

Mathematical modelling and computer simulations in theory and practice

Documentation of laboratory task no 4

Title: SHADOW OF FIGURE

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Field of studies: Informatics (sem.V)

Project Objective:

Project objective is to visualise a shadow casted by a figure on a selected plane.

Description:

If we're given a source of light in a given point $\{x, y, z\}$ we can find 'shadow' of any other point by finding a straight line crossing both points – point at which this kind of line is crossing with a plane is 'shadow' casted on such plane.

In practice we are finding parametric equation of a line crossing two points:

$$\begin{cases} x = x_l + (x_a - x_l) t \\ y = y_l + (y_a - y_l) t \\ z = z_l + (z_a - z_l) t \end{cases} \quad t \in \mathbb{R}.$$

Figure 1: Parametric equation of the line passing through point a and l .

And then finding value 't' by giving additional constrain (known plane we're crossing). We will consider only 3 examples:

- XY plane: $z=0$
- XZ plane: $y=0$
- ZY plane: $x=0$

It's important to note that this approach works only if source of light, object and plane are correctly placed. In reality we can interpret this as possibility to cast shadow on a plane by any point on a figure.

As an input we will take position of our source of light,

Inputs of the program are very simple – user is choosing a type of approximation by pressing a correct button. After that a few input fields are displayed where user can input data necessary for given type of approximation.

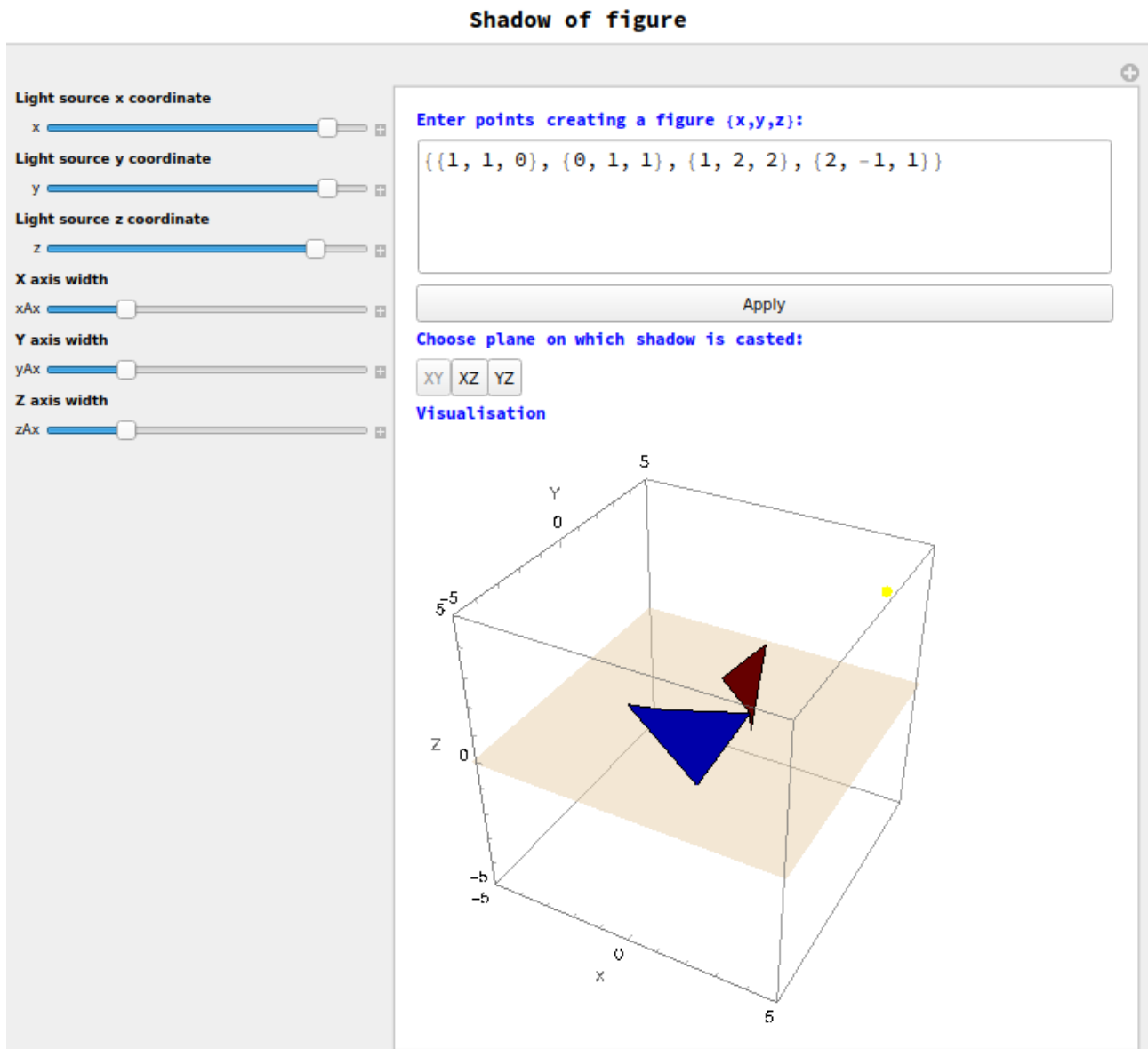


Figure 2: Complete program view.

