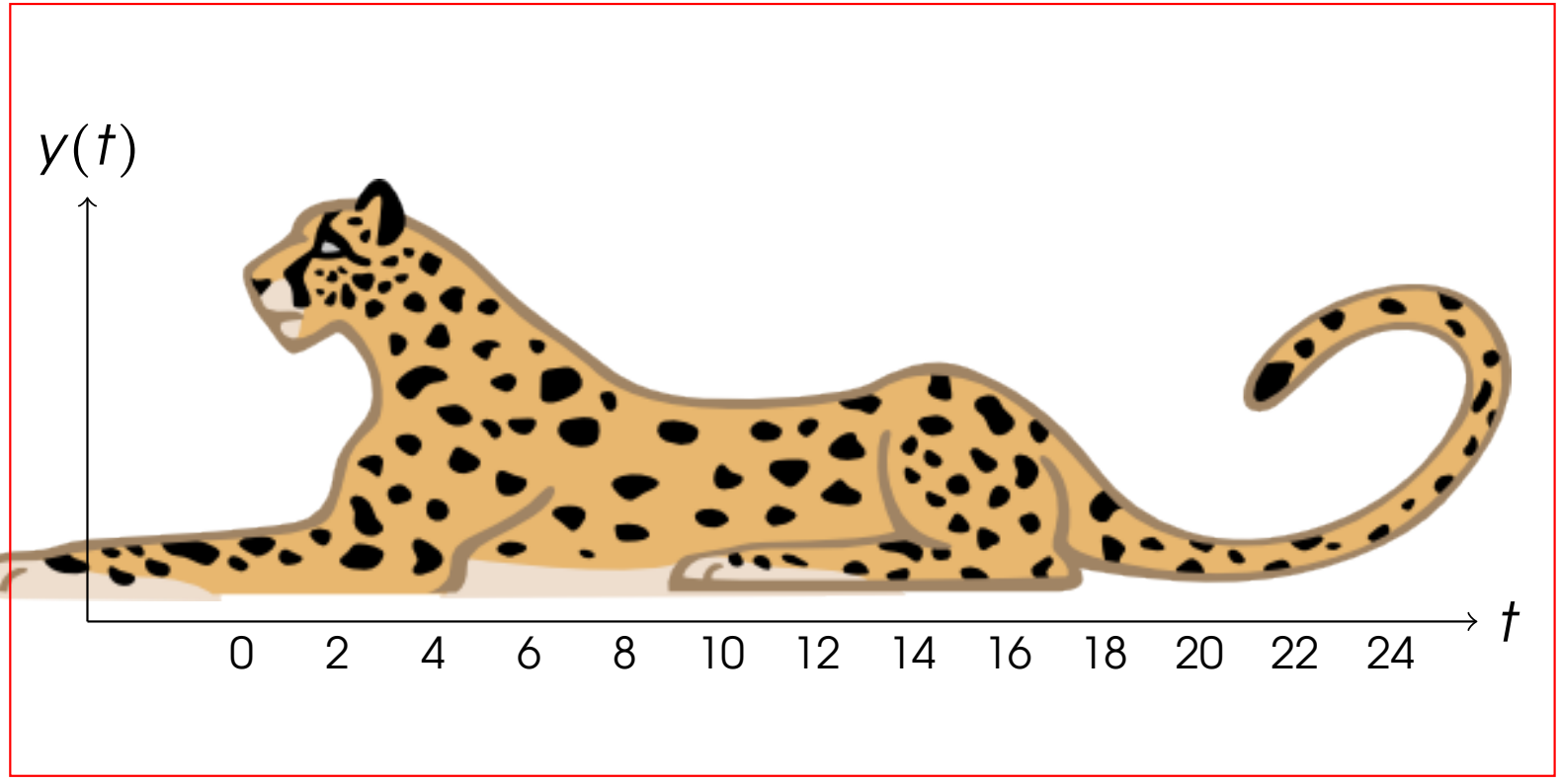

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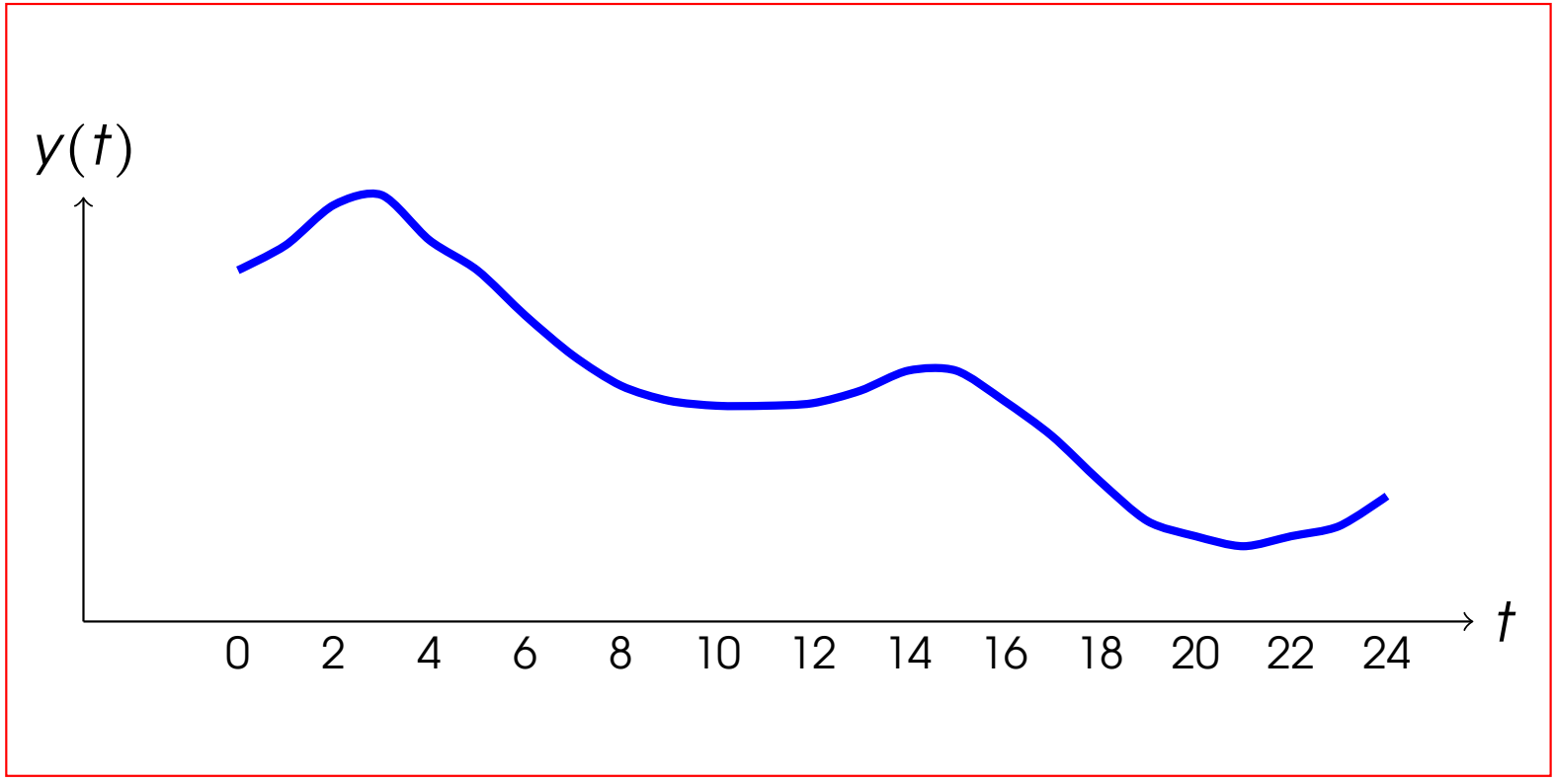

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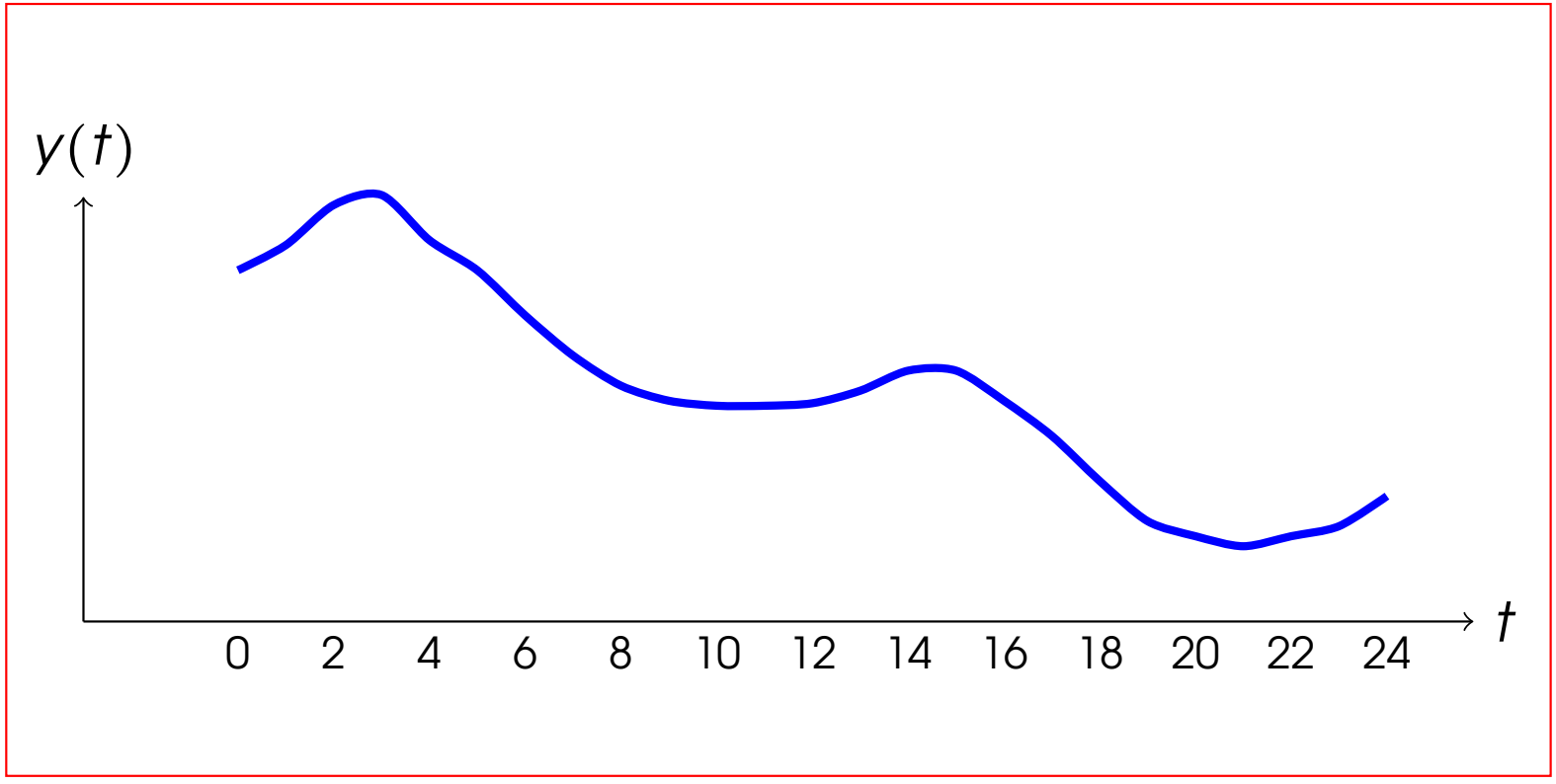

