1 Figure

1.1 Angle2D

1. **Definition**

Angle2D
type = Angle2D
center
start
end
height
right
key
key_object
key_label
method

2. **Method**

1 construct

CO | *center* | *start* | *end* | *height* | *right*

= [*this* ▶ *center* / *center*]

= [*this* ▶ *start* / *start*]

= [*this* ▶ *end* / *end*]

= [*this* ▶ *right* / right]

SW | *this* ▶ *right*

arc | = [*this* ▶ *height* / *height*]

right | = [*this* ▶ *height* / $\frac{1}{\sqrt{2}} \times height$]

2 angle | center angle

angle

angle_start = *this* ▶ [*center* / vector_angle(*this* ▶ *start*)]

angle_end = *this* ▶ [*center* / vector_angle(*this* ▶ *end*)]

RE | − [*angle_end* / *angle_start*]

3 height_contact | height when *object* contacts

height_contact | *object* | *type* = min

SW | *object* ▶ *type*

∨ [Label2D / Rectangle2D]

Rectangle2D = *object*

heights = ∅

FE | *Rectangle2D* ▶ *vertices* | *vertex*

heights ≜ + | − [*this* ▶ *center* / *vertex*]

SW | *type*

min | RE | min(*heights*)

max | RE | max(*heights*)

RE | max(*distances*)

4 | interval_angle | **Interval_angle** formed by two edges of *this*

interval_angle

angle_start = *this* ▶ [*center* / vector_angle(*this* ▶ *start*)]

RE | **Interval_angle** (*angle_start* / *this* ▶ angle)

5 | rotation | rotate arround *center* with *angle*

rotation | *center* | *angle*

this_rotated = *this*

this_rotated ▶ *start* = *this* ▶ [*start* / rotation (*center* / *angle*)]

this_rotated ▶ *end* = *this* ▶ [*end* / rotation (*center* / *angle*)]

RE | *this_rotated*

6 | translation | translate with *vector*

translation | *vector*

this_translated = *this*

this_translated ▶ *center* = + [*this* ▶ *center* / *vector*]

this_translated ▶ *start* = + [*this* ▶ *start* / *vector*]

this_translated ▶ *end* = + [*this* ▶ *end* / *vector*]

RE | *this_translated*

1.2 Arc2D

1. **Definition**

Arc2D

type = Arc2D

center

start

angle

measure = ∅

key

key_object

key_label

method

2. **Method**

1 | construct

CO | *center* | *start* | *angle* | *measure*

$\left[\begin{array}{l} this \blacktriangleright cetner \\ center \end{array}\right]$
$\left[\begin{array}{l} this \blacktriangleright start \\ start \end{array}\right]$
$\left[\begin{array}{l} this \blacktriangleright angle \\ angle \end{array}\right]$
$\left[\begin{array}{l} this \blacktriangleright measure \\ measure \end{array}\right]$

2 | center | center

center

RE | $this \blacktriangleright \left[\begin{array}{l} start \\ \text{rotation}\left(\begin{array}{l} this \blacktriangleright center \\ \frac{1}{2} \times this \blacktriangleright angle \end{array}\right) \end{array}\right]$

3 | end | end

end

RE | $this \blacktriangleright \left[\begin{array}{l} start \\ \text{rotation}\left(\begin{array}{l} this \blacktriangleright center \\ this \blacktriangleright angle \end{array}\right) \end{array}\right]$

4 | interval_angle | **Interval_angle** formed by start and end angles

interval_angle

RE | $\textbf{Interval\_angle}\left(\begin{array}{l} this \blacktriangleright \left[\begin{array}{l} center \\ \text{vector\_angle}(this \blacktriangleright start) \end{array}\right] \\ this \blacktriangleright angle \end{array}\right)$

5 | is_tangent | check if *object* is tangent with *this*

is_tangent	*object*

SW *object* ▶ *type*

Segment2D = *object*

$$\boxed{=}\begin{bmatrix} raduis\_this \\ this \blacktriangleright \text{radius} \end{bmatrix}$$

$$\boxed{=}\begin{bmatrix} angle\_Segment2D \\ Segment2D \blacktriangleright \text{vector\_angle} \end{bmatrix}$$

$$angle\_Segment2D\_start = this \blacktriangleright \begin{bmatrix} center \\ \text{vector\_angle}(Segment2D \blacktriangleright start) \end{bmatrix}$$

$$angle\_Segment2D\_end = this \blacktriangleright \begin{bmatrix} center \\ \text{vector\_angle}(Segment2D \blacktriangleright end) \end{bmatrix}$$

$$sign\_Segment2D = \text{sign}\left(\begin{matrix} \pi - \text{polar}\left(\boxed{-}\begin{bmatrix} angle\_Segment2D\_end \\ angle\_segment2D\_start \end{bmatrix}\right) \\ 1 \end{matrix}\right)$$

$$angle\_perpendicular = \boxed{\times}\begin{bmatrix} sign\_Segment2D \\ angle\_Segment2D \end{bmatrix} - \frac{\pi}{2}$$

$$\boxed{=}\begin{bmatrix} interval\_angle\_this \\ this \blacktriangleright \text{interval\_angle} \end{bmatrix}$$

IF $\notin \begin{bmatrix} angle\_perpendicular \\ interval\_angle\_this \end{bmatrix}$ | **RE** | **FA**

Segment2D

$$angle\_start = \min\left(\begin{matrix} \boxed{\times}\begin{bmatrix} -sign\_Segment2D \\ angle\_segment2D\_start \end{bmatrix} \\ \boxed{\times}\begin{bmatrix} sign\_Segment2D \\ angle\_Segment2D\_start \end{bmatrix} \end{matrix}\right)$$

$$angle\_end = \max\left(\begin{matrix} \boxed{\times}\begin{bmatrix} sign\_Segment2D \\ angle\_segment2D\_start \end{bmatrix} \\ \boxed{\times}\begin{bmatrix} -sign\_Segment2D \\ angle\_Segment2D\_start \end{bmatrix} \end{matrix}\right)$$

$$interval\_angle\_Segment2D = \textbf{Interval\_angle}\left(\begin{matrix} angle\_start \\ \boxed{-}\begin{bmatrix} angle\_end \\ angle\_start \end{bmatrix} \end{matrix}\right)$$

IF $\boxed{\notin} \begin{bmatrix} angle\_perpendicular \\ interval\_angle\_Segment2D \end{bmatrix}$ | **RE** | **FA**

$$angle\_start = \boxed{-}\begin{bmatrix} angle\_perpendicular \\ interval\_angle\_Segment2D \blacktriangleright start \end{bmatrix}$$

$$angle\_end = \boxed{-}\begin{bmatrix} interval\_angle\_Segment2D \blacktriangleright end \\ angle\_perendicular \end{bmatrix}$$

$$distance = \boxed{\div}\begin{bmatrix} |Segment2D| \\ \boxed{+}\begin{bmatrix} \tan(angle\_start) \\ \tan(angle\_end) \end{bmatrix} \end{bmatrix}$$

RE | $distance \equiv radius\_this$

6	radius	radius

radius

RE | $\boxed{-}\begin{bmatrix} this \blacktriangleright start \\ this \blacktriangleright center \end{bmatrix}$

7	rotation	rotate arround *center* with *angle*

rotation	*center* | *angle*
	this_rotated = *this*
	$\begin{bmatrix} center \\ \text{rotation}\left(\begin{matrix} center \\ angle \end{matrix}\right) \end{bmatrix}$
	$\begin{bmatrix} start \\ \text{rotation}\left(\begin{matrix} center \\ angle \end{matrix}\right) \end{bmatrix}$
	RE | *this_rotated*

8 | translation | translate with *vector*

translation	*vector*
	this_translated = *this*
	$\begin{bmatrix} \pm \\ = \end{bmatrix}$ $\begin{bmatrix} this\_rotated \blacktriangleright center \\ vector \end{bmatrix}$
	$\begin{bmatrix} \pm \\ = \end{bmatrix}$ $\begin{bmatrix} this\_rotated \blacktriangleright start \\ vector \end{bmatrix}$
	RE | *this_translated*

1.3 Curve2D

1. **Definition**

Curve2D	*type* = Curve2D
	equation
	bounds
	key
	key_object
	key_label
	method

2. **Method**

1 | construct |

CO	*equation* | *bounds*
	$\begin{bmatrix} = \end{bmatrix}$ $\begin{bmatrix} this \blacktriangleright equation \\ \text{javascript\_to\_php}(equation) \end{bmatrix}$
	$\begin{bmatrix} = \end{bmatrix}$ $\begin{bmatrix} this \blacktriangleright bounds \\ bounds \end{bmatrix}$

2 | centroid | centroid

centroid	
	$\begin{bmatrix} = \end{bmatrix}$ $\begin{bmatrix} region \\ this \blacktriangleright \text{region} \end{bmatrix}$
	$x = 0$
	$y = 0$
	FE | *region* | *rectalgle*
	$x \overset{\pm}{=} rectangle \blacktriangleright \begin{bmatrix} center \\ x \end{bmatrix}$
	$y \overset{\pm}{=} rectangle \blacktriangleright \begin{bmatrix} center \\ y \end{bmatrix}$
	$x \overset{\pm}{=} \lvert region \rvert$
	$y \overset{\pm}{=} \lvert region \rvert$
	RE | $\mathbf{xy}\begin{pmatrix} x \\ y \end{pmatrix}$