Inputs:

1. Position (x,y,z) of the source of light
2. Position of the figure vertices defined as set of x,y,z points.
3. Plane on which shadow is casted (XY,XZ or ZY)
4. Size of displayed view (as x,y,z widths – center is always in point 0,0,0)

Light source x coordinate
x

Light source y coordinate
y

Light source z coordinate
z

X axis width
xAxis

Y axis width
yAxis

Z axis width
zAxis

Figure 3: Light position and visualisation range sliders.

Enter points creating a figure {x,y,z}:

`{{1, 1, 0}, {0, 1, 1}, {1, 2, 2}, {2, -1, 1}}`

Apply

Figure 4: Input field for defining figures.

Choose plane on which shadow is casted:

XY XZ YZ

Figure 5: Buttons used to choose plane.

Outputs:

As an output program is displaying visualisation showing figure (red), its shadow (blue), and light source (yellow).

Visualisation

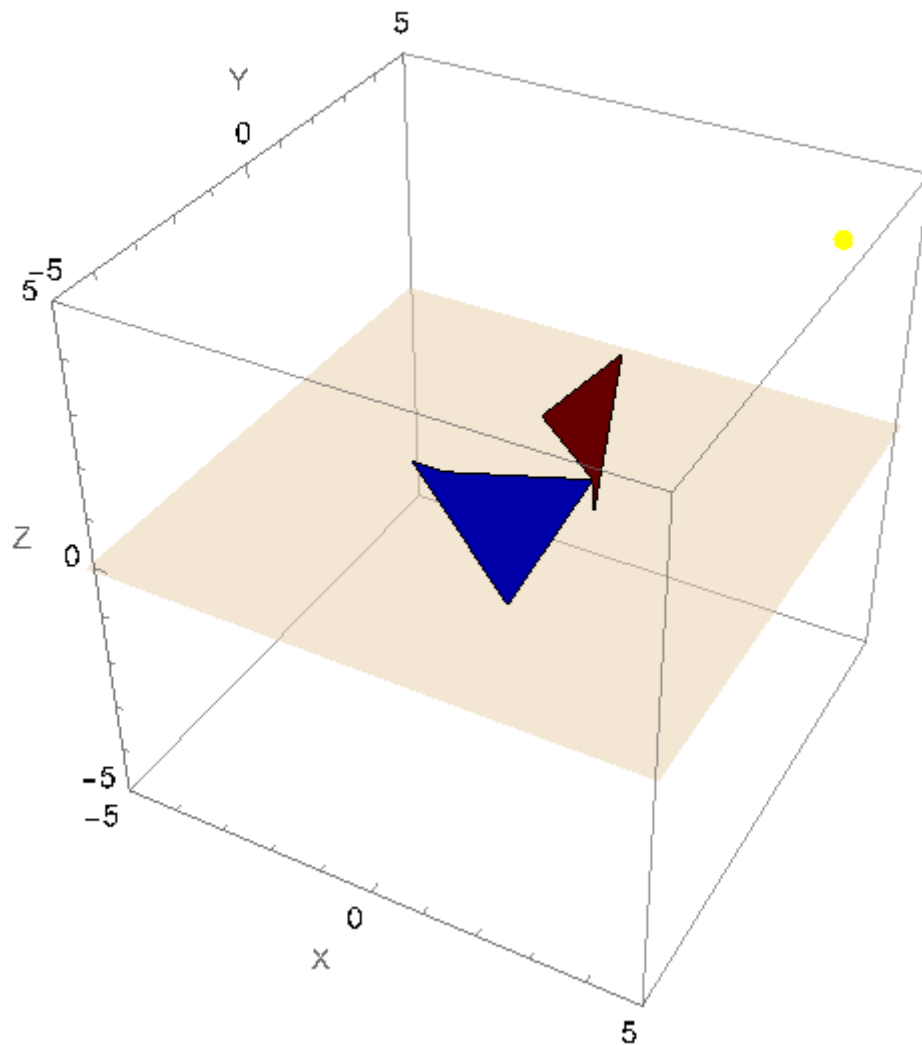


Figure 6: Visualisation outputed by program.

If, as mentioned previously, source of light and or figure are in wrong positions the warning will be displayed.