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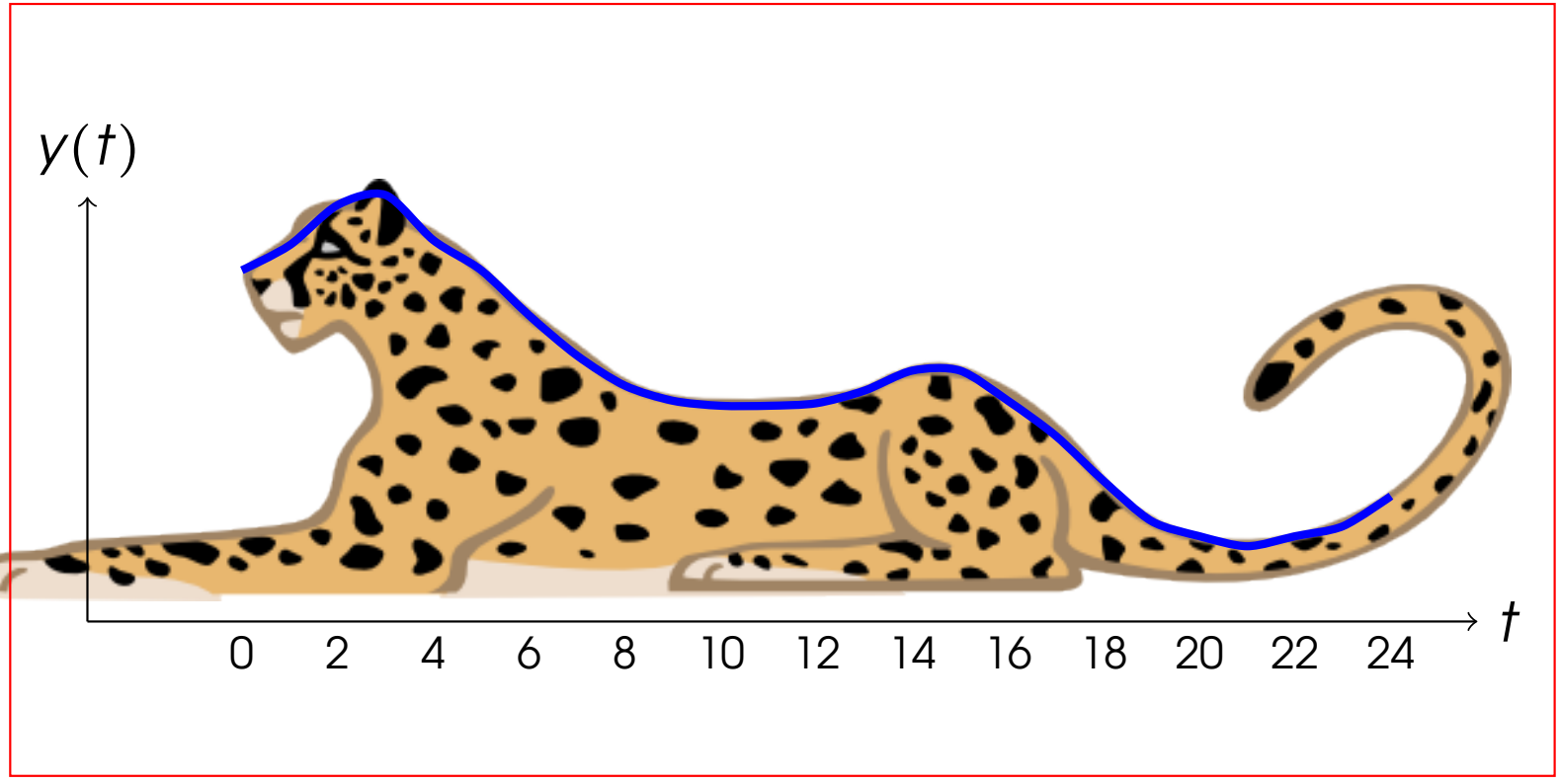

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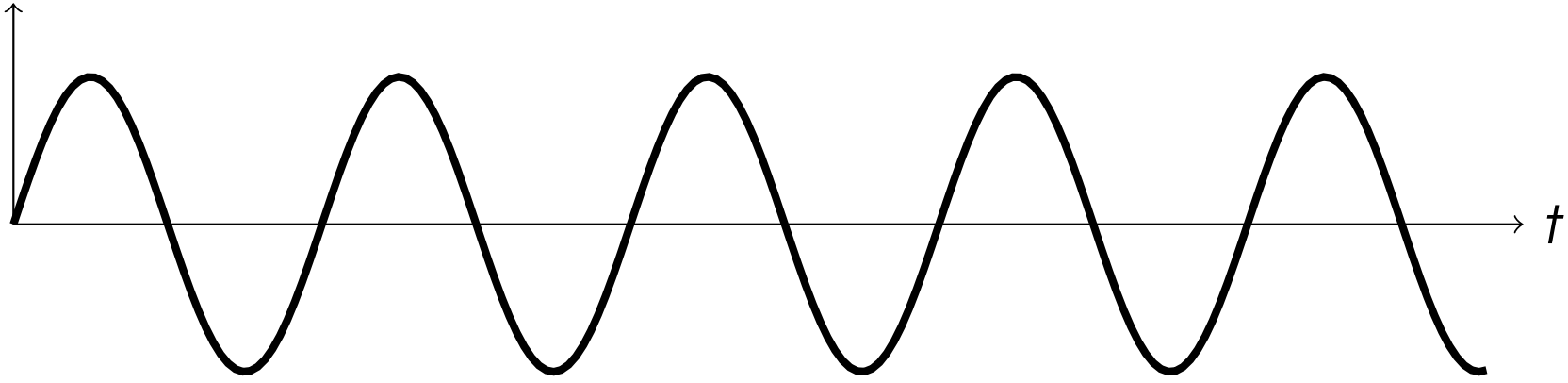
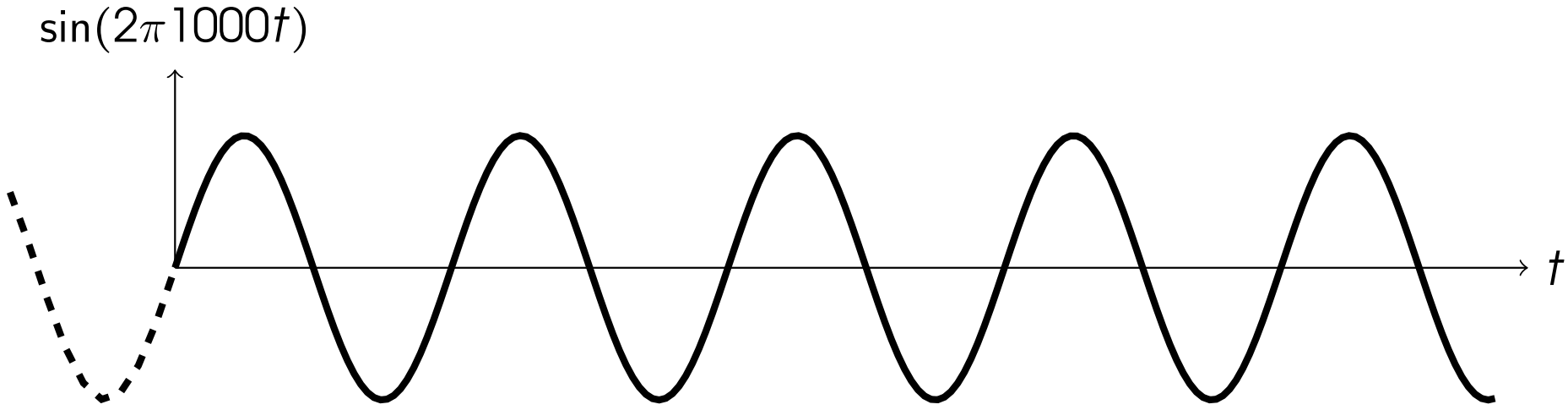
1 kHz Sinusoid: what is it?

$\sin(2\pi 1000t)$



1 kHz Sinusoid: what is it?