3 | region | region

region

$unit = 0.1$

$size = \mathbf{xy}\begin{pmatrix} unit \\ unit \end{pmatrix}$

$x\_size = \left\lceil \left[\div \right] \begin{bmatrix} \left| this \blacktriangleright \begin{bmatrix} bounds \\ x \end{bmatrix} \right| \\ unit \end{bmatrix} \right\rceil$

$y\_size = \left\lceil \left[\div \right] \begin{bmatrix} \left| this \blacktriangleright \begin{bmatrix} bounds \\ y \end{bmatrix} \right| \\ unit \end{bmatrix} \right\rceil$

$parts = \text{strok}\begin{pmatrix} this \blacktriangleright equation \\ = \end{pmatrix}$

$expression = \left[- \right] \begin{bmatrix} parts[0] \\ parts[1] \end{bmatrix}$

$region = \emptyset$

$centroid = \mathbf{xy}\begin{pmatrix} 0 \\ 0 \end{pmatrix}$

sublevel

$centroid = \left[\div \right] \begin{bmatrix} centroid \\ |region| \end{bmatrix}$

$densities = \emptyset$

$region\_sorted = \emptyset$

FO $0 \leq i < |region|$

FO $i + 1 \leq j < |region|$

$density = \left[\div \right] \begin{bmatrix} 1 \\ \left[- \right] \begin{bmatrix} region[i] \blacktriangleright center \\ region[j] \blacktriangleright center \end{bmatrix} \end{bmatrix}$

$densities[i][j] = density$

$densities[j][i] = density$

$key = \left[\times \right] \begin{bmatrix} |densities[i]| \\ \left| \left[- \right] \begin{bmatrix} centroid \\ region[i] \blacktriangleright center \end{bmatrix} \right| \end{bmatrix}$

$\left[= \right] \begin{bmatrix} region\_sorted[key] \\ region[i] \end{bmatrix}$

$region\_sorted \blacktriangleright \text{krsort}$

RE $region\_sorted$

FO $0 \leq i \leq x.size$

$xs = \emptyset$

$$xs[0] = \boxed{+} \begin{bmatrix} this \blacktriangleright \begin{bmatrix} bounds \\ x \\ min \end{bmatrix} \\ i \times unit \end{bmatrix}$$

$$xs[1] = \boxed{+} \begin{bmatrix} xs[0] \\ 1 \\ 2 \end{bmatrix} \times unit \Bigg]$$

$$xs[2] = \boxed{+} \begin{bmatrix} xs[1] \\ 1 \\ 2 \end{bmatrix} \times unit \Bigg]$$

3 1 FO $0 \leq j < y.size$

$ys = \emptyset$

$$ys[0] = \boxed{+} \begin{bmatrix} this \blacktriangleright \begin{bmatrix} bounds \\ y \\ min \end{bmatrix} \\ j \times unit \end{bmatrix}$$

$$ys[1] = \boxed{+} \begin{bmatrix} ys[0] \\ 1 \\ 2 \end{bmatrix} \times unit \Bigg]$$

$$ys[2] = \boxed{+} \begin{bmatrix} ys[1] \\ 1 \\ 2 \end{bmatrix} \times unit \Bigg]$$

$signs = \emptyset$

FE | xs | x

FE | ys | y

$$signs \stackrel{+}{=} \text{sign} \left(\text{evaluation\_xy} \left(\begin{matrix} x \\ y \\ expression \end{matrix} \right) \right)$$

IF | $|signs| \equiv 0$

$$center = \mathbf{xy} \begin{pmatrix} xs[1] \\ ys[1] \end{pmatrix}$$

$$centroid \stackrel{+}{=} center$$

$$region \stackrel{+}{=} \mathbf{Rectangle2D} \begin{pmatrix} center \\ size \end{pmatrix}$$

1.4 Face2D

1. **Definition**

Face2D
$type =$ Face2D
$vertices$
key
key_object
key_label
method

2. **Method**

1 | construct |

CO | $vertices$

$$\boxed{=} \begin{bmatrix} this \blacktriangleright vertices \\ vertices \end{bmatrix}$$

2 | centroid | centroid |

centroid | *type*

SW | *type*

polygon

$$\left[\begin{array}{l} = \\ \begin{array}{l} centroid\_vertices \\ this \blacktriangleright \text{centroid(vertices)} \end{array} \end{array}\right]$$

$$\left[\begin{array}{l} = \\ \begin{array}{l} vertices\_anticlockwise \\ \emptyset \end{array} \end{array}\right]$$

FE | $this \blacktriangleright vertices$ | $vertex$

$$\left[\begin{array}{l} = \\ \begin{array}{l} key \\ centroid\_vertices \blacktriangleright \text{vector\_angle}(vertex) \end{array} \end{array}\right]$$

$vertices\_anticlockwise[key] = vertex$

$vertices\_anticlockwise \blacktriangleright \text{ksort}$

$area = 0$

$centroid = \mathbf{xy}\begin{pmatrix} 0 \\ 0 \end{pmatrix}$

FO | $0 \leq i < |vertices\_anticlockwise|$

$$matrix = \begin{bmatrix} vertices\_anticlockwise[i] \blacktriangleright x & vertices\_anticlockwise[i] \blacktriangleright y \\ vertices\_anticlockwise[i+1] \blacktriangleright x & vertices\_anticlockwise[i+1] \blacktriangleright y \end{bmatrix}$$

$$\left[\begin{array}{l} = \\ \begin{array}{l} area\_i \\ matrix \blacktriangleright \text{determinant} \end{array} \end{array}\right]$$

$area \mathrel{+}= area\_i$

$$centroid \stackrel{+}{=} \left[\begin{array}{l} \times \\ \begin{array}{ll} area\_i & \\ \left[\begin{array}{l} + \\ \begin{array}{l} vertices\_anticlockwise[i] \\ vertices\_anticlockwise[i+1] \end{array} \end{array}\right] & \end{array} \end{array}\right]$$

$$centroid = \left[\begin{array}{l} \div \\ \begin{array}{l} centroid \\ 3 \times area \end{array} \end{array}\right]$$

RE | centroid

vertices

$centroid\_vertices = \mathbf{xy}\begin{pmatrix} 0 \\ 0 \end{pmatrix}$

FE | $this \blacktriangleright vertices$ | $vertex$

$centroid\_vertices \stackrel{+}{=} vertex$

RE | $$\left[\begin{array}{l} \div \\ \begin{array}{l} centroid\_vertices \\ |this \blacktriangleright vertices| \end{array} \end{array}\right]$$

3 | edges | edges

edges

$edges = \emptyset$

FE | $this \blacktriangleright vertices$ | key | vertex

$edges \stackrel{+}{=} \mathbf{Segment2D}\begin{pmatrix} this \blacktriangleright vertices[key] \\ this \blacktriangleright vertices[key+1] \end{pmatrix}$

RE | $edges$

4 | rotation | rotate arround *center* with *angle*

rotation | $center$ | $angle$

$this\_rotated = this$

$$\left[\begin{array}{l} = \\ \begin{array}{l} this\_rotated \blacktriangleright vertices \\ \emptyset \end{array} \end{array}\right]$$

FE | $this \blacktriangleright vertices$ | $vertex$

$this\_rotated \stackrel{+}{=} vertex \blacktriangleright \text{rotation}\begin{pmatrix} center \\ angle \end{pmatrix}$

RE | $this\_rotated$

5 | translation | translate with *vector*

translation | *vector*

this_translated = *this*

= [*this_translated* ▶ *vertices* / ∅]

FE | *this* ▶ *vertices* | *vertex*

this_translated ▶ *vertices* ≜ + [*vertex* / *vector*]

RE | *this_translated*

1.5 Label2D

1. **Definition**

Label2D ◀ Rectangle2D	*type* = Label2D
	type_labeled
	center
	size
	rotation
	target
	key
	key_object
	key_labeled
	key_labeled_object
	method

2. **Method**

1 | center | center

center | *inputs*

object = *inputs*[0]

SW | *object* ▶ *type*

Angle2D	sublevel
Arc2D	sublevel
Curve2D	sublevel
Face2D	sublevel
Measure2D	sublevel
MeasureArc2D	sublevel
Point2D	sublevel
Segment2D	sublevel