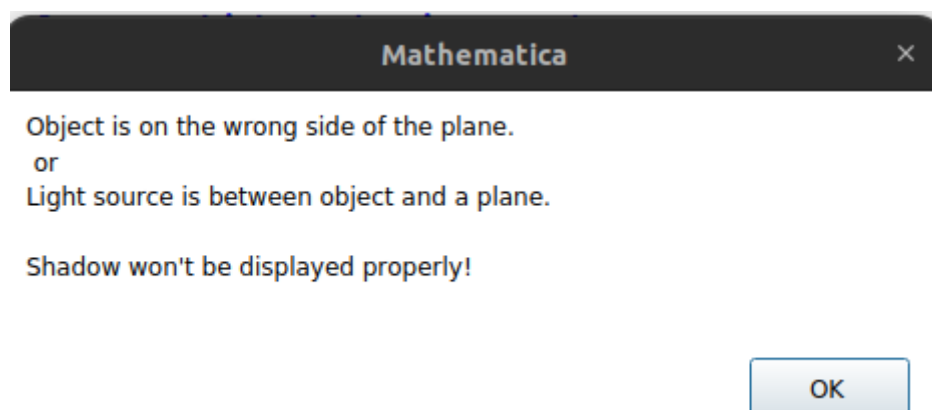


Figure 7: Warning message.

We can notice some basic optical relations. For example if we move source of light closer to the figure, than shadow will become longer (Figure 8: Source of light close to the figure.) and if we move source of light relatively far away from the figure, than the shadow will approach orthographic projection, more so if the

source of light is directly above the figure (Figure 9: Source of light far away from the figure. Closeup of the figure and shadow.).

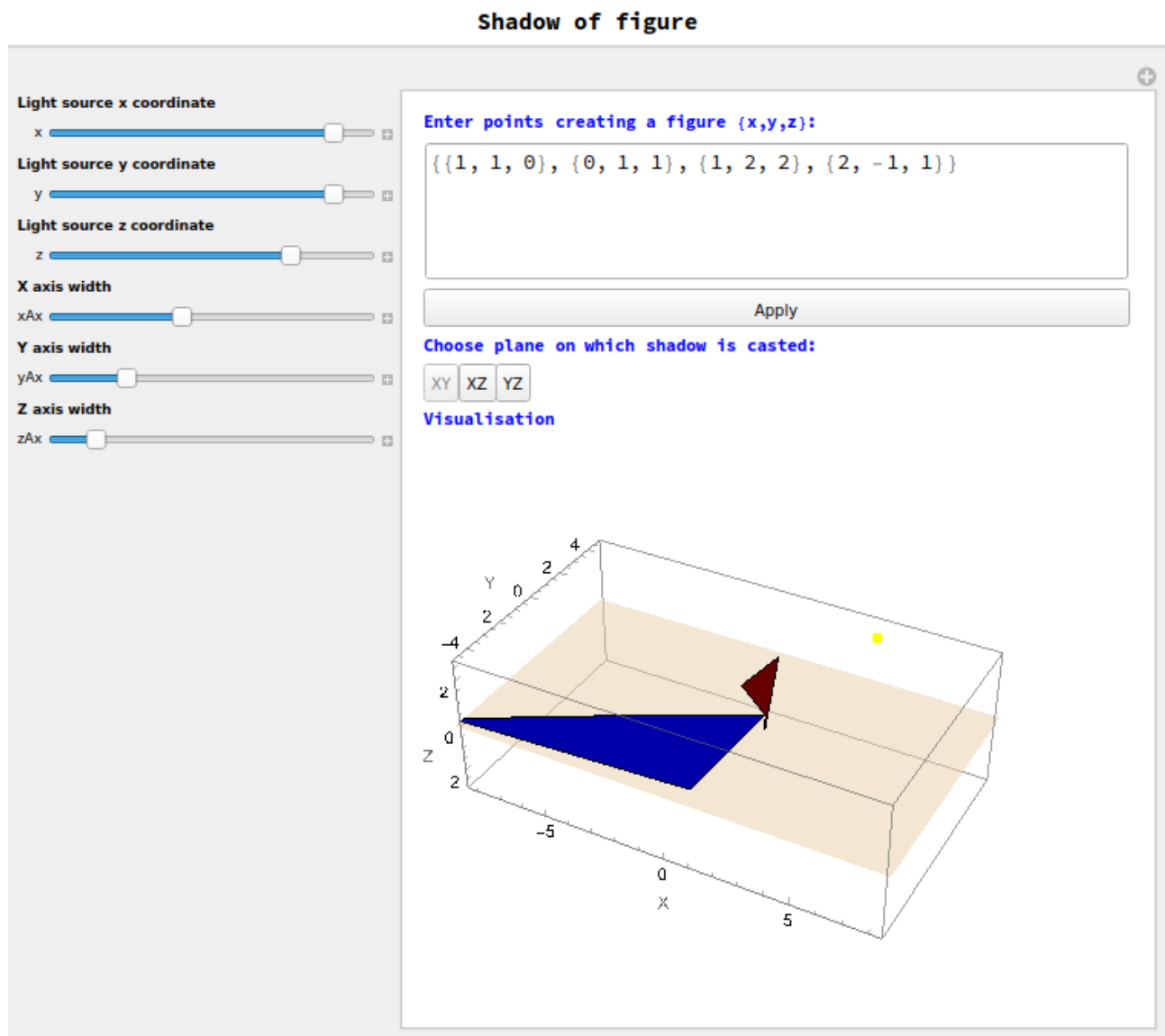


Figure 8: Source of light close to the figure.