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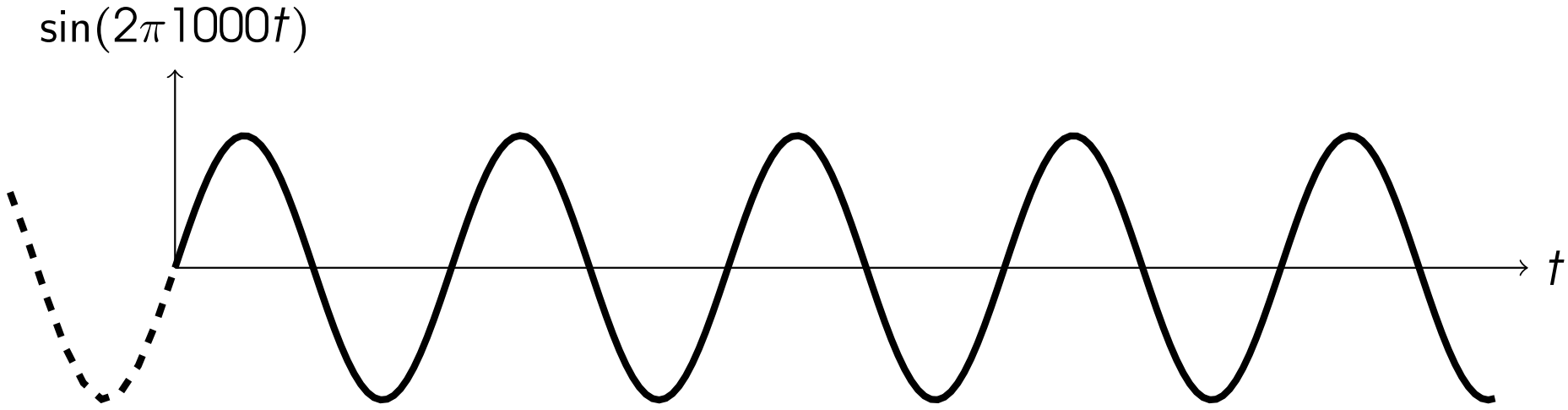

Can we see it?

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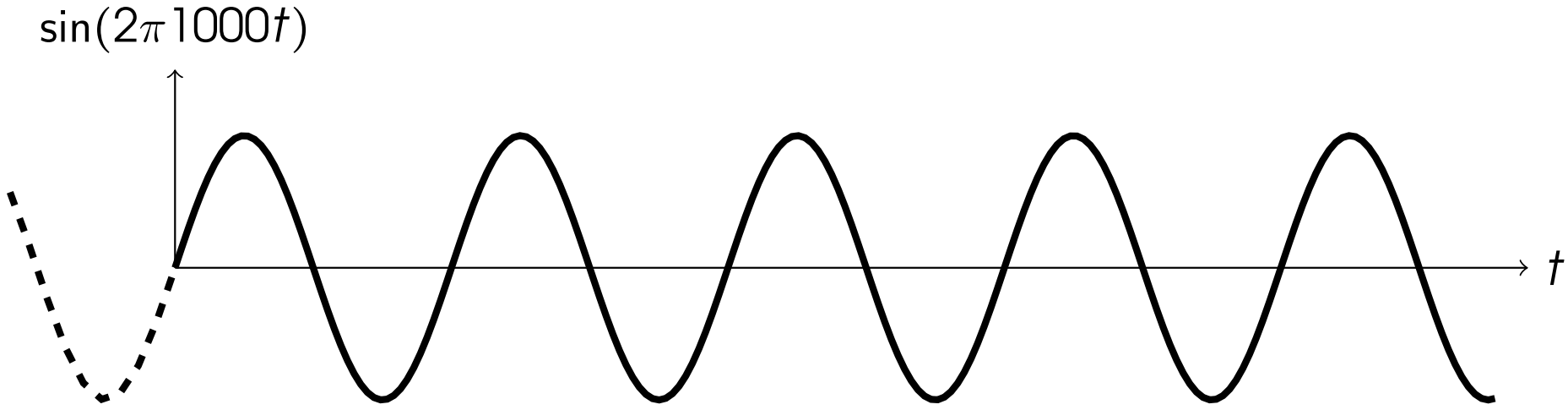

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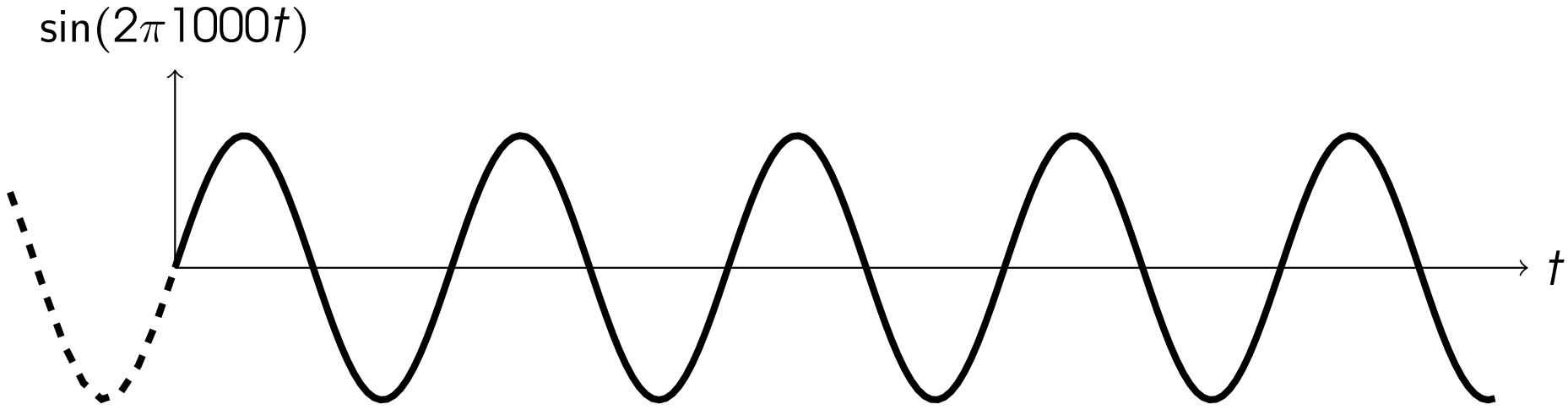
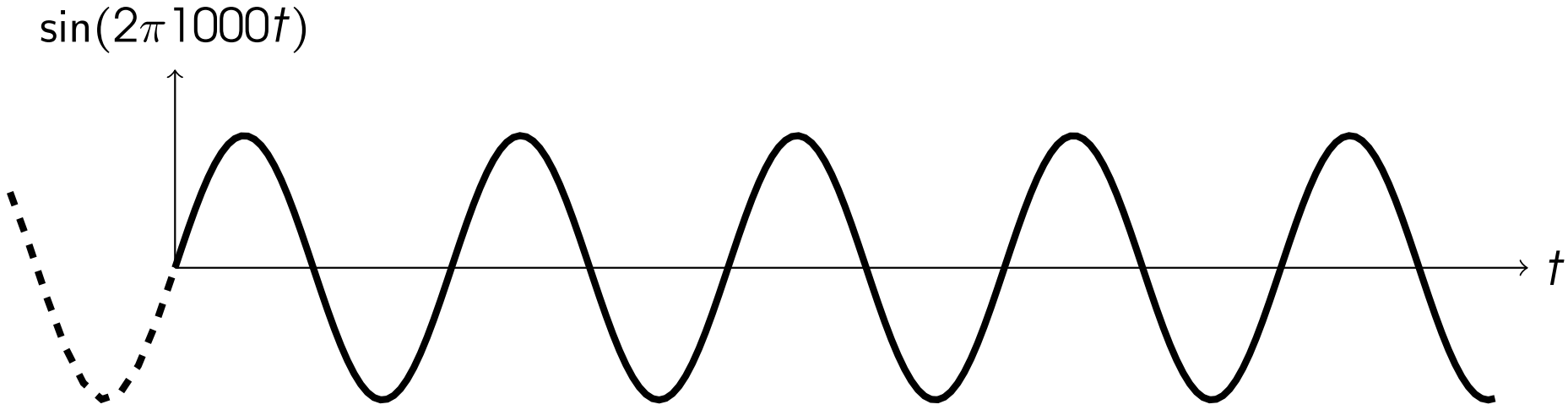


Can we see it?

Can you hear it?

Can you produce it?

1 kHz Sinusoid: what is it?



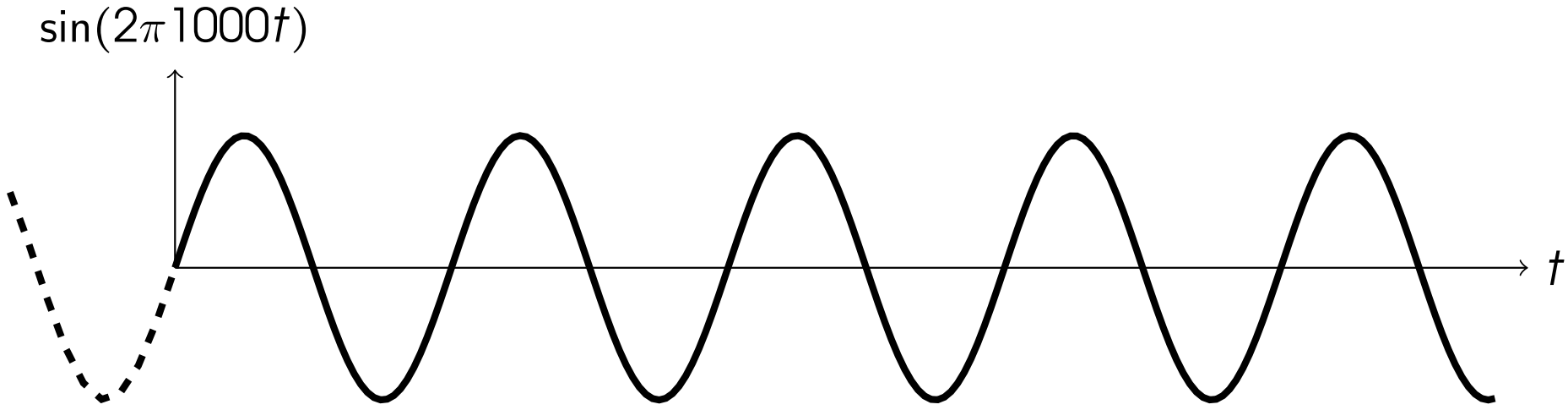
Can we see it?

