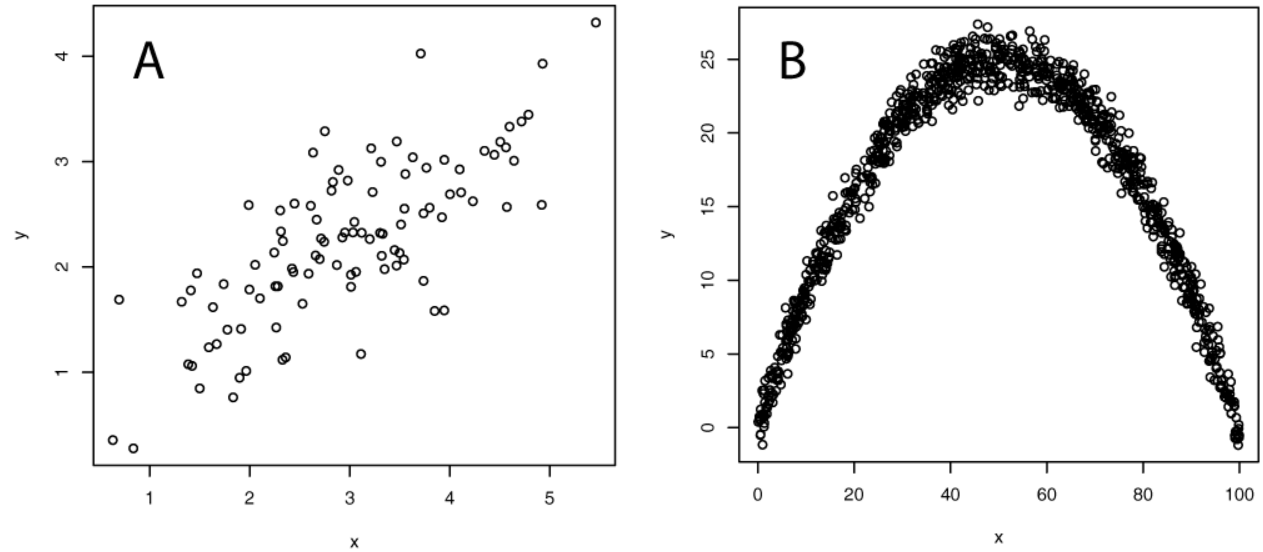
Question 1



Consider the data shown in Panel A, above. **Sketch (on the panel) a pair of eigenvectors that you would expect to obtain from a Principal Components Analysis (PCA) of the data.**

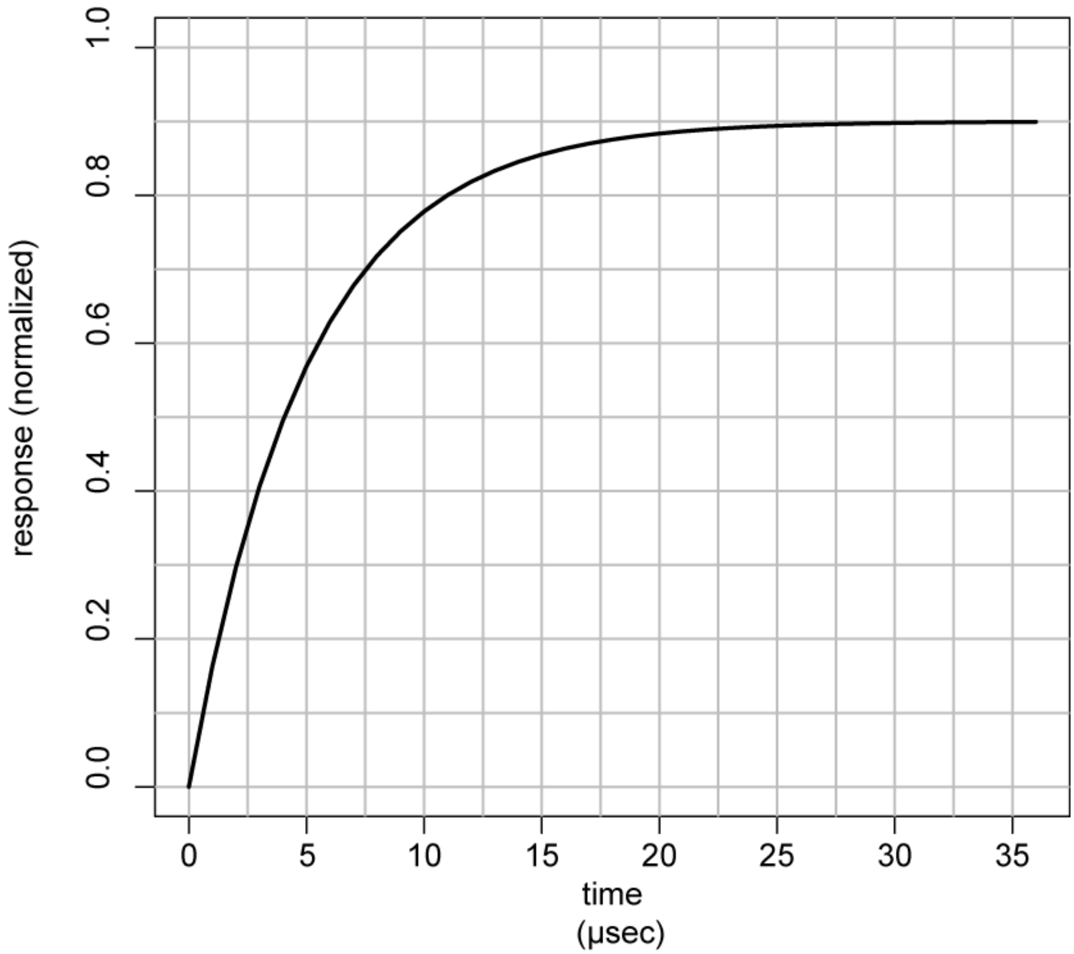
Indicate which eigenvector you would expect to have the larger corresponding eigenvalue.

What do the numerical values of the eigenvalues tell you about the data?

Do you think it is appropriate to use PCA to reduce the dimensionality of the dataset shown in panel B? Why or why not?

Question 2

Consider the time-dependent response shown in the figure below. Estimate the time constant for the response, and explain your reasoning.



Question 3

Consider the following differential equation giving the rate of change of the concentration of a protein monomer M.

$$\frac{d[M]}{dt} = v_1 + K_{eq}[M]^2 - v_2[M]$$

Take the numerical values of the kinetic parameters to be…

$$v_1 = 2$$
$$v_2 = 1.5$$
$$K_{eq} = 0.25$$

A. Find any equilibrium values of [M].

B. Sketch $\frac{d[M]}{dt}$ as a function of [M].

$$\frac{d[M]}{dt} = v_1 + K_{eq}[M]^2 - v_2[M]$$

$$v_1 = 2$$
$$v_2 = 1.5$$
$$K_{eq} = 0.25$$

(another page if you need it)

$$\frac{d[M]}{dt} = v_1 + K_{eq}[M]^2 - v_2[M]$$

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C. Which equilibrium values for [M] are stable? Which are unstable? Explain your reasoning.

D. For what range(s) of initial conditions will the system remain bounded (i.e., not 'explode')? Explain.

Question 4

Several lectures have shown that a set of ordinary differential equations (ODEs) can be alternatively represented using a Markov matrix formulation. Do you think this applies to a set of delay differential equations (DDEs)? Why or why not?

Question 5

Explain the phenomenon of aliasing, and what implications it has for determining sampling rate in experimental designs.