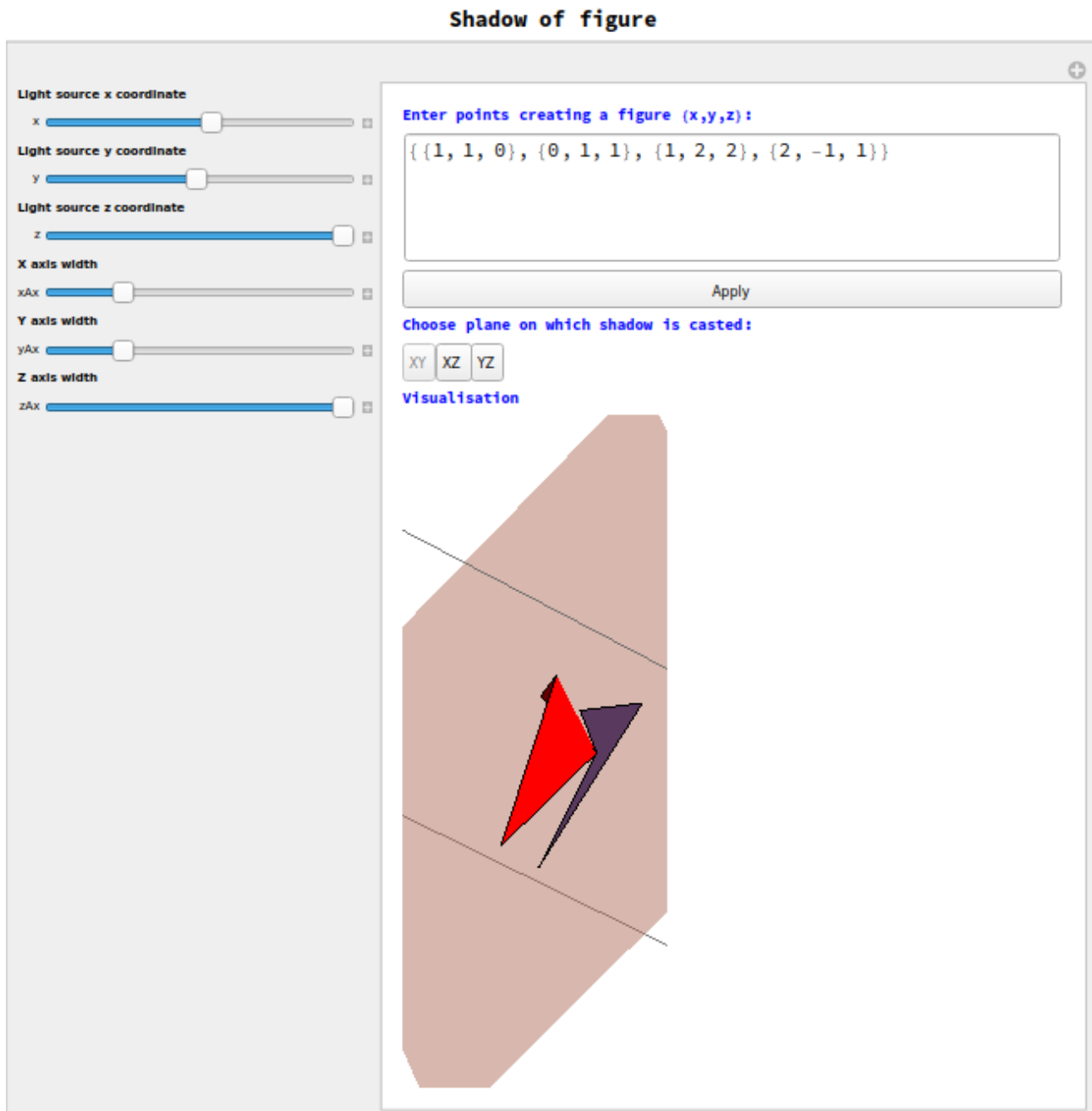


Figure 9: Source of light far away from the figure. Closeup of the figure and shadow.

Enclosures:

- ☐ File with the program (Jędrzejczyk_Radosław_proj_4)