Can you hear it?

Can you produce it?

Can you taste it?

1 kHz Sinusoid: what is it?



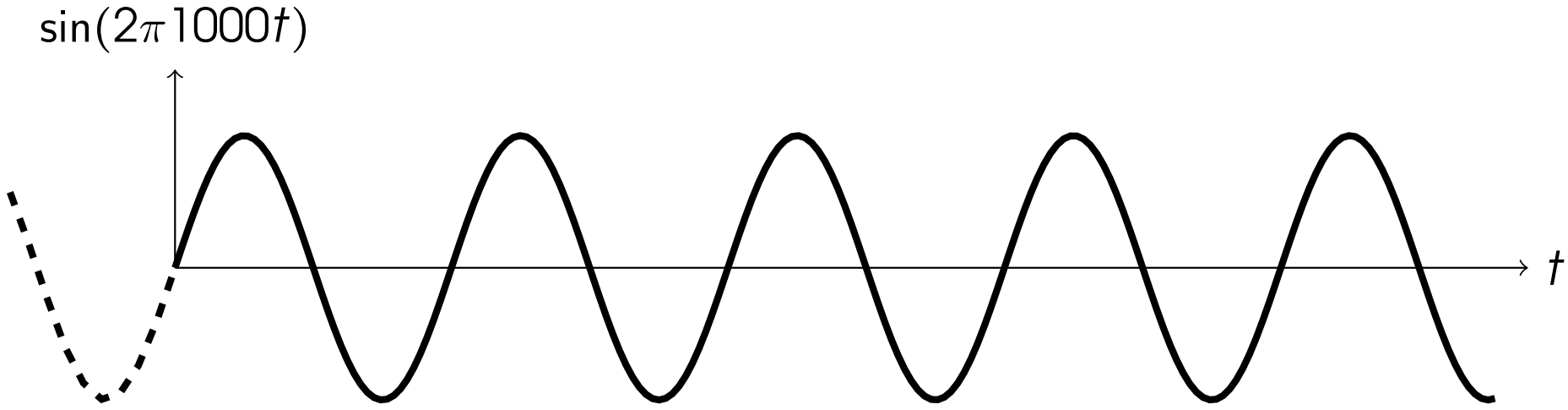
Can we see it?

Can you hear it?

Can you produce it?

Can you taste it? *"you can sample it!"*

1 kHz Sinusoid: what is it?



Can we see it?

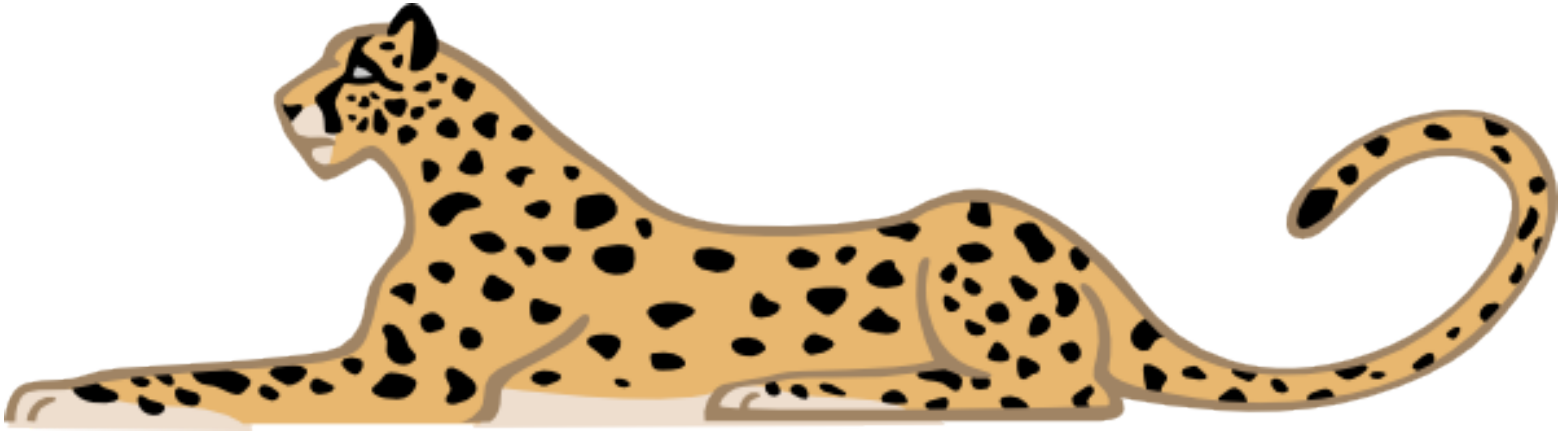
Can you hear it?

Can you produce it?

Can you taste it? *"you can sample it!"*

There is another *DIMENSION* to it

Signals: Analog and Digital



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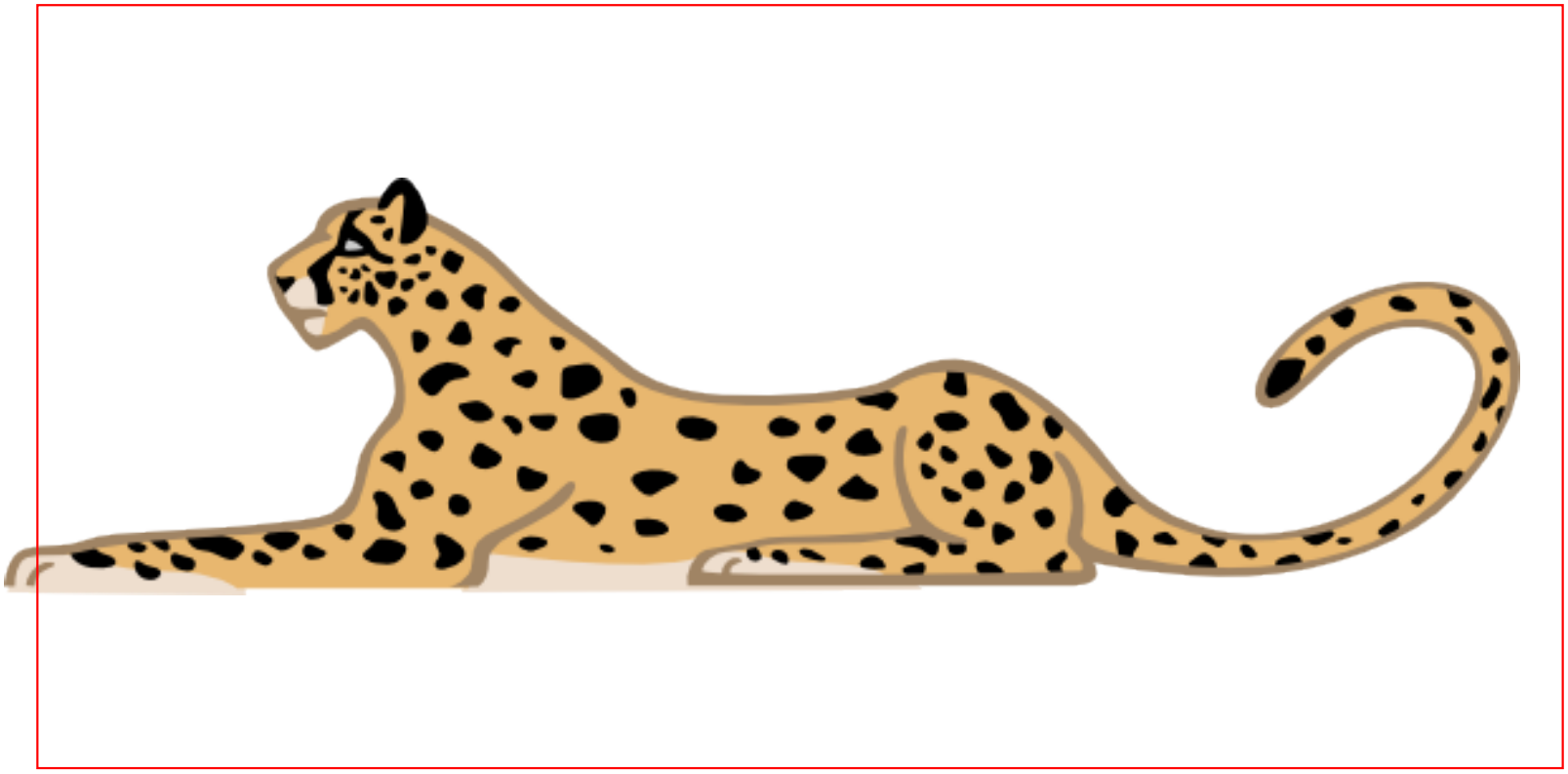

