

Basics of Physics with Biophysics

1. semester 2024/25

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Course lectures and exam

- lectures and exercises – programming in Matlab
- exam consist of 10 questions; 60 minutes

60-69	6
70-79	7
80-89	8
90-95	9
96-100	10

- attendance at lectures is strongly encouraged
- Laboratory work – programming in Matlab
- homework's are mandatory (E-class)

Grading:

- 1/3 oral defense of homework's (your code)
- 2/3 written exam

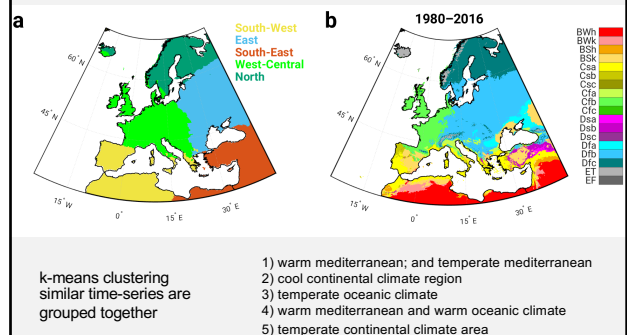
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Research work

- Air pollution – particulate matters/data analysis
- proteins (validation, modeling)
- structural bio-informatics

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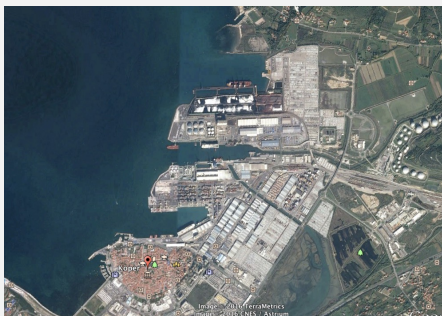
Particulate matters



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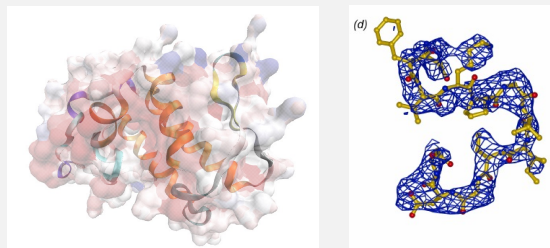
Port of Koper

Monitoring of sea water and measurements of air pollution



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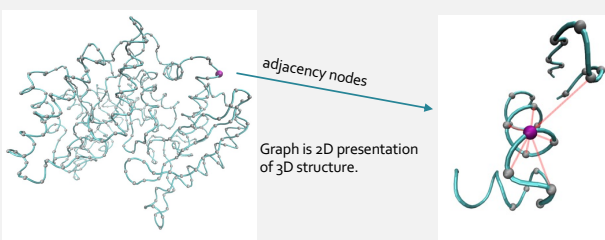
Proteins



- graph theory and protein validation
- application of graph theory for analysis of macromolecular structures

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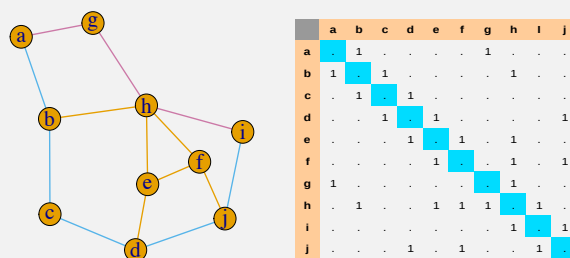
Proteins



The Ca atom of an amino acid residue is considered to be a node, and the edge is created when the distance between them is equal or below a threshold value of 7Å

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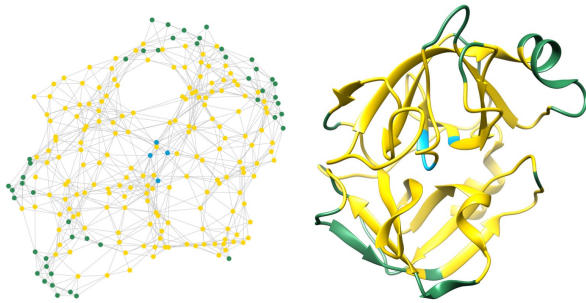
Proteins



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Proteins

Graph-like and ribbon presentation of 3D protein model

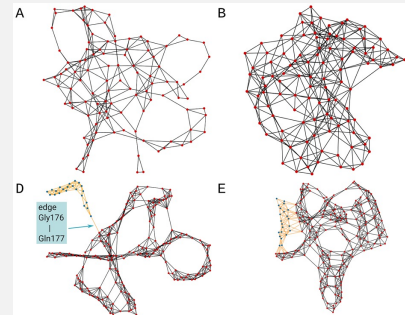


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Proteins

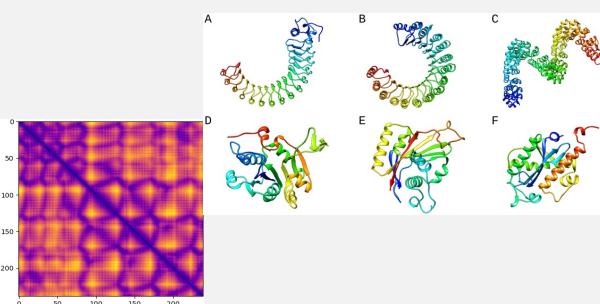
Wrong model

Correct model



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Quantitative analysis of visual codewords of a protein distance matrix.