1.1 Angle2D

Angle2D = *object*

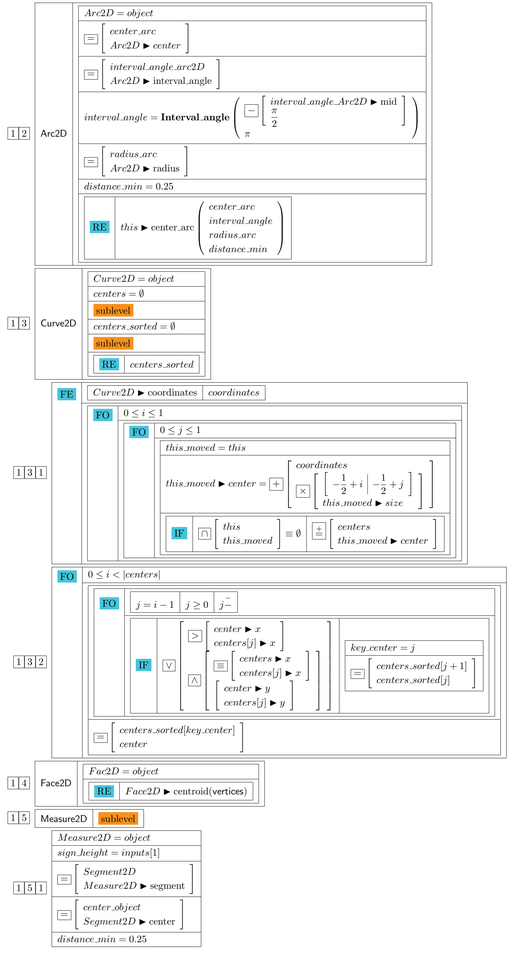
center_arc = *inputs*[1]

IF | *interval_angle* ≡ ∅ | = [*interval_angle* / *Angle2D* ▶ interval_angle]

distance_min = 0.25

= [*radius_arc* / *Angle2D* ▶ *height*]

RE | *this* ▶ center_arc (*center_arc* / *interval_angle* / *radius_arc* / *distance_min*)


1 2
Arc2D
Arc2D = object
center_arc
Arc2D ► center
interval_angle_arc2D
Arc2D ► interval_angle
interval_angle = Interval_angle
interval_angle_Arc2D ► mid
radius_arc
Arc2D ► radius
distance_min = 0.25
RE
this ► center_arc
center_arc
interval_angle
radius_arc
distance_min
1 3
Curve2D
Curve2D = object
centers = ∅
sublevel
centers_sorted = ∅
sublevel
RE
centers_sorted
1 3 1
FE
Curve2D ► coordinates
coordinates
FO
0 ≤ i ≤ 1
FO
0 ≤ j ≤ 1
this_moved = this
this_moved ► center =
coordinates
this_moved ► size
IF
this
this_moved
≡ ∅
centers
this_moved ► center
1 3 2
FO
0 ≤ i < |centers|
FO
j = i − 1
j ≥ 0
IF
center ► x
centers[j] ► x
center ► y
centers[j] ► y
key_center = j
centers_sorted[j + 1]
centers_sorted[j]
centers_sorted[key_center]
center
1 4
Face2D
Face2D = object
RE
Face2D ► centroid(vertices)
1 5
Measure2D
sublevel
Measure2D = object
sign_height = inputs[1]
1 5 1
Segment2D
Measure2D ► segment
center_object
Segment2D ► center
distance_min = 0.25

$$
\begin{array}{|l|}
\hline
angle\_Segment2D = \boxed{-}\left[\begin{array}{l} Segment2D \blacktriangleright \text{vector\_angle} \\ this \blacktriangleright rotation \end{array}\right] \\
\hline
\begin{array}{|l|l|l|}
\hline
\textbf{IF} & sign\_height \equiv 0 & sign\_height = \boxed{-}\left[\begin{array}{l} \lceil 1 + \text{sign}(Measure2D \blacktriangleright height) \rceil \\ 1 \end{array}\right] \\
\hline
\end{array} \\
\hline
angle\_rotation = \boxed{+}\left[\begin{array}{l} angle\_Segment2D \\ \pi \times sign\_height \end{array}\right] \\
\hline
\boxed{1}\boxed{5}\boxed{2} \quad angle\_label = \boxed{+}\left[\begin{array}{l} this \blacktriangleright rotation \\ angle\_rotation \end{array}\right] \\
\hline
angles\_label = \textbf{index}(\text{direction}) \\
\hline
angles\_label \blacktriangleright right = \text{mod}\left(\begin{array}{l} angle\_lagel \\ \frac{\pi}{2} \end{array}\right) \\
\hline
\boxed{=}\left[\begin{array}{l} angles\_label \blacktriangleright left \\ \frac{\pi}{2} - angles\_label \blacktriangleright right \end{array}\right] \\
\hline
\end{array}
$$

$$
\begin{array}{|l|}
\hline
parity = \text{mod}\left(\begin{array}{l} \left\lfloor \frac{\pi}{2} \times angle\_label \right\rfloor \\ 2 \end{array}\right) \\
\hline
lengths\_label = \textbf{index}(\text{direction}) \\
\hline
lengths\_label \blacktriangleright left = \boxed{\times}\left[\begin{array}{l} \left[\begin{array}{c|c} parity & 1 - parity \end{array}\right] \\ this \blacktriangleright size \end{array}\right] \\
\hline
lengths\_label \blacktriangleright right = \boxed{\times}\left[\begin{array}{l} \left[\begin{array}{c|c} 1 - parity & parity \end{array}\right] \\ this \blacktriangleright size \end{array}\right] \\
\hline
widths\_label = \textbf{index}(\text{direction}) \\
\hline
widths\_label \blacktriangleright left = \boxed{\times}\left[\begin{array}{l} lengths\_label \blacktriangleright left \\ \cos(angles\_label \blacktriangleright left) \end{array}\right] \\
\hline
widths\_label \blacktriangleright right = \boxed{\times}\left[\begin{array}{l} lengths\_label \blacktriangleright right \\ \cos(angles\_label \blacktriangleright right) \end{array}\right] \\
\hline
heights\_label = \textbf{index}(\text{direction}) \\
\hline
\boxed{1}\boxed{5}\boxed{3} \quad heights\_label \blacktriangleright left = \boxed{\times}\left[\begin{array}{l} lengths\_label \blacktriangleright left \\ \sin(angles\_label \blacktriangleright left) \end{array}\right] \\
\hline
heights\_label \blacktriangleright right = \boxed{\times}\left[\begin{array}{l} lengths\_label \blacktriangleright right \\ \sin(angles\_label \blacktriangleright right) \end{array}\right] \\
\hline
angle = \min\left(\begin{array}{l} angles\_label \blacktriangleright left \\ angles\_label \blacktriangleright right \end{array}\right) \\
\hline
sign = \text{sign}\left(\begin{array}{l} \boxed{-}\left[\begin{array}{l} angles\_label \blacktriangleright left \\ angles\_label \blacktriangleright right \end{array}\right] \\ 1 \end{array}\right) \\
\hline
length = \boxed{+}\left[\begin{array}{l} \boxed{\times}\left[\begin{array}{l} \max\left(\begin{array}{l} sign \\ 0 \end{array}\right) \\ lengths\_label \blacktriangleright left \end{array}\right] \\ \boxed{\times}\left[\begin{array}{l} \min\left(\begin{array}{l} sign \\ 0 \end{array}\right) \\ lengths\_label \blacktriangleright right \end{array}\right] \end{array}\right] \\
\hline
\end{array}
$$

$$x\_label\_min = \left[\begin{array}{l} \frac{1}{2} \times length \\ \cos\left(angle + \frac{\pi}{4}\right) \end{array}\right]$$

$$a = \left[\begin{array}{l} \frac{1}{2} \times |Segment2D| \\ distance\_min \end{array}\right]$$

$$\left[\begin{array}{l} b \\ \frac{1}{2} \times Measure2D \blacktriangleright height \end{array}\right]$$

$$\left[\begin{array}{l} y\_label\_min \\ -\frac{b}{a^2} \times (x\_label\_min)^2 + b \end{array}\right]$$

$$length\_diagonal\_half = \frac{1}{2} \times \sqrt{\left[\begin{array}{l} (lengths\_label \blacktriangleright left)^2 \\ (lengths\_label \blacktriangleright right)^2 \end{array}\right]}$$

1 5 4

$$angle\_diagonal = \text{vector\_angle}\left(\begin{array}{l} lengths\_label \blacktriangleright right \\ lengths\_label \blacktriangleright left \end{array}\right)$$

$$label\_min = \mathbf{xy}\left(\begin{array}{l} x\_label\_min \\ y\_label\_min \end{array}\right)$$

$$translation = \mathbf{xy}\left(\begin{array}{l} length\_diagonal\_half \\ \left[\begin{array}{l} angles\_label \blacktriangleright right \\ angle\_diagonal \end{array}\right] \\ \text{polar} \end{array}\right)$$

$$translation\_center = \left[\begin{array}{l} label\_min \\ translation \end{array}\right] \blacktriangleright \text{rotation}\left(\begin{array}{l} center\_rotation \\ -angle\_rotation \end{array}\right)$$

RE

$$\left[\begin{array}{l} this \blacktriangleright center \\ translation\_center \\ center\_object \end{array}\right]$$

1 6 MeasureArc2D

$$MeasureArc2D = object$$

$$\left[\begin{array}{l} Arc2D \\ MeasureArc2D \blacktriangleright \text{arc} \end{array}\right]$$

$$\left[\begin{array}{l} center\_arc \\ Arc2D \blacktriangleright center \end{array}\right]$$

$$\left[\begin{array}{l} radius\_arc \\ Arc2D \blacktriangleright \text{radius} \end{array}\right]$$

$$distance\_min = 0.25$$

$$angle\_mid = Arc2D \blacktriangleright \left[\begin{array}{l} center \\ \text{vector\_angle}(center\_arc) \end{array}\right]$$

$$interval\_angle = \mathbf{Interval\_angle}\left(\begin{array}{l} angle\_mid - \frac{\pi}{2} \\ \pi \end{array}\right)$$