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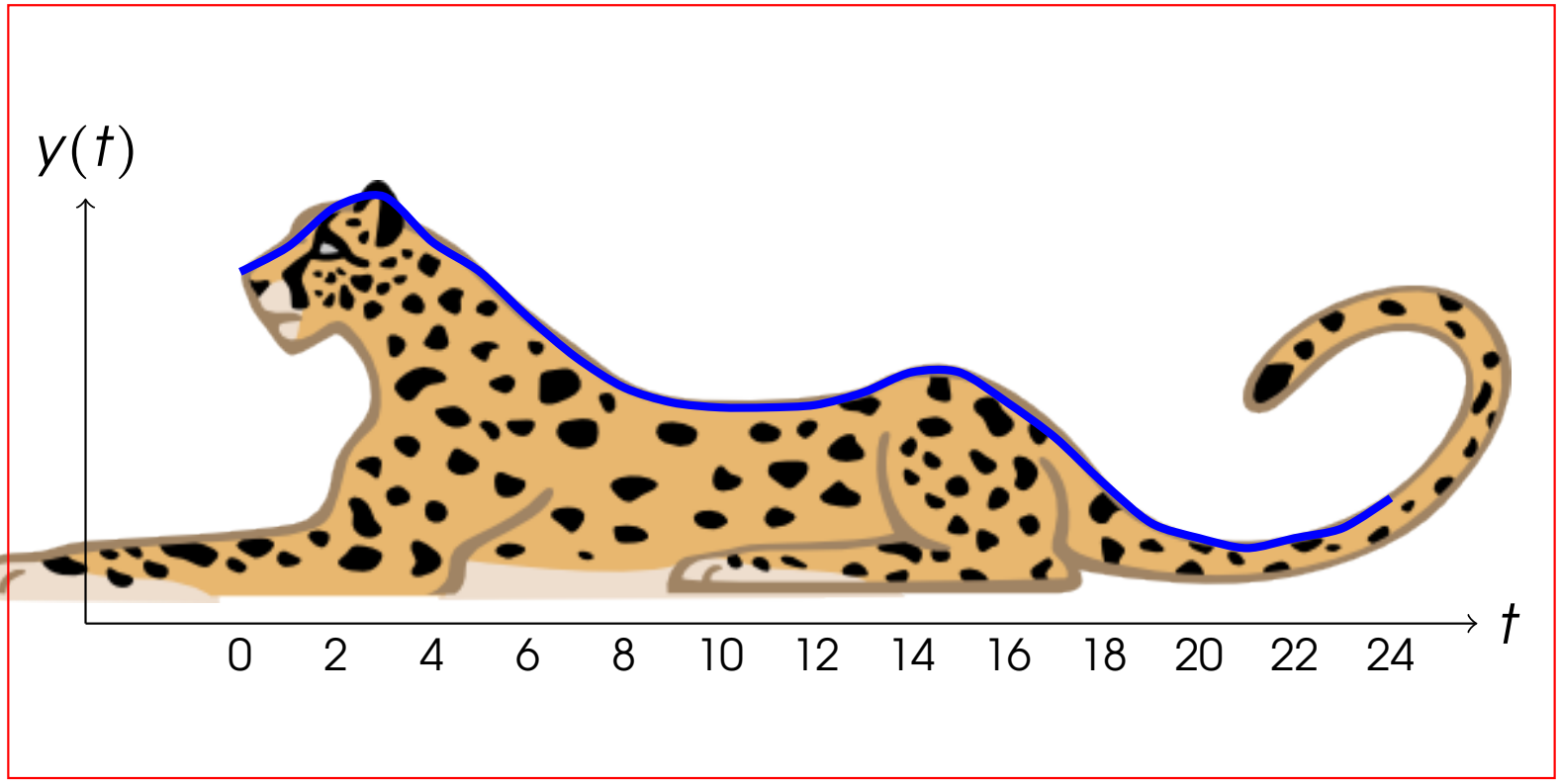

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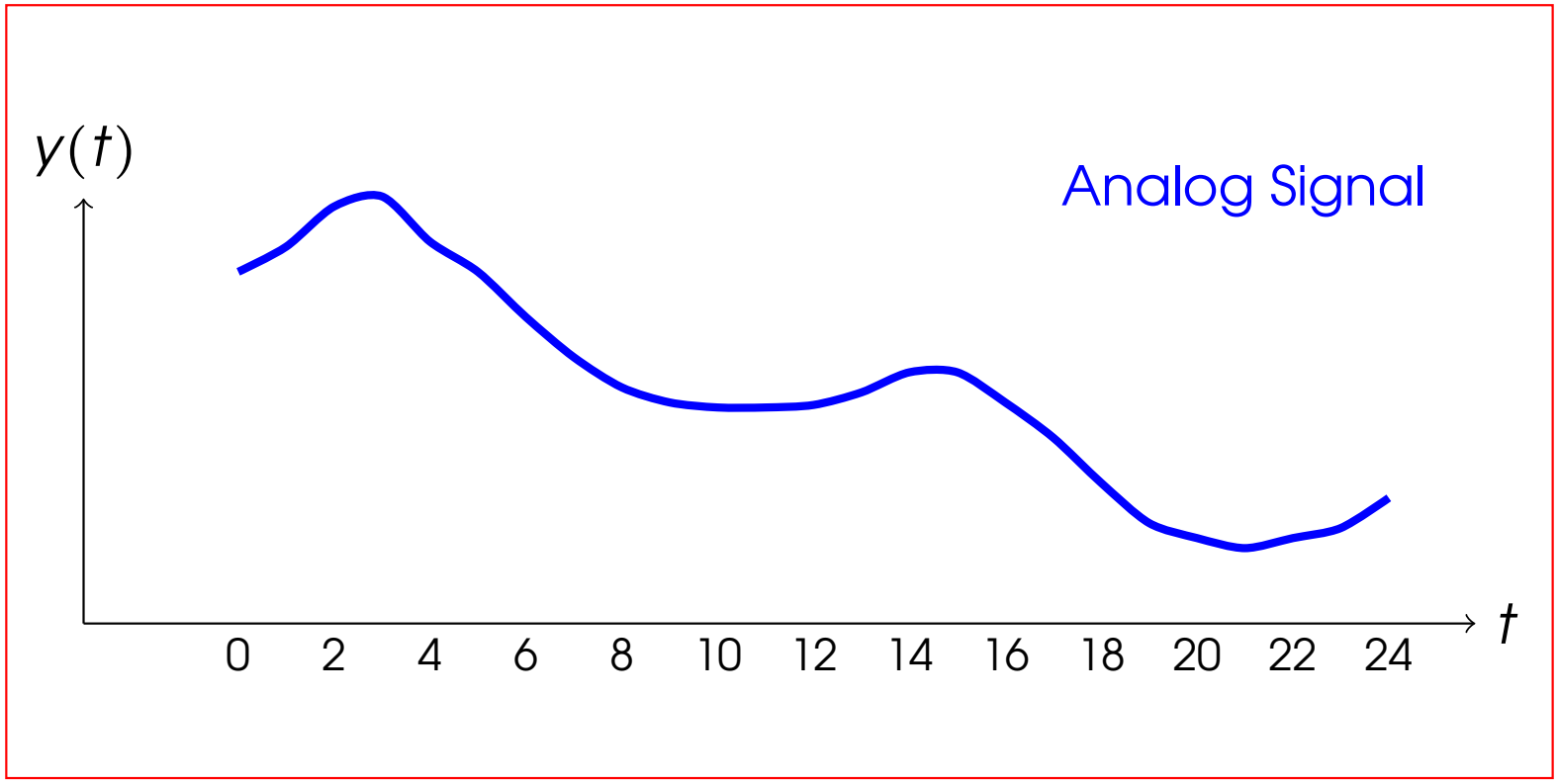

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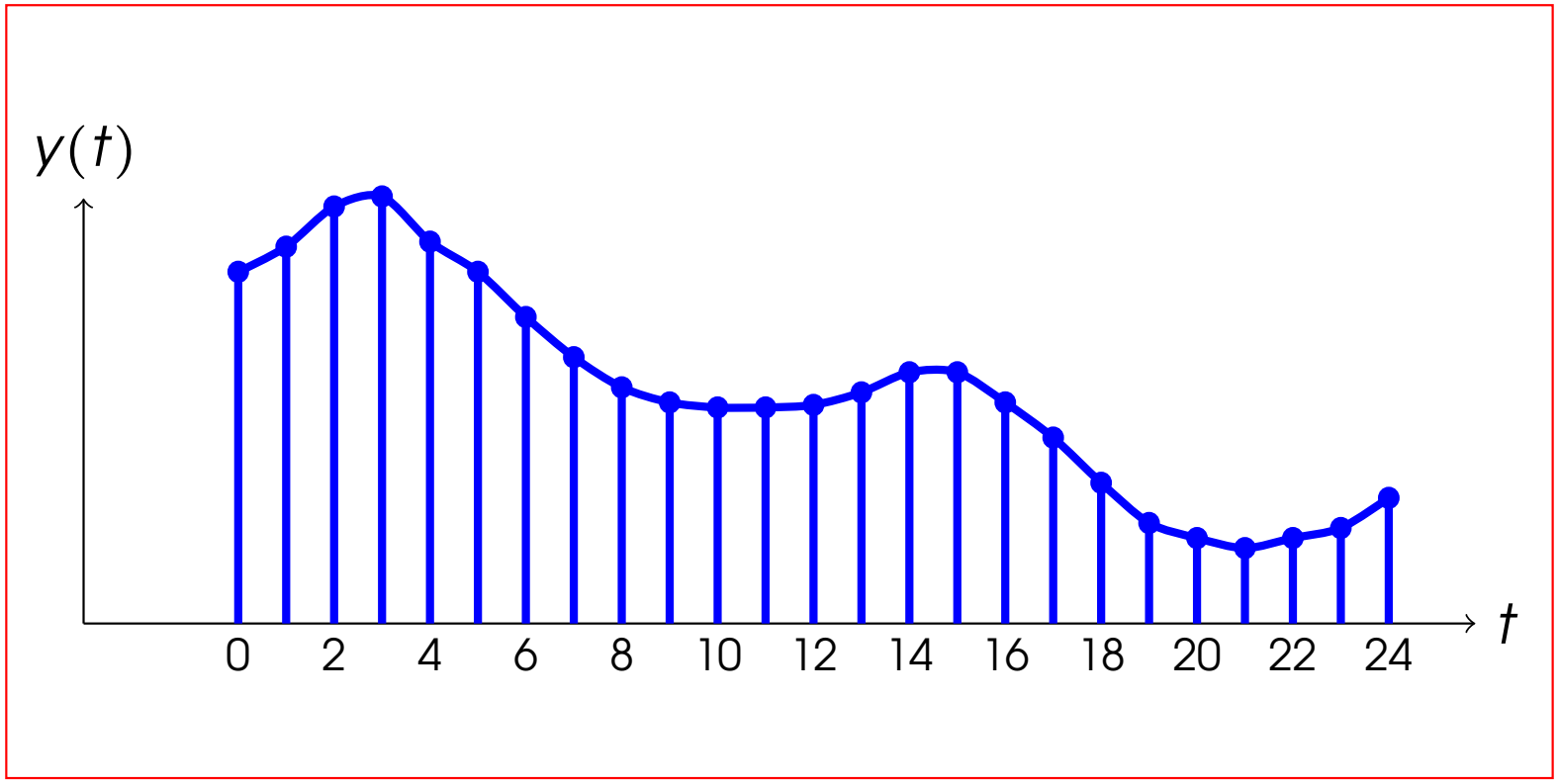

