void RectDp::Intersection_disk(DiskDp disk)

Description

The function approximates a rectangle and a circle intersection area by horizontal and vertical lines. Basing on the intersection points of these lines, we construct a rectangle with a minimum area, which contains the intersection area of the rectangle and the circle.
If there is no intersection, the function makes at least one of the rectangle parameters satisfies the condition:

$$coordinates_{i,0} \geq coordinates_{i,1}, \qquad i = 0 : p-1. \tag{1}$$

Input parameters:

- **disk** is the circle, the element of class **DiskDp**

Algorithm:

Preprocessing

- We define:
  - the parameters of the circle **disk**:

$$\begin{aligned} c &= disk.get\_center(), \\ r &= disk.get\_radius(). \end{aligned} \tag{2}$$

  - the point pnt_min is the point of the rectangle that is minimally distant from the center of the $disk$.
  - vector $dx^2(4)$ is the values of a discriminant devided by 4 of the system (3) for all $k = 0 : p-1$.

$$\begin{cases} (x_k - c_k)^2 + \sum_{i=0, i\neq k}^{p-1} (x_i - c_i)^2 = r^2, \\ x_i = pnt\_min_i, \qquad i = 0 : p-1, \;\; i \neq k. \end{cases} \tag{3}$$

$$dx_k^2 = r^2 - \sum_{i=0, i\neq k}^{p-1} (pnt\_min_i - c_i)^2, \qquad k = 0 : p-1. \tag{4}$$

- if for each $k = 0 : p-1$ dx_k^2 is positive we define the characteristics of rectangle as:

$$\begin{cases} dx_k^2 > 0, \\ x_{k0} = c_k - \sqrt{dx_k^2}, \\ x_{k1} = c_k + \sqrt{dx_k^2}. \end{cases} \tag{5}$$

$$\begin{aligned} coordinates_{k,0} &= \max\{coordinates_{k,0}, x_{k0}\}, \\ coordinates_{k,1} &= \min\{coordinates_{k,1}, x_{k1}\}. \end{aligned} \tag{6}$$

- else (isn't intersection) we define the characteristics of rectangle as:

$$coordinates_{0,0} = coordinates_{0,1}. \tag{7}$$

void RectDp::Exclusion_disk(DiskDp disk)

Description

The function approximates a rectangle and a circle difference area by horizontal and vertical lines. Basing on the intersection points of these lines, we construct a rectangle with a minimum area, which contains the difference area of the rectangle and the circle.
If the difference is the empty set, the function makes the rectangle with parameters that correspond to the condition (11).

Input parameters:

The input of this function consists:

- **disk** is the circle, the element of class **DiskDp**

Algorithm:

Preprocessing

- We define the parameters of the circle **disk**.
- We find the point *pnt_max* is the vertex of the rectangle that are maximally distant from the center of the *disk*.
- For each $k = 0 : p-1$:
  - we calculate dx_k^2 (9)(the value of a discriminant devided by 4 of the system (8)):

$$\begin{cases} (x_k - c_k)^2 + \sum_{i=0, i\neq k}^{p-1} (x_i - c_i)^2 = r^2, \\ x_i = pnt\_max_i, \quad i = 0 : p-1, \;\; i \neq k. \end{cases} \tag{8}$$

$$dx_k^2 = r^2 - \sum_{i=0, i\neq k}^{p-1} (pnt\_max_i - c_i)^2, \tag{9}$$

  - if dx_k^2 is positive we find the intersection points with $p-1$-planes:

$$\begin{cases} dx_k^2 > 0, \\ x_{k0} = c_k + \sqrt{dx_k^2}, \\ x_{k1} = c_k - \sqrt{dx_k^2}. \end{cases} \tag{10}$$

    We define the characteristics of rectangle as:
    - if $pnt\_max_k = coordinates_{k,1}$:

$$coordinates_{k,0} = \max\{coordinates_{k,0}, x_{k0}\}. \tag{11}$$

    - if $pnt\_max_k = coordinates_{k,0}$:

$$coordinates_{k,1} = \min\{coordinates_{k,1}, x_{k1}\}. \tag{12}$$

bool RectDp::IsEmpty_rect()

Description

The function checks the parameters of the rectangle. If the parameters are not correct, this rectangle is empty.

Output parameters:

The function returns a boolean value **true** if the rectangle is empty, and **false** if it is not empty.

Algorithm:

If at least one of the rectangle parameters satisfies the condition (11) this rectangle is empty and the function returns a boolean value **true**, else **false**.