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MODULE IV - BIOINFORMATICS: ASSIGNMENT 3

Please your return solution to G Bordyugov (office #1324 in the ground floor of the ITB) in hard copy until Friday May 16, 15:00.

1. Exponential decay

The isotope ^{35}S decays exponentially with a half-time of about 87 days.

- Sketch the time course of the ^{35}S decay.
- Formulate a differential equation for the concentration of ^{35}S .
- Calculate the rate constant λ of the decay.
- Provide a general formula relating the rate constant λ and the half-life time $t_{1/2}$.
- After how many months will only 0.1% of the isotope remain?

2. Integrals

Calculate the following integrals:

$$\int_0^1 x\,\mathrm{d}x, \quad \int_{-3}^3 x^3\,\mathrm{d}x, \quad \int_0^\infty \mathrm{e}^{-ax}\,\mathrm{d}x, \quad \int_0^{2\pi} \left(a\sin\phi + b\cos\phi\right)\mathrm{d}\phi, \quad \int_1^\mathrm{e} \frac{\mathrm{d}x}{x}, \quad \int_0^{2\pi} \sin^2 x\,\mathrm{d}x.$$

3. Trigonometry

Using trigonometric identities, prove the following formula:

- $$(1+\sin(\omega t))\,(1+cos(\omega t)) = 1+\sin(\omega t)+\cos(\omega t)+\frac{1}{2}\sin(2\omega t)\,.$$
- Here, additionally express A and ϕ in terms of a and b such that the following identity holds:
$$a\sin(\omega t)+b\cos(\omega t) = A\cos\left(\omega t+\phi\right).$$

4. Oscillations

The abundance $x(t)$ of protein A and abundance $y(t)$ of protein B is approximated by harmonic oscillations:

$$x(t) = 1.25\cos(\omega t),$$
$$y(t) = \cos(\omega t) + \sin(\omega t),$$

where $\omega = \frac{2\pi}{24}$ and time t is measured in hours.

1. Determine the amplitudes of both oscillations, their periods and the phase difference between them.

2. Is it protein A that peaks before protein B or vice versa?

3. Sketch graphs of $x(t)$ and $y(t)$. Pay attention to the proper amplitudes, periods and phases of the oscillations.

4. Another protein C oscillates according to

   $$z(t) = \cos(\omega t) + \cos(2\omega t).$$

   Sketch the graph of $z(t)$. What is the period of oscillations of protein C? How would you determine the peak phase of protein C?

5. Feedback and oscillations

Give three examples of feedback-induced oscillations in everyday life and explain how the delay of the feedback influences the period of the oscillations.

6. Binary classification

Please explain the following concepts in a couple of short sentences

- True positive rate and false negative rate
- Sensitivity and specificity of a binary classifier
- ROC-curve and area under curve in the context of ROC-curves