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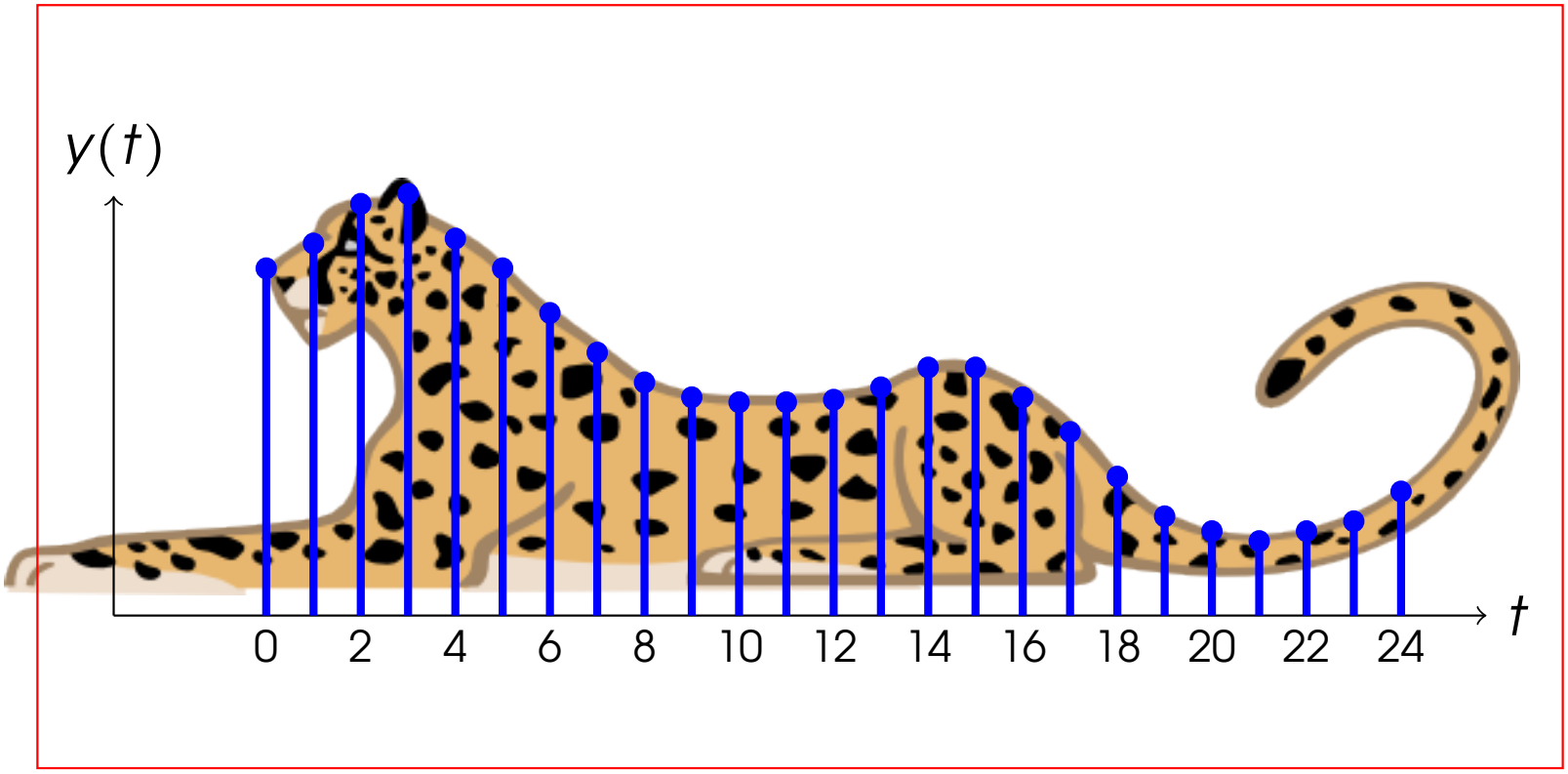

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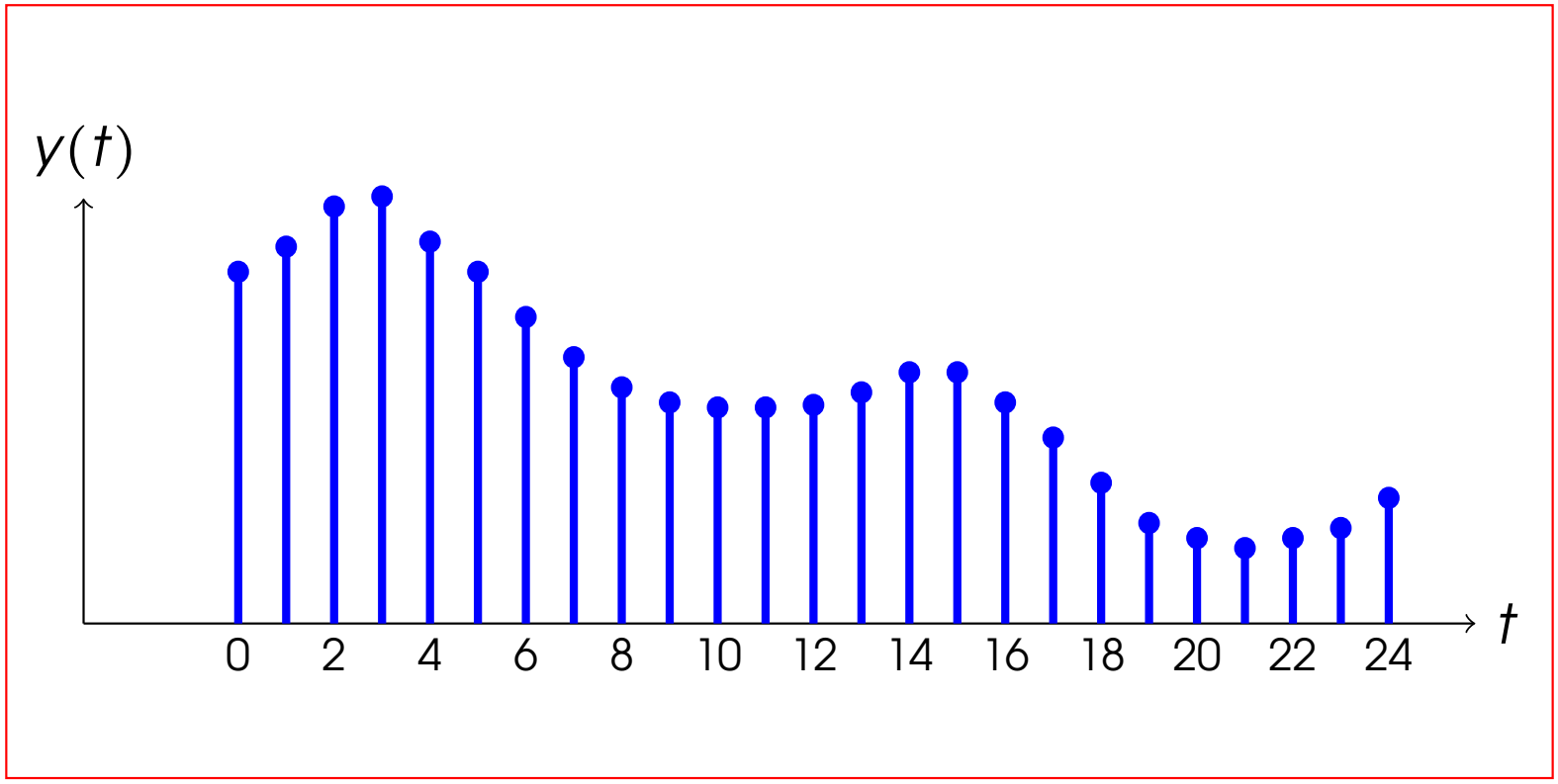