RE $this \blacktriangleright \text{center\_arc}\left(\begin{array}{l} center\_arc \\ interval\_angle \\ radius\_arc \\ distance\_min \end{array}\right)$

1 7 Point2D

$$Point2D = object$$

$$center\_arc = Poin2D$$

$$interval\_angle = inputs[1]$$

$$radius\_arc = 0$$

$$distance\_min = inputs[2]$$

IF $distance\_min \equiv \emptyset$ | $distance\_min = 0.35$

RE $this \blacktriangleright \text{center\_arc}\left(\begin{array}{l} center\_arc \\ interval\_angle \\ radius\_rac \\ distance\_min \end{array}\right)$

18	Segment2D	$Segment2D = object$ $distance\_min = 0.35$ $center = \mathbf{xy}\begin{pmatrix}0\\0\end{pmatrix}$ $Segment2D\_rotated = Segment2D \blacktriangleright \text{rotation}\begin{pmatrix}center\\this \blacktriangleright rotation\end{pmatrix}$ $angle\_this\_rotated = \text{mod}\begin{pmatrix}Segment2D\_rotated \blacktriangleright \text{vetor\_angle}\\\pi\end{pmatrix}$ $\boxed{=}\begin{bmatrix}center\_Segment2D\_rotated\\Segment2D\_rotated \blacktriangleright \text{center}\end{bmatrix}$ $vector\_Segment2D\_rotated\_half = \mathbf{xy}\begin{pmatrix}\frac{1}{2}\times\lvert Segment2D\_rotated\rvert\\angle\_Segment2D\_rotated\\\text{polar}\end{pmatrix}$ $start\_Segment2D\_rotated = \boxed{+}\begin{bmatrix}center\_Segment2D\_rotated\\vector\_Segment2D\_rotated\_half\end{bmatrix}$ $angles = \mathbf{index}(\text{polar})$ $angles \blacktriangleright right = \text{mod}\begin{pmatrix}angle\_this\_rotated\\\frac{\pi}{2}\end{pmatrix}$ $\boxed{=}\begin{bmatrix}angles \blacktriangleright left\\\frac{\pi}{2} - angles \blacktriangleright right\end{bmatrix}$ $lengths = \mathbf{index}(\text{direction})$ $lengths \blacktriangleright left = \boxed{\times}\begin{bmatrix}\cos(angles \blacktriangleright right) \mid \cos(angles \blacktriangleright left)\\this \blacktriangleright size\end{bmatrix}$ $lengths \blacktriangleright right = \boxed{\times}\begin{bmatrix}\cos(angles \blacktriangleright left) \mid \cos(angles \blacktriangleright right)\\this \blacktriangleright size\end{bmatrix}$ $radius = \sqrt{\begin{bmatrix}\boxed{-}\begin{bmatrix}\left(\boxed{+}\begin{bmatrix}\frac{1}{2}\times lengths \blacktriangleright left\\distance\_min\end{bmatrix}\right)^2\\\left(\boxed{+}\begin{bmatrix}\frac{1}{2}\times lengths \blacktriangleright right\\distance\_min\end{bmatrix}\right)^2\end{bmatrix}}$ $sign\_angle = \text{sign}\begin{pmatrix}\cos(angle\_this)\\1\end{pmatrix}$ $angle\_diagonal = \text{vector\_angle}\left(\begin{bmatrix}\boxed{+}\begin{bmatrix}\frac{1}{2}\times lengths \blacktriangleright left\\distance\_min\end{bmatrix}\\\boxed{+}\begin{bmatrix}\frac{1}{2}\times lengths \blacktriangleright right\\distance\_min\end{bmatrix}\end{bmatrix}\right)$ $angle = sign\_angle \times \left(\boxed{+}\begin{bmatrix}-angle\_Segment2D\_rotated\\-angle\_diagonal\end{bmatrix}\right)$ $vector\_addition = \mathbf{xy}\begin{pmatrix}radius\\angle\\\text{polar}\end{pmatrix}$ RE $\boxed{+}\begin{bmatrix}start\_Segment2D\_rotated\\vector\_addition\end{bmatrix}$

2 | center_arc | center of label whose object is **Arc2D** or **Angle2D**

center_arc

center_arc	*interval_angle*	*radius_arc*	*distance_min*

sublevel

sublevel

sublevel

sublevel

sublevel

RE

$$+\begin{bmatrix} label\_min \\ translation\_center \\ center\_arc \end{bmatrix}$$

$$distance\_min\_center = +\begin{bmatrix} distance\_min \\ radius\_arc \end{bmatrix}$$

$$=\begin{bmatrix} angle\_rotation \\ \frac{\pi}{2} - interval\_angle \blacktriangleright \text{mid} \end{bmatrix}$$

2 1

$$angle\_arc = \max\left(\begin{matrix} 0 \\ \text{polar}\left(\begin{matrix} +\begin{bmatrix} interval\_angle \blacktriangleright start \\ angle\_rotation \end{bmatrix} \\ -\pi \end{matrix}\right) \end{matrix}\right)$$

$$angle\_label = +\begin{bmatrix} this \blacktriangleright rotation \\ angle\_rotation \end{bmatrix}$$

$$angles\_label \blacktriangleright right = \text{mod}\left(\begin{matrix} angle\_label \\ \frac{\pi}{2} \end{matrix}\right)$$

$$=\begin{bmatrix} angles\_label \blacktriangleright left \\ \frac{\pi}{2} - angles\_label \blacktriangleright right \end{bmatrix}$$

$$parity\_label = \operatorname{mod}\left(\left\lfloor \frac{2}{\pi} \times angle\_label \right\rfloor, 2\right)$$

$lengths\_label = \textbf{index}(\text{direction})$

$$lengths\_label \blacktriangleright left = \boxed{+}\begin{bmatrix} \boxed{\times}\begin{bmatrix} 1 - parity\_label \\ this \blacktriangleright \begin{bmatrix} size \\ x \end{bmatrix} \end{bmatrix} \\ \boxed{\times}\begin{bmatrix} parity\_label \\ this \blacktriangleright \begin{bmatrix} size \\ y \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

$$lengths\_label \blacktriangleright right = \boxed{+}\begin{bmatrix} \boxed{\times}\begin{bmatrix} parity\_label \\ this \blacktriangleright \begin{bmatrix} size \\ x \end{bmatrix} \end{bmatrix} \\ \boxed{\times}\begin{bmatrix} 1 - parity\_label \\ this \blacktriangleright \begin{bmatrix} size \\ y \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

$widths\_label = \textbf{index}(\text{direction})$

$$widths\_label \blacktriangleright left = \boxed{\times}\begin{bmatrix} lengths\_label \blacktriangleright left \\ \cos(angles\_label \blacktriangleright left) \end{bmatrix}$$

$$widths\_label \blacktriangleright right = \boxed{\times}\begin{bmatrix} lengths\_label \blacktriangleright right \\ \cos(angles\_label \blacktriangleright right) \end{bmatrix}$$

$heights\_label = \textbf{index}(\text{direction})$

$$heights\_label \blacktriangleright left = \boxed{\times}\begin{bmatrix} lengths\_label \blacktriangleright left \\ \sin(angles\_label \blacktriangleright left) \end{bmatrix}$$

$$heights\_label \blacktriangleright left = \boxed{\times}\begin{bmatrix} lengths\_label \blacktriangleright right \\ \sin(angles\_label \blacktriangleright right) \end{bmatrix}$$