Pražnikar J, Attygalle NT (2022) Quantitative analysis of visual codewords of a protein distance matrix. PLoS ONE 17(2): e0263566. <https://doi.org/10.1371/journal.pone.0263566>

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Graphlets

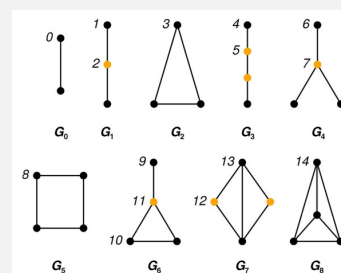
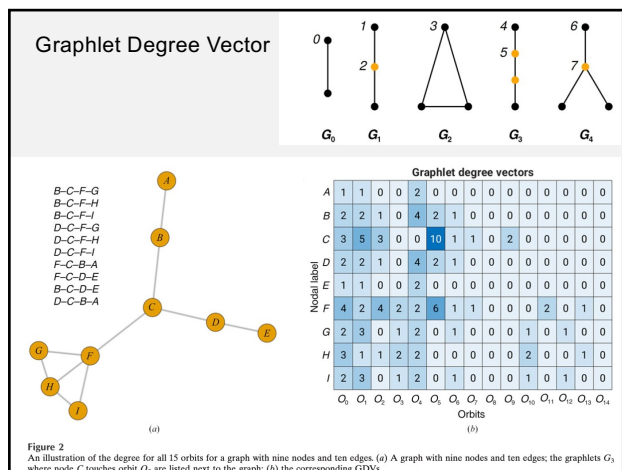
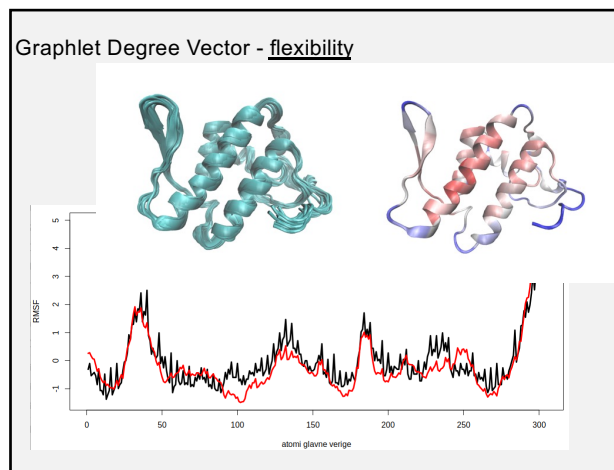


Figure 1
Graphlets of size 2 (G_0), 3 (G_1 and G_2) and 4 (G_3 – G_8). Orbits, i.e. topologically different nodes, are labeled 0, 1, 2, 3, ..., 14.

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Useful Fact: the Mass of Water

- one liter of water weights 1 kilogram
- one cubic meter equals to 1000 liters
- one cubic meter of water weights 1000 kilograms, that is about weight of a small car

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Question?

Estimate the volume of your body?

Give answer in cubic meters.

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How to Find the Radius of the Earth



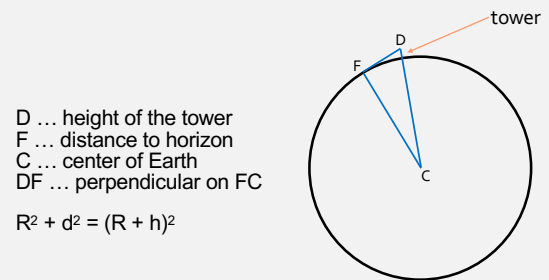
Dubai's **Burj Khalifa**
is 800 meters tall.

Distance to the horizon is 100 km.

What is the radius of the Earth?

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How to Find the Radius of the Earth



D ... height of the tower
F ... distance to horizon
C ... center of Earth
DF ... perpendicular on FC

$$R^2 + d^2 = (R + h)^2$$

$$d^2 = 2Rh + h^2, h \text{ is a lot smaller than } R \text{ therefore we can neglect } h^2$$

$$d^2 = 2Rh$$

$$R = d^2 / 2h$$

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Question?

If Dubai tower would build on the Moon,
how far would be the horizon?

Diameter of the Moon is 4 times smaller than is
Earth's diameter.

- A. 400 km
- B. 200 km
- C. 100 km
- D. 50 km
- E. 25 km

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Mountains on the Moon

How would you calculate the height of the mountains on the Moon?

$$d = \frac{1}{20} \text{ of radius}$$

$$R_{\text{Moon}} = \frac{R_E}{4}$$

$$d^2 = 2Rh$$



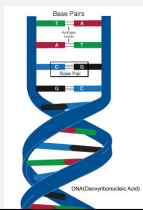
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Exercise

How big (the size) is the water molecule?

How many human DNA molecules do we need to make a DNA wire from the earth to the sun?

Estimate the distance between atoms in a salt crystal (NaCl).



adenine always pairs with thymine
guanine always pairs with cytosine