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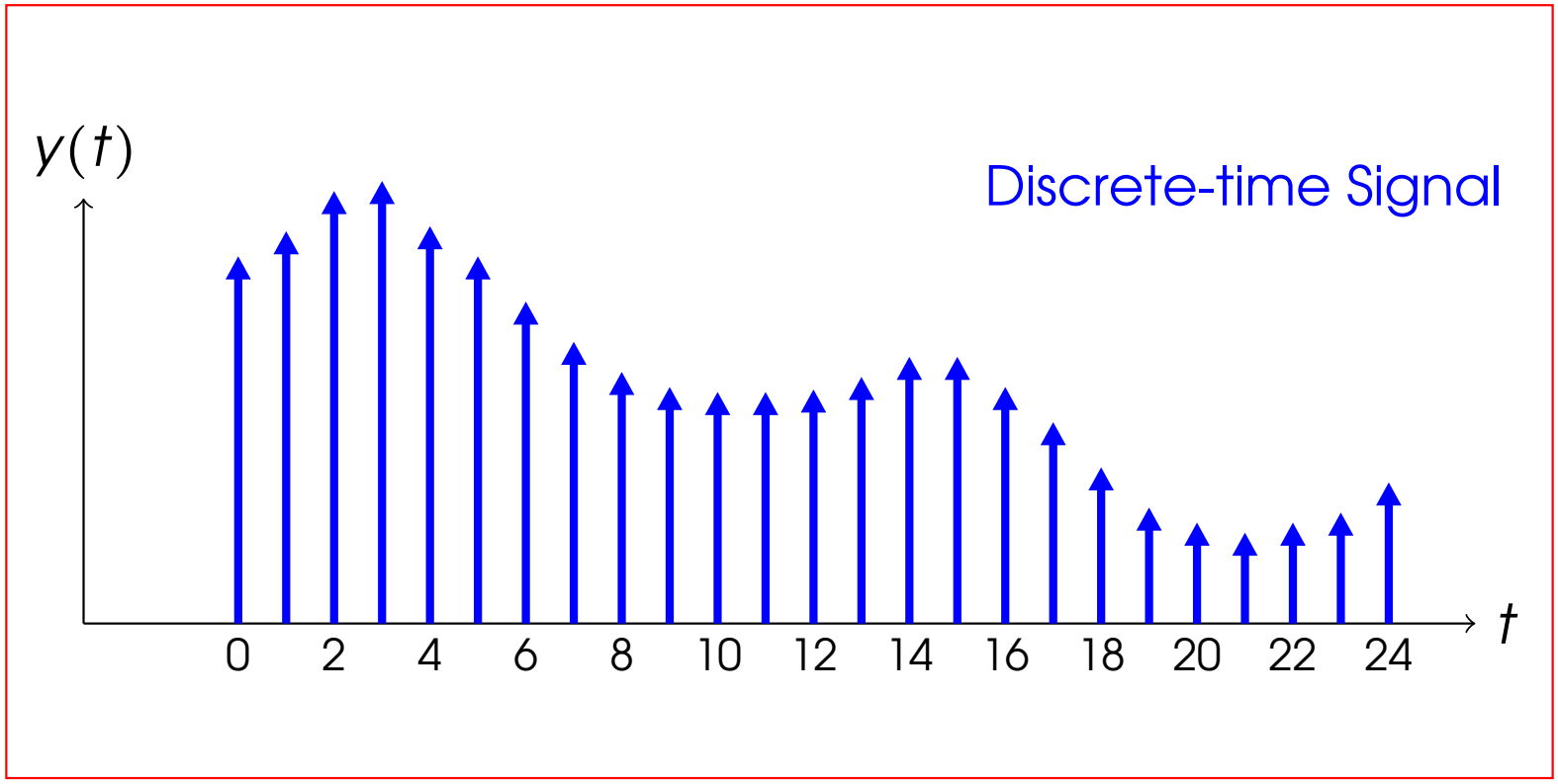

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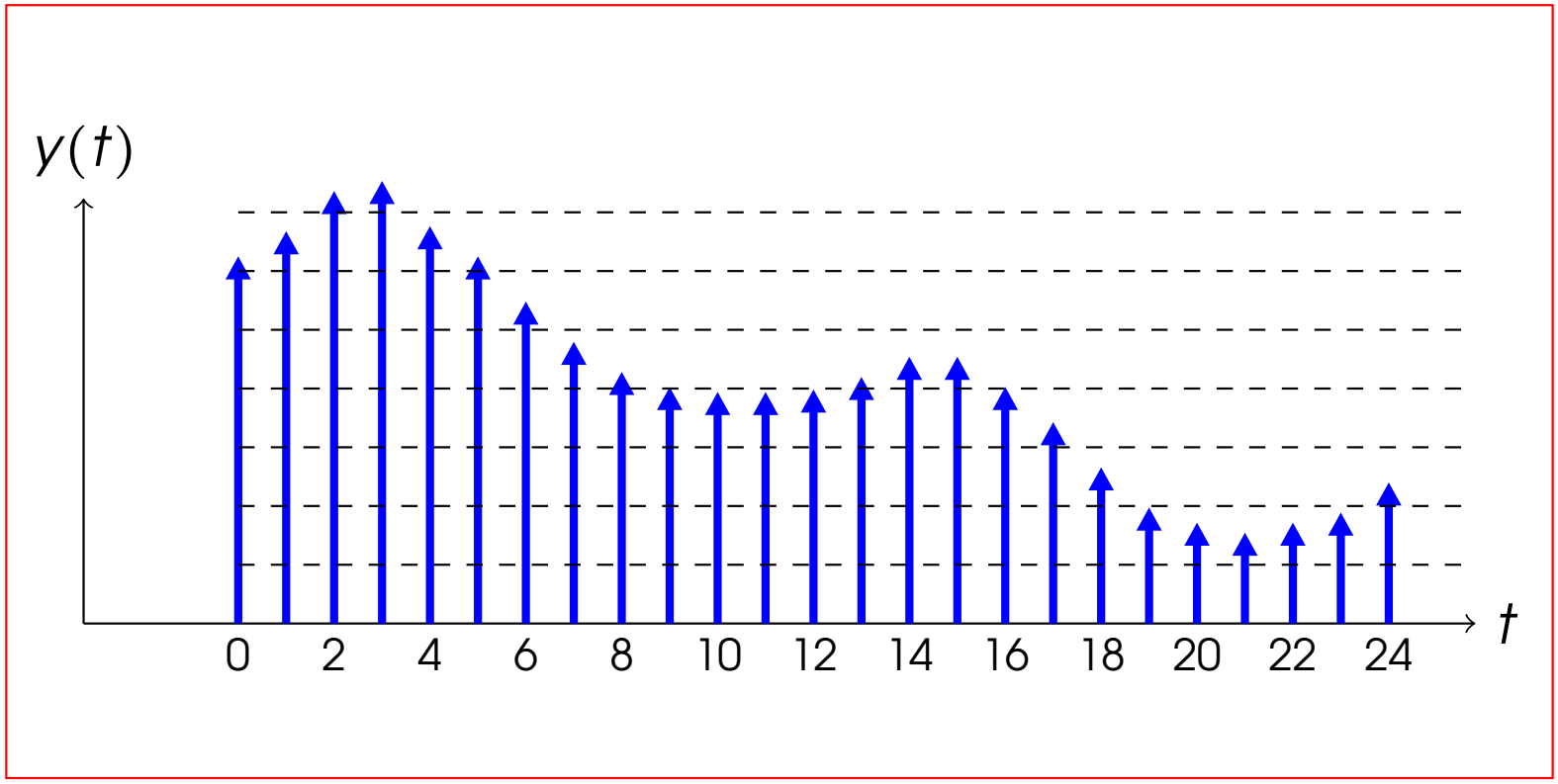

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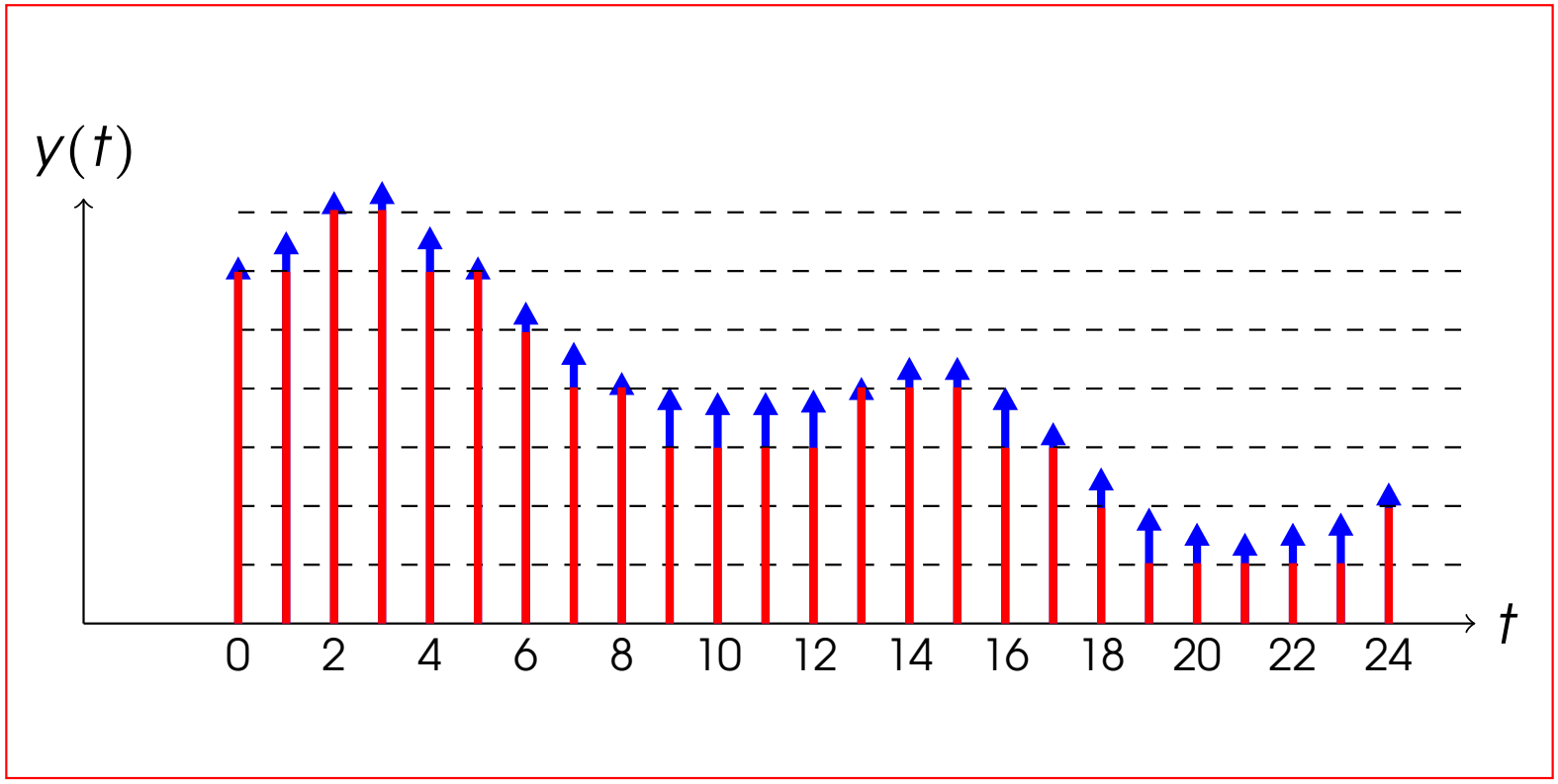

