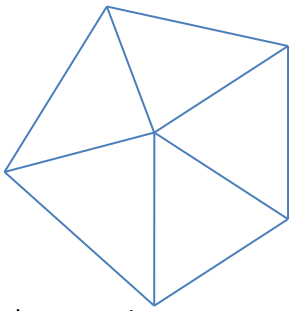
Exercise 4: Estimation of Gaussian curvature

Task: estimate per-vertex Gaussian curvature and visualize it as vertex colors.

For each vertex, it is possible to compute the sum of inner angles α surrounding it. Having the expression

$$g = 2\pi - \sum_i \alpha_i$$



One can see that its sign has a similar behavior as the Gaussian curvature of the surface at vertex *v*. In particular, for **elliptical** points (hills, walleys), *g* is positive, for **parabolic** points (flat or developable) *g* = 0, and for **hyperbolic** points (saddle points) *g* is negative.

Task (4 points)

Compute g for each vertex of the mesh, using a proper data structure from the last exercise. Transform the scalar values of *g* into colors, represented by the `ColorRGBA` structure. There are two constructors you may use:

```
new ColorRGBA(byte red, byte green, byte blue)
```

- In this case, arguments are expected in range 0-255

```
new ColorRGBA(float red, float green, float blue)
```

- In this case, arguments are expected in range 0.0-1.0

Ideally, you should use the full scale of the colors, i.e. for example map the largest negative value of *g* to full red color, zero *g* value to blue and largest positive *g* to green. Consider some mapping function

Having an array of vertex colors, assign it to the field `Colors` of the `TriangleMesh` instance. Finally, inform the rendering framework that it should use the color attribute by setting the `ShowColorAttribute` flag of the renderer instance to true.

To evaluate your results, please use 3D models located at https://home.zcu.cz/~hachaf/ZPOS/

- elliptical.obj
- hyperbolic.obj
- parabolic.obj

Optional (1 point)

Consider the difference between g and the real Gaussian curvature G. From the analysis above it seems that the sign of g matches the sign of G. Can you find an example that demonstrates that g!=G?

Hint: Consider bodies where determining G is easy.

Can you imagine how does one have to adjust g to match G better? Hint: use Gauss-Bonnet theorem.