$widths\_label\_min = \textbf{index}(\text{direction})$

$$angle\_label\_min = \max\begin{pmatrix} angle\_arc \\ angles\_label \blacktriangleright left \\ angles\_label \blacktriangleright right \end{pmatrix}$$

$$widths\_label\_min \blacktriangleright left = \boxed{-}\begin{bmatrix} widths\_label \blacktriangleright left \\ \boxed{\div}\begin{bmatrix} heights\_label \blacktriangleright left \\ \sin(angle\_label\_min) \end{bmatrix} \end{bmatrix}$$

$$widths\_label\_min \blacktriangleright right = \boxed{-}\begin{bmatrix} widths\_label \blacktriangleright right \\ \boxed{\div}\begin{bmatrix} heights\_label \blacktriangleright right \\ \sin(angle\_label\_min) \end{bmatrix} \end{bmatrix}$$

$$x\_label\_min = \boxed{-} \begin{bmatrix} widths\_label\_min \blacktriangleright left \\ widths\_label\_min \blacktriangleright right \end{bmatrix} \times \frac{1}{2}$$

$$y\_label\_min\_fit = \boxed{+} \begin{bmatrix} \boxed{\times} \begin{bmatrix} |x\_label\_min| \\ \tan(angle\_arc) \end{bmatrix} \\ distance\_min \end{bmatrix}$$

$$xs\_label = \textbf{index}(\text{direction})$$

$$xs\_label \blacktriangleright left = \boxed{-} \begin{bmatrix} x\_label\_min \\ widths\_label \blacktriangleright left \end{bmatrix}$$

$$xs\_label \blacktriangleright right = \boxed{+} \begin{bmatrix} x\_label\_min \\ widths\_label \blacktriangleright right \end{bmatrix}$$

$$y\_label\_contact\_min = \sqrt{\max \left(\begin{matrix} 0 \\ \boxed{-} \begin{bmatrix} (distance\_min\_center)^2 \\ (x\_label\_min)^2 \end{bmatrix} \end{matrix} \right)}$$

$$ys\_label\_contact = \textbf{index}(\text{direction})$$

$$ys\_label\_contact \blacktriangleright left = \sqrt{\max \left(\begin{matrix} 0 \\ \boxed{-} \begin{bmatrix} (distance\_min\_center)^2 \\ (x\_label \blacktriangleright left)^2 \end{bmatrix} \end{matrix} \right)}$$

$$ys\_label\_contact \blacktriangleright left = \sqrt{\max \left(\begin{matrix} 0 \\ \boxed{-} \begin{bmatrix} (distance\_min\_center)^2 \\ (x\_label \blacktriangleright right)^2 \end{bmatrix} \end{matrix} \right)}$$

$$y\_label\_min\_contact = \max \left(\begin{matrix} y\_label\_contact\_min \\ \boxed{-} \begin{bmatrix} ys\_label\_contact \blacktriangleright left \\ heights\_label \blacktriangleright left \end{bmatrix} \\ \boxed{-} \begin{bmatrix} ys\_label\_contact \blacktriangleright right \\ heights\_label \blacktriangleright right \end{bmatrix} \end{matrix} \right)$$

$$interval\_x\_min\_contact = \textbf{Interval} \left(\begin{matrix} \boxed{\times} \begin{bmatrix} -distance\_min\_center \\ \cos(angles\_label \blacktriangleright left) \end{bmatrix} \\ \boxed{\times} \begin{bmatrix} distance\_min\_center \\ \cos(angles\_label \blacktriangleright right) \end{bmatrix} \end{matrix} \right)$$

$$\boxed{=} \begin{bmatrix} intervals\_x\_min\_tangent \\ \textbf{index}(\text{direction}) \end{bmatrix}$$

$$intervals\_x\_min\_tangent \blacktriangleright left = \textbf{Interval} \left(\begin{matrix} \boxed{-} \begin{bmatrix} interval\_x\_min\_contact \blacktriangleright min \\ widths\_label \blacktriangleright left \end{bmatrix} \\ interval\_x\_min\_contact \blacktriangleright min \end{matrix} \right)$$

$$intervals\_x\_min\_tangent \blacktriangleright right = \textbf{Interval} \left(\begin{matrix} interval\_x\_min \blacktriangleright max \\ \boxed{+} \begin{bmatrix} interval\_x\_min\_contact \blacktriangleright max \\ widths\_label \blacktriangleright right \end{bmatrix} \end{matrix} \right)$$

$$indicators\_tangent = \textbf{index}(\text{direction})$$

$$indicators\_tangent \blacktriangleright left = intervals\_x\_min\_tangent \blacktriangleright \begin{bmatrix} left \\ \text{indicator}(x\_label\_min) \end{bmatrix}$$

$$indicators\_tangent \blacktriangleright right = intervals\_x\_min\_tangent \blacktriangleright \begin{bmatrix} right \\ \text{indicator}(x\_label\_min) \end{bmatrix}$$

$ys\_tangent = \textbf{index}(\text{direction})$
$ys\_tangent \blacktriangleright left = \boxed{\times} \begin{bmatrix} distance\_min\_center \\ \sin(angles\_label \blacktriangleright left) \end{bmatrix}$
$ys\_tangent \blacktriangleright right = \boxed{\times} \begin{bmatrix} distance\_min\_center \\ \sin(angles\_label \blacktriangleright right) \end{bmatrix}$
$y\_label\_min\_tangent = \begin{bmatrix} \boxed{\times} \begin{bmatrix} indicators\_tangent \blacktriangleright left \\ ys\_tangent \blacktriangleright left \end{bmatrix} \\ \boxed{\times} \begin{bmatrix} indicators\_tangent \blacktriangleright right \\ ys\_tangent \blacktriangleright right \end{bmatrix} \end{bmatrix}$
$y\_label\_min = \max \begin{pmatrix} y\_label\_min\_fit \\ y\_label\_min\_contact \\ y\_label\_min\_tangent \end{pmatrix}$
$\boxed{2}\boxed{5}$ $length\_diagonal\_half = \frac{1}{2} \times \sqrt{\boxed{-} \begin{bmatrix} (legnths\_label \blacktriangleright left)^2 \\ (lengths\_label \blacktriangleright right)^2 \end{bmatrix}}$
$angle\_diagonal = \text{vector\_angle} \begin{pmatrix} lengths\_label \blacktriangleright right \\ lengths\_label \blacktriangleright left \end{pmatrix}$
$label\_min = \textbf{xy} \begin{pmatrix} x\_label\_min \\ y\_label\_min \end{pmatrix}$
$translation = \textbf{xy} \begin{pmatrix} length\_diagonal\_half \\ \boxed{+} \begin{bmatrix} angles\_label \blacktriangleright right \\ angle\_diagonal \end{bmatrix} \\ \text{polar} \end{pmatrix}$
$center\_rotation = \textbf{xy} \begin{pmatrix} 0 \\ 0 \end{pmatrix}$
$translation\_center = \boxed{+} \begin{bmatrix} label\_min \\ translation \end{bmatrix} \blacktriangleright \text{rotation} \begin{pmatrix} center\_rotation \\ -angle\_rotation \end{pmatrix}$

1.6 Line2D

1. **Definition**

Line2D	
	$type = \text{Line2D}$
	a
	b
	c
	method

2. **Method**

$\boxed{1}$ construct

CO	a	b	c
	$\boxed{=} \begin{bmatrix} this \blacktriangleright a \\ a \end{bmatrix}$		
	$\boxed{=} \begin{bmatrix} this \blacktriangleright b \\ b \end{bmatrix}$		
	$\boxed{=} \begin{bmatrix} this \blacktriangleright c \\ c \end{bmatrix}$		

$\boxed{2}$	coordinate	coordinate when other *axis value* is given

coordinate	*value* | *axis* = x
	SW *axis*
	x: **IF** $\neq \begin{bmatrix} this \blacktriangleright b \\ 0 \end{bmatrix}$ **RE** $\div \begin{bmatrix} + \begin{bmatrix} \times \begin{bmatrix} -this \blacktriangleright a \\ value \end{bmatrix} \\ -this \blacktriangleright c \end{bmatrix} \\ this \blacktriangleright b \end{bmatrix}$
	x: **RE** | **IN**
	y: **IF** $\neq \begin{bmatrix} this \blacktriangleright a \\ 0 \end{bmatrix}$ **RE** $\div \begin{bmatrix} + \begin{bmatrix} \times \begin{bmatrix} -this \blacktriangleright b \\ value \end{bmatrix} \\ -this \blacktriangleright c \end{bmatrix} \\ this \blacktriangleright a \end{bmatrix}$
	y: **RE** | **IN**

3	evaluation	evalute with given *coordinates*

evaluation	*coordinates*
	RE $+ \begin{bmatrix} \times \begin{bmatrix} this \blacktriangleright a \\ coordinates \blacktriangleright x \end{bmatrix} \\ \times \begin{bmatrix} this \blacktriangleright b \\ coordinates \blacktriangleright y \end{bmatrix} \\ this \blacktriangleright c \end{bmatrix}$

1.7 Measure2D

1. **Definition**

Measure2D	*type* = Measure2D
	start
	end
	height
	key_object
	key_label
	method

2. **Method**

1	construct	

CO	*start* | *end* | *height*
	$= \begin{bmatrix} this \blacktriangleright start \\ start \end{bmatrix}$
	$= \begin{bmatrix} this \blacktriangleright end \\ end \end{bmatrix}$
	$= \begin{bmatrix} this \blacktriangleright height \\ height \end{bmatrix}$

2	angles_height	start and end angles formed by height

angles_height

$angles = \textbf{index}(\text{position})$

$$\boxed{=}\begin{bmatrix} angles \blacktriangleright start \\ \textbf{index}(\text{sign}) \end{bmatrix}$$

$$\boxed{=}\begin{bmatrix} angles \blacktriangleright end \\ \textbf{index}(\text{sign}) \end{bmatrix}$$

$$angle = \text{vector\_angle}\begin{pmatrix} \frac{1}{2} \times |this| \\ this \blacktriangleright height \end{pmatrix}$$

$$angles \blacktriangleright \begin{bmatrix} start \\ positive \end{bmatrix} = \max \begin{bmatrix} 0 \\ angle \end{bmatrix}$$

$$angles \blacktriangleright \begin{bmatrix} start \\ negative \end{bmatrix} = \min \begin{pmatrix} 0 \\ angle \end{pmatrix}$$

$$angles \blacktriangleright \begin{bmatrix} end \\ positve \end{bmatrix} = angles \blacktriangleright \begin{bmatrix} start \\ positive \end{bmatrix}$$

$$angles \blacktriangleright \begin{bmatrix} end \\ negative \end{bmatrix} = angles \blacktriangleright \begin{bmatrix} start \\ negative \end{bmatrix}$$

RE | $angles$

3 | Bezeir | equation in the form of Bezier curve

Bezier

$$\text{RE} \quad \textbf{Bezier}\begin{pmatrix} this \blacktriangleright start \\ this \blacktriangleright \text{center} \\ this \blacktriangleright end \end{pmatrix}$$

4 | center | center

center

$$angle = this \blacktriangleright \begin{bmatrix} start \\ \text{vector\_angle}(this \blacktriangleright end) \end{bmatrix}$$

$$angle\_height = \boxed{+}\begin{bmatrix} angle \\ \frac{\pi}{2} \times \text{sign}(this \blacktriangleright height) \end{bmatrix}$$

$$translation = \textbf{xy}\begin{pmatrix} this \blacktriangleright height \\ angle\_height \\ \textbf{polar} \end{pmatrix}$$

$$\text{RE} \quad \boxed{+}\begin{bmatrix} \boxed{+}\begin{bmatrix} this \blacktriangleright start \\ this \blacktriangleright end \end{bmatrix} \times \frac{1}{2} \\ translation \end{bmatrix}$$

5 | height | height

height | $angle$

$$angle = \min\begin{pmatrix} angle \\ \frac{\pi}{2} \end{pmatrix}$$

$$\text{RE} \quad \boxed{\times}\begin{bmatrix} \frac{1}{2} \times \left|\boxed{-}\begin{bmatrix} this \blacktriangleright start \\ this \blacktriangleright end \end{bmatrix}\right| \\ \tan(angle) \end{bmatrix}$$

6 | height_contact | height when $this$ contacts $label\_this$

height_contact

object	*label_this*	*type* = max

heights = **index**(sign)

(=) [*Segment2D_this* / *this* ▶ segment]

(=) [*translation* / *Segment2D_this* ▶ center]

center_rotation = **xy** (0 / 0)

(=) [*angle_rotation* / −*Segment2D_this* ▶ vector_angle]

Segment2D_this_moved = *Segment2D_this* ▶ [translation(*translation*) / rotation (*center_rotation* / *angle_rotation*)]

(=) [*interval_x_this* / *Segment2D_this_moved* ▶ interval(x)]

interval_x_label_this = **Interval** (−*label_this* ▶ [*size* / *x*] × 1/2 / *label_this* ▶ [*size* / *x*] × 1/2)

distance = 0

SW *object* ▶ *type*

(V) [Label2D / Rectangle2D]	sublevel
Measure2D	sublevel
Segment2D	sublevel
xy	sublevel

6 1 (V) [Label2D / Rectangle2D]

Rectangle2D = *object*

Rectangle2D = *Rectangle2D* ▶ [translation(*translation*) / rotation (*center* / *angle*)]

SW *type*

min	sublevel
max	sublevel

6 1 1 min

$$\left[= \left[\begin{array}{l} heights \blacktriangleright positive \\ 0 \end{array} \right] \right]$$

$$\left[= \left[\begin{array}{l} heights \blacktriangleright negative \\ 0 \end{array} \right] \right]$$

$$Rectangle2D = Rectangle2D \blacktriangleright \left[\begin{array}{l} \text{translation}(translation) \\ \text{rotation} \left(\begin{array}{l} center \\ -angle \end{array} \right) \end{array} \right]$$

IF $\left[\leq \left[\begin{array}{l} |Sement2D\_this| \\ Rectangle2D \blacktriangleright \left[\begin{array}{l} center \\ x \end{array} \right] \end{array} \right] \right]$ RE $heights$

IF $\left[\sqcap \left[\begin{array}{l} Rectangle2D \blacktriangleright \text{interval(x)} \\ interval\_x\_label\_this \end{array} \right] \right] \neq \emptyset$

$$sign\_height = \text{sign} \left(\begin{array}{l} Rectangle2D \blacktriangleright \left[\begin{array}{l} center \\ y \end{array} \right] \\ 1 \end{array} \right)$$

$$height\_abs = \max \left(\begin{array}{l} 0 \\ \left[+ \right] \left[\begin{array}{l} \left| Rectangle2D \blacktriangleright \left[\begin{array}{l} center \\ y \end{array} \right] \right| \\ \frac{1}{2} \times Rectangle2D \blacktriangleright \left[\begin{array}{l} size \\ y \end{array} \right] \\ label\_this \blacktriangleright \left[\begin{array}{l} size \\ y \end{array} \right] \\ -distance \end{array} \right] \end{array} \right)$$

$$heights\_positive = \max \left(\begin{array}{l} 0 \\ \left[\times \right] \left[\begin{array}{l} sign\_height \\ height\_abs \end{array} \right] \end{array} \right)$$

$$heights\_negative = \max \left(\begin{array}{l} 0 \\ \left[\times \right] \left[\begin{array}{l} -sign\_height \\ height\_abs \end{array} \right] \end{array} \right)$$

FO $Rectangle2D \blacktriangleright \text{vertices}$ $vertex$

$$height = \left[\div \right] \left[\begin{array}{l} \left[\times \right] \left[\begin{array}{l} vertex \blacktriangleright y \\ (2 \times vertex \blacktriangleright x)^2 \end{array} \right] \\ \left[- \right] \left[\begin{array}{l} |Segment2D\_this|^2 \\ (2 \times vertex \blacktriangleright x)^2 \end{array} \right] \end{array} \right]$$

$$sign\_height = \text{sign} \left(\begin{array}{l} height \\ 1 \end{array} \right)$$

$$heights \blacktriangleright positive = \max \left(\begin{array}{l} heights \blacktriangleright positive \\ \left[\times \right] \left[\begin{array}{l} sign\_height \\ |height| \end{array} \right] \end{array} \right)$$

$$heights \blacktriangleright negative = \max \left(\begin{array}{l} heights \blacktriangleright negative \\ \left[\times \right] \left[\begin{array}{l} -sign\_height \\ |height| \end{array} \right] \end{array} \right)$$

RE $heights$

6 1 2 max sublevel

$height\_Segment2D =$ IN

6 1 2 1 $height\_Rectangle2D = \text{sign} \left(Rectangle2D \blacktriangleright \left[\begin{array}{l} center \\ y \end{array} \right] \right)$

$$\left[= \left[\begin{array}{l} vertices \\ Rectangle2D \blacktriangleright \text{vertices} \end{array} \right] \right]$$

6 1 2 2 FO $0 \leq i < 4$

IF $\left[\begin{array}{l} vertices[i] \\ (interval\_x\_this)^\circ \end{array}\right]$

IF $\left[\begin{array}{l} vertices[i] \blacktriangleright x \\ interval\_x\_label\_this \end{array}\right]$ $height\_Rectangle2D = \min\left(\begin{array}{l} height\_Rectangle2D \\ \max\left(\begin{array}{l} 0 \\ -\left[\begin{array}{l} \times\left[\begin{array}{l} |vertices[i] \blacktriangleright y| \\ \frac{1}{2} \times label\_this \blacktriangleright \left[\begin{array}{l} size \\ y \end{array}\right] \end{array}\right] \\ distance \end{array}\right] \end{array}\right) \end{array}\right)$

$height = \left|\left[\begin{array}{l} \div\left[\begin{array}{l} \times\left[\begin{array}{l} vertices[i] \blacktriangleright y \\ |interval\_x\_this|^2 \end{array}\right] \\ -\left[\begin{array}{l} |interval\_x\_this|^2 \\ 4 \times (vertices[i] \blacktriangleright x)^2 \end{array}\right] \end{array}\right] \right|\right|$

$height\_Segment2D = \min\left(\begin{array}{l} height\_Segment2D \\ height \end{array}\right)$

$edge = \textbf{Segment2D}\left(\begin{array}{l} vertices[i] \\ vertices[i+1] \end{array}\right)$

$\left[\begin{array}{l} line\_edge \\ edge \blacktriangleright \text{line} \end{array}\right]$

sublevel

6 1 2 2 1 IF $\left[\begin{array}{l} line\_edge \blacktriangleright b \\ 0 \end{array}\right]$

$A = \div\left[\begin{array}{l} -line\_edge \blacktriangleright a \\ line\_edge \blacktriangleright b \end{array}\right]$

$C = \div\left[\begin{array}{l} -line\_edge \blacktriangleright c \\ line\_edge \blacktriangleright b \end{array}\right]$

$D\_height = -\left[\begin{array}{l} C^2 \\ (A \times interval\_x\_this \blacktriangleright max)^2 \end{array}\right]$

IF $D\_height \geq 0$

$sign\_C = \text{sign}\left(\begin{array}{l} C \\ 1 \end{array}\right)$

$x = \div\left[\begin{array}{l} A \times (interval\_x\_this \blacktriangleright max)^2 \\ \times\left[\begin{array}{l} sign\_C \\ \sqrt{D\_height} \end{array}\right] + C \end{array}\right]$

IF $\left[\begin{array}{l} x \\ edge \blacktriangleright \text{interval(x)} \end{array}\right]$

$height = \frac{1}{2} \times \left|\times\left[\begin{array}{l} sign\_C \\ \sqrt{D\_height} \end{array}\right] + C\right|$

$height\_Segment2D = \min\left(\begin{array}{l} height\_Segment2D \\ height \end{array}\right)$

6 1 2 3

$height\_abs = \min\left(\begin{array}{l} height\_Rectangle2D \\ height\_Segment2D \end{array}\right)$

$heights \blacktriangleright positive = \max\left(\begin{array}{l} 0 \\ \times\left[\begin{array}{l} sign\_height \\ height\_abs \end{array}\right] \end{array}\right)$

$heights \blacktriangleright negative = \max\left(\begin{array}{l} 0 \\ \times\left[\begin{array}{l} -sign\_height \\ height\_abs \end{array}\right] \end{array}\right)$

RE $heights$

7 Measure2D

$Measure2D = object$

SW	type
min	sublevel
max	sublevel

7 1 min sublevel

$$\left[= \right] \left[\begin{array}{l} Segment2D\_Measure2D \\ Measure2D \blacktriangleright \text{segment} \end{array} \right]$$

7 1 1

IF $\left[\subseteq \right] \left[\begin{array}{l} Segment2D\_Measure2D \\ Segment2D\_this \end{array} \right]$

$$\left[= \right] \left[\begin{array}{l} heights \blacktriangleright positive \\ 0 \end{array} \right]$$

$$\left[= \right] \left[\begin{array}{l} heights \blacktriangleright negative \\ 0 \end{array} \right]$$

RE $heights$

$$distance\_start\_start = \left| \left[- \right] \left[\begin{array}{l} Segment2D\_this \blacktriangleright start \\ Segment2D\_Measure2D \blacktriangleright start \end{array} \right] \right|$$

$$distance\_start\_end = \left| \left[- \right] \left[\begin{array}{l} Segment2D\_this \blacktriangleright start \\ Segment2D\_Measure2D \blacktriangleright end \end{array} \right] \right|$$

$$sign\_height = \text{sign} \left(\left[- \right] \left[\begin{array}{l} distance\_start\_end \\ distance\_start\_start \end{array} \right] \right)$$

7 1 2

$$min = \left[+ \right] \left[\begin{array}{l} interval\_x\_this \blacktriangleright min \\ \min \left(\begin{array}{l} distance\_start\_start \\ distance\_start\_end \end{array} \right) \end{array} \right]$$

$$max = \left[+ \right] \left[\begin{array}{l} interval\_x\_this \blacktriangleright min \\ \max \left(\begin{array}{l} distance\_start\_start \\ distance\_start\_end \end{array} \right) \end{array} \right]$$

$$interval\_x\_Measure2D = \textbf{Interval} \left(\begin{array}{l} min \\ max \end{array} \right)$$

$$x\_center\_Measure2D = \left[+ \right] \left[\begin{array}{l} interval\_x\_Measure2D \blacktriangleright min \\ interval\_x\_Measure2D \blacktriangleright max \end{array} \right] \times \frac{1}{2}$$

$$\left[= \right] \left[\begin{array}{l} height\_Measure2D \\ |Measure2D \blacktriangleright height| \end{array} \right]$$

$$\left[= \right] \left[\begin{array}{l} A.height \\ |Segment2D\_Measure2D|^2 \end{array} \right]$$

$$B.height = \times \left[\begin{array}{l} -height\_Measure2D \\ \left[+ \right] \left[\begin{array}{l} |Segment2D\_Measure2D|^2 \\ |Segment2D\_this|^2 \\ -(2 \times x\_center\_Measure2D)^2 \end{array} \right] \end{array} \right]$$

$$C.height = \left[\times \right] \left[\begin{array}{l} |Segment2D\_this|^2 \\ (height\_Measure2D)^2 \end{array} \right]$$

7 1 3

$$height\_abs = \left[\div \right] \left[\begin{array}{l} \left[+ \right] \left[\begin{array}{l} -B.height \\ -\sqrt{\left[- \right] \left[\begin{array}{l} (B.height)^2 \\ \left[\times \right] \left[\begin{array}{l} 4 \times A.height \\ C.height \end{array} \right] \end{array} \right]} \end{array} \right] \\ 2 \times A.height \end{array} \right]$$

$$heights \blacktriangleright positive = \max \left(\begin{array}{l} 0 \\ \left[\times \right] \left[\begin{array}{l} sign\_height \\ height\_abs \end{array} \right] \end{array} \right)$$

$$heights \blacktriangleright negative = \max \left(\begin{array}{l} 0 \\ \left[\times \right] \left[\begin{array}{l} -sign\_height \\ height\_abs \end{array} \right] \end{array} \right)$$

RE $heights$

7 2 max sublevel

$Measure2D = object$

7 2 1

IF $\left[\equiv \right] \left[\begin{array}{l} Measure2D \blacktriangleright height \\ 0 \end{array} \right]$

RE $this \blacktriangleright \text{height\_contact} \left(\begin{array}{l} Measure2D \blacktriangleright \text{segment} \\ label\_this \\ \text{max} \end{array} \right)$

$$\left[\begin{array}{l} heights \blacktriangleright positive \\ \boxed{\text{IN}} \end{array}\right]$$

$$\left[\begin{array}{l} heights \blacktriangleright negative \\ \boxed{\text{IN}} \end{array}\right]$$

$$Measure2D\_moved = \boxed{+}\left[\begin{array}{l} Measure2D \\ translation \end{array}\right] \blacktriangleright \text{rotation}\left(\begin{array}{l} center \\ angle \end{array}\right)$$

$$\left[\begin{array}{l} Segment2D\_moved \\ Measure2D\_moved \blacktriangleright \text{segment} \end{array}\right]$$

$$\left[\begin{array}{l} Bezier \\ Segment2D\_moved \blacktriangleright \text{Bezier} \end{array}\right]$$

$$interval\_t = \textbf{Interval}\left(\begin{array}{l} 0 \\ 1 \end{array}\right)$$

$$\left[\begin{array}{l} quadratic\_x \\ Bezier \blacktriangleright \text{quadratic(x)} \end{array}\right]$$

7 2 2
$$\left[\begin{array}{l} interval\_x \\ quadratic\_x \blacktriangleright \text{image}(interval\_t) \end{array}\right]$$

$$\boxed{\text{IF}} \quad \left|\boxed{\cap}\left[\begin{array}{l} interval\_x \\ interval\_x\_this \end{array}\right]\right| \equiv 0 \quad \boxed{\text{RE}} \; heights$$

$$interval\_t\_intersection = \boxed{\cap}\left[\begin{array}{l} quadratic\_x \blacktriangleright \text{preimage}(interval\_x\_this) \\ interval\_t \end{array}\right]$$

$$\boxed{\text{IF}} \quad \boxed{\equiv}\left[\begin{array}{l} interval\_t\_intersection \\ \emptyset \end{array}\right] \quad \boxed{\text{RE}} \; heights$$

$$\left[\begin{array}{l} quadratic\_y \\ Bezier \blacktriangleright \text{quadratic(y)} \end{array}\right]$$

$$\left[\begin{array}{l} ts\_y \\ quadratic \blacktriangleright \text{solution(0)} \end{array}\right]$$

$$\boxed{\text{FE}} \quad \boxed{ts\_y} \; \boxed{t}$$

$$\boxed{\text{IF}} \quad \boxed{\in}\left[\begin{array}{l} t \\ interval\_t\_intersection \end{array}\right] \quad \boxed{\text{RE}} \; heights$$

$ts\_bound = \emptyset$

$\doteq$ [ts_bound / $interval\_t\_intersection \blacktriangleright min$]

$\doteq$ [ts_bound / $interval\_t\_intersection \blacktriangleright max$]

$=$ [ts_x / $quadratic\_x \blacktriangleright \text{solution}(0)$]

FE | ts_x | t

IF | $\in$ [t / $interval\_t\_intersection$] | $ts\_bound \doteq t$

$t\_apex\_y = \div$ [$-quadratic\_y \blacktriangleright b$ / $2 \times quadratic\_y \blacktriangleright a$]

7 2 3 IF | $\in$ [t_apex_y / $interval\_t\_intersection$] | $\doteq$ [ts_bound / t_apex_y]

FE | ts_bound | t

$height = \div$ [$\times$ [$(interval\_x\_this \blacktriangleright max)^2$ / $quadratic\_y \blacktriangleright \text{evaluation}(t)$] / $-$ [$(interval\_x\_this \blacktriangleright max)^2$ / $(quadratic\_x \blacktriangleright \text{evaluation}(5))^2$]]

$height \blacktriangleright positive = \min\left(\begin{matrix} heights \blacktriangleright positive \\ \max\left(\begin{matrix} 1 \\ e^{height} \end{matrix}\right) \end{matrix}\right)$

$height \blacktriangleright negative = \min\left(\begin{matrix} heights \blacktriangleright positive \\ \max\left(\begin{matrix} 1 \\ e^{-height} \end{matrix}\right) \end{matrix}\right)$

RE | $heights$

8 Segment2D sublevel

$Segment2D = object$

$Segment2D\_moved = +$ [$Segment2D$ / $translation$] $\blacktriangleright \text{rotation}\left(\begin{matrix} center \\ angle \end{matrix}\right)$

IF | $\vee$ [$\equiv$ [$Segment2D\_intersection$ / $\emptyset$] / $\subsetneq$ [$Segment2D\_intersection \blacktriangleright \text{interval(x)}$ / $interval\_x\_this$]]

$=$ [$heights \blacktriangleright positive$ / IN]

$=$ [$heights \blacktriangleright negative$ / IN]

RE | $heights$

$=$ [$interval\_y\_Segment2D$ / $Segment2D\_intersection \blacktriangleright \text{interval(y)}$]

8 1 $sign\_y = \text{sign}\left(\times\right.$ [$interval\_y\_segment2D \blacktriangleright min$ / $interval\_y\_Segment2D \blacktriangleright max$] $\left.\right)$

IF | $sign\_y \leq 0$

$heights \blacktriangleright positive = \max\left(\begin{matrix} 0 \\ -\text{sign}\left(\begin{matrix} interval\_y\_Segment2D \blacktriangleright max \\ -1 \end{matrix}\right) \\ \text{IN} \end{matrix}\right)$

$heights \blacktriangleright negative = \max\left(\begin{matrix} 0 \\ -\text{sign}\left(\begin{matrix} interval\_y\_Segment2D \blacktriangleright min \\ -1 \end{matrix}\right) \\ \text{IN} \end{matrix}\right)$

RE | $heights$

$$\left[\begin{array}{l} line\_Segment2D \\ Segment2D\_moved \blacktriangleright \text{line} \end{array}\right]$$

$$\left[\begin{array}{l} sign\_height \\ \text{sign}(interval\_y\_Segment2D \blacktriangleright max) \end{array}\right]$$

$$Segment2D\_intersection\_label\_this = \left[\begin{array}{l} Segment2D\_intersection \\ interval\_x\_label\_this \end{array}\right]$$

IF

$$\left[\begin{array}{l} \wedge \\ \left[\begin{array}{l} \neq \left[\begin{array}{l} Segment2D\_intersection\_label\_this \\ \emptyset \end{array}\right] \\ \neq \left[\begin{array}{l} |Segment2D\_intersection\_label\_this \blacktriangleright \text{interval(y)}| \\ 0 \end{array}\right] \end{array}\right] \end{array}\right]$$

$$height\_label\_this = \max\left(\begin{array}{l} 0 \\ -\left[\begin{array}{l} |Segment2D\_intersection\_label\_this \blacktriangleright \text{interval(y)}| \\ distance \end{array}\right] \end{array}\right)$$

$$height\_Segment2D\_start = \left|\left[\begin{array}{l} \div \\ \left[\begin{array}{l} \times \left[\begin{array}{l} Segment2D\_intersection \blacktriangleright start \\ (interval\_x\_this \blacktriangleright max)^2 \end{array}\right] \\ - \left[\begin{array}{l} (interval\_x\_this \blacktriangleright max)^2 \\ \left(Segment2D\_intersection \blacktriangleright \left[\begin{array}{l} start \\ x \end{array}\right]\right)^2 \end{array}\right] \end{array}\right] \end{array}\right]\right|$$

$$height\_Segment2D\_end = \left|\left[\begin{array}{l} \div \\ \left[\begin{array}{l} \times \left[\begin{array}{l} Segment2D\_intersection \blacktriangleright end \\ (interval\_x\_this \blacktriangleright max)^2 \end{array}\right] \\ - \left[\begin{array}{l} (interval\_x\_this \blacktriangleright max)^2 \\ \left(Segment2D\_intersection \blacktriangleright \left[\begin{array}{l} end \\ x \end{array}\right]\right)^2 \end{array}\right] \end{array}\right] \end{array}\right]\right|$$

$$\left[\begin{array}{l} \equiv \\ \left[\begin{array}{l} height\_Segment2D\_tangent \\ \mathbb{N} \end{array}\right] \end{array}\right]$$

8 2

IF $\left[\begin{array}{l} \neq \\ \left[\begin{array}{l} line\_Segment2D \blacktriangleright b \\ 0 \end{array}\right] \end{array}\right]$

$$A = \left[\begin{array}{l} \div \\ \left[\begin{array}{l} -line\_Segment2D \blacktriangleright a \\ line\_Segment2D \blacktriangleright b \end{array}\right] \end{array}\right]$$

$$C = \left[\begin{array}{l} \div \\ \left[\begin{array}{l} -line\_Segment2D \blacktriangleright c \\ line\_Segment2D \blacktriangleright b \end{array}\right] \end{array}\right]$$

$$D\_height = \left[\begin{array}{l} - \\ \left[\begin{array}{l} C^2 \\ A \times (interval\_x\_this \blacktriangleright max)^2 \end{array}\right] \end{array}\right]$$

IF $D\_height \geq 0$

$$sign\_C = \text{sign}\left(\begin{array}{l} C \\ 1 \end{array}\right)$$

$$x = \left[\begin{array}{l} \div \\ \left[\begin{array}{l} A \times (interval\_x\_this \blacktriangleright max)^2 \\ \left[\begin{array}{l} \times \\ \left[\begin{array}{l} sign\_C \\ \sqrt{D\_height} \end{array}\right] \end{array}\right] + C \end{array}\right] \end{array}\right]$$

IF $\left[\begin{array}{l} \in \\ \left[\begin{array}{l} x \\ Segment2D\_intersection \blacktriangleright \text{interval(x)} \end{array}\right] \end{array}\right]$

$$height\_Segment2D\_tangent = \frac{1}{2} \times \left|\left[\begin{array}{l} \times \\ \left[\begin{array}{l} sign\_C \\ \sqrt{D\_height} \end{array}\right] \end{array}\right] + C\right|$$

$$height\_Segment2D = \min\left(\begin{array}{l} height\_Segment2D\_start \\ height\_Segment2D\_end \\ height\_Segment2D\_tangent \end{array}\right)$$

$$height\_abs = \min\left(\begin{array}{l} height\_label\_this \\ height\_Segment2D \end{array}\right)$$

$$heights \blacktriangleright positive = \max\left(\begin{array}{l} 0 \\ \left[\begin{array}{l} \times \\ \left[\begin{array}{l} sign\_height \\ height\_abs \end{array}\right] \end{array}\right] \end{array}\right)$$

$$heights \blacktriangleright negative = \max\left(\begin{array}{l} 0 \\ \left[\begin{array}{l} \times \\ \left[\begin{array}{l} -sign\_height \\ height\_abs \end{array}\right] \end{array}\right] \end{array}\right)$$

RE $heights$

9 | xy

xy = object

$xy\_moved = [+] \begin{bmatrix} xy \\ translation \end{bmatrix} \blacktriangleright \text{rotation} \begin{pmatrix} center\_rotation \\ angle\_rotation \end{pmatrix}$

IF $[\notin] \begin{bmatrix} xy\_moved \blacktriangleright x \\ (interval\_x\_this)^\circ \end{bmatrix}$

$[=] \begin{bmatrix} heights \blacktriangleright positive \\ \text{IN} \end{bmatrix}$

$[=] \begin{bmatrix} heights \blacktriangleright negative \\ \text{IN} \end{bmatrix}$

RE | *heights*

IF $[\in] \begin{bmatrix} xy \blacktriangleright x \\ interval\_x\_label\_this \end{bmatrix}$

$height = [\times] \begin{bmatrix} \text{sign}(xy\_moved \blacktriangleright y) \\ \max \begin{pmatrix} 0 \\ [+] \begin{bmatrix} |xy\_moved \blacktriangleright y| \\ -\frac{1}{2} \times label\_this \blacktriangleright \begin{bmatrix} size \\ y \end{bmatrix} \\ -distance \end{bmatrix} \end{pmatrix} \end{bmatrix}$

$height = [\div] \begin{bmatrix} [\times] \begin{bmatrix} xy\_moved \blacktriangleright y \\ (interval\_x\_this \blacktriangleright max)^2 \end{bmatrix} \\ [-] \begin{bmatrix} (interval\_x\_this \blacktriangleright max)^2 \\ (xy\_moved \blacktriangleright x)^2 \end{bmatrix} \end{bmatrix}$

$sign\_height = \text{sign} \begin{pmatrix} height \\ 1 \end{pmatrix}$

$heights \blacktriangleright positive = \max \begin{pmatrix} 0 \\ [\times] \begin{bmatrix} sign\_height \\ |height| \end{bmatrix} \end{pmatrix}$

$heights \blacktriangleright negative = \max \begin{pmatrix} 0 \\ [\times] \begin{bmatrix} -sign\_height \\ |height| \end{bmatrix} \end{pmatrix}$

RE | *heights*

10 | segment | compute **Segment2D** of *this*

segment

RE | **Segment2D** $\begin{pmatrix} this \blacktriangleright start \\ this \blacktriangleright end \end{pmatrix}$

1.8 MeasureArc2D

1. **Definition**

MeasureArc2D