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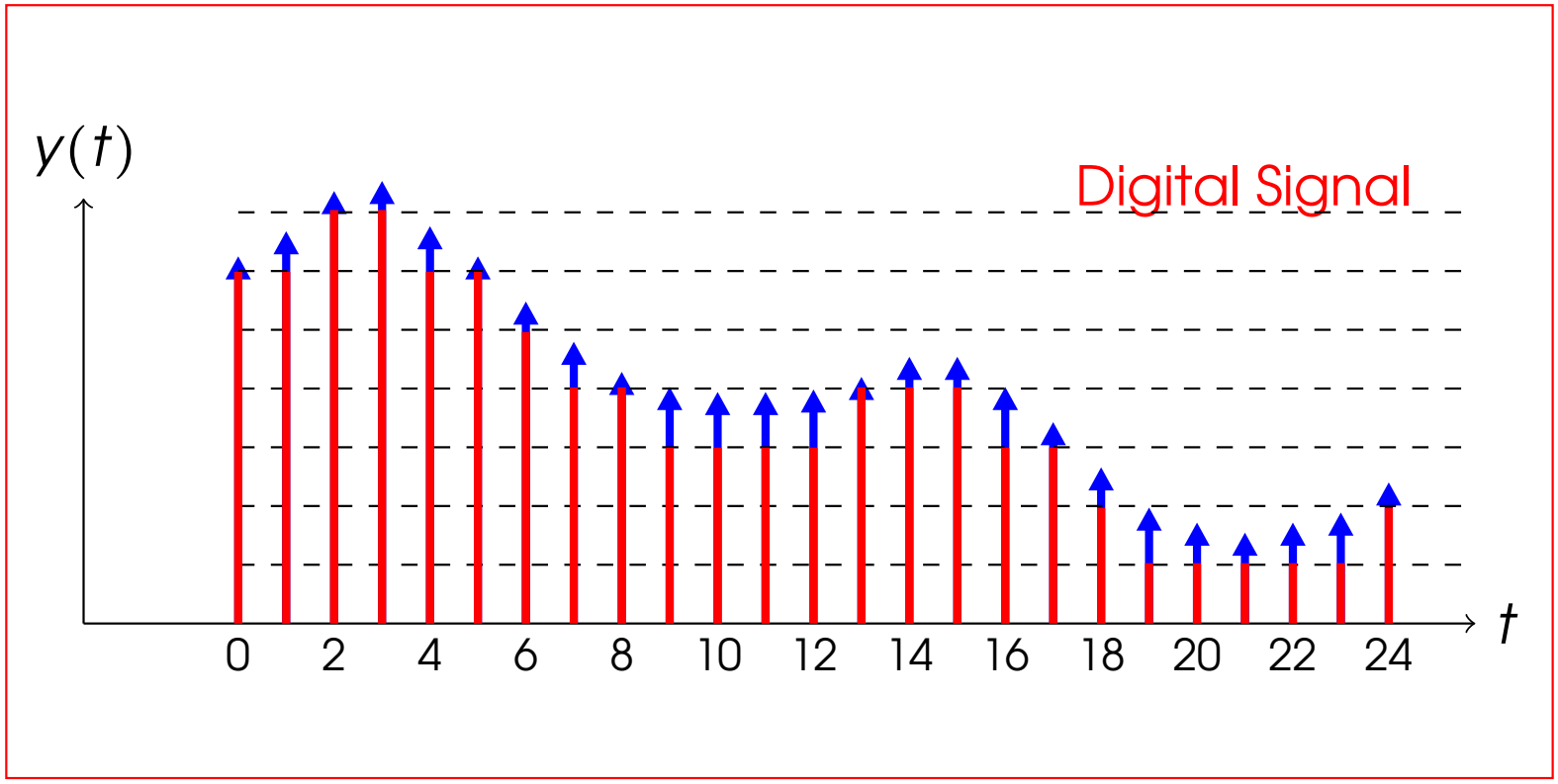

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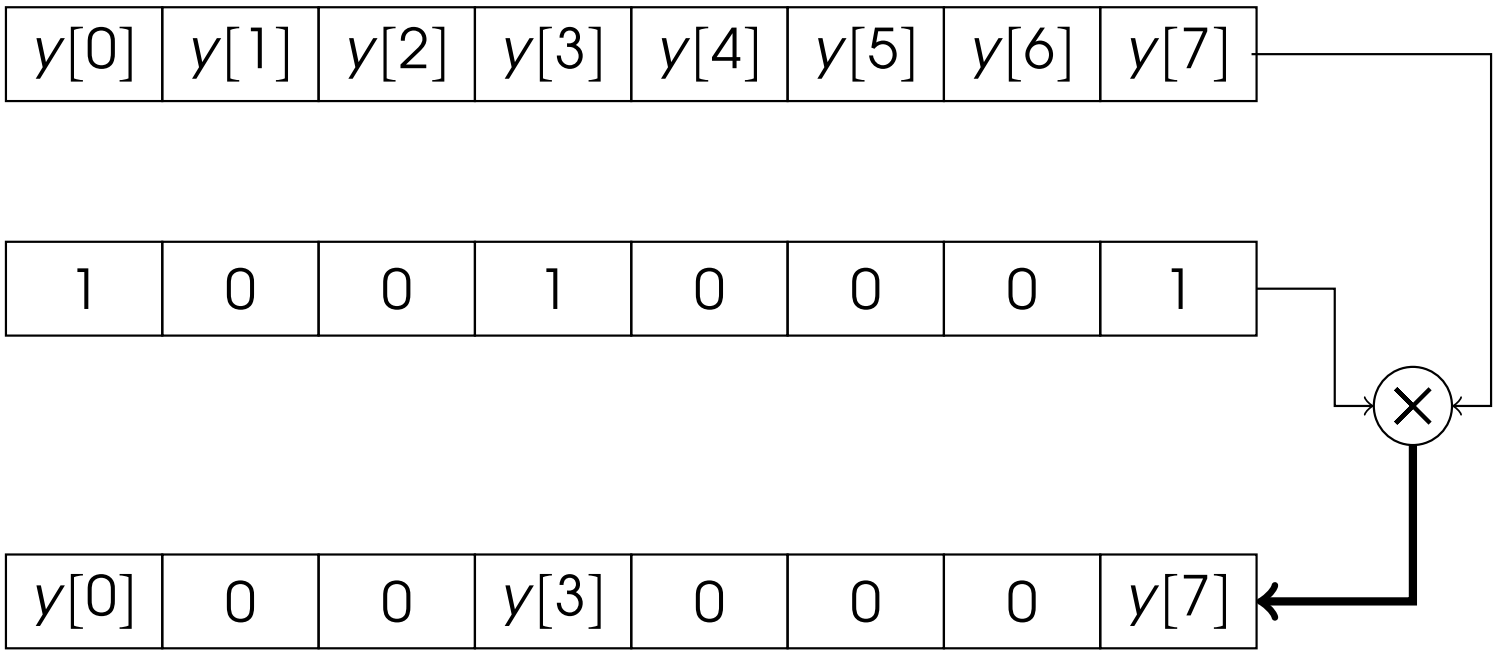
$$\bar{y} = (y[0], y[1], \ldots, y[N-1]).$$

Subsampling/Decimation



Homework

Exercise: Please download a signal corresponding to your roll number (filename: Signal_ROLLNOxx.wav) from the link emailed to you. There are 5 different sine-wave segments (each segment is taken from a different *proper sinewave* for a fixed duration), and 25 such segments are randomly stitched together to make your 'wav' file. Notice that there is no particular sequence in which they are put together (it is random), and possible repetitions of the same segment may happen as well.
Given this data, use GNURADIO or any other tools to figure out the frequencies and the order in which they occur in your file.

Answer: Roll Number - $[1, 1, 1, 1, 1, 2, 2, 2, 2, 2, \ldots, 5, 5, 5, 5, 5]$

(replace 1 by f_1, 2 by f_2 etc)

Recap

- Analog Signals: Continuous-time signals.
- Discrete-time Signals: Indexed sequence of $(t, y(t))$.
- Digital signal: a sequence of quantized values.
- Sampling: From analog to discrete-time.
- Subsampling: Repeated sampling.

Elementary Signal Calculus

- **Amplitude scaling** of Signals: $y(t) = \alpha x(t)$, $\alpha \in \mathbb{R}$ or $\alpha \in \mathbb{C}$.
- **DC offset**: $y(t) = \alpha + x(t)$.
- **Addition** of signals: $z(t) = x(t) + y(t)$ (point-wise $\forall t \in \mathbb{R}$).
- **Time-shift**: $y(t) = x(t - \tau)$, $\tau \in \mathbb{R}$.
- **Multiplication** of Signals: $z(t) = x(t).y(t)$ (point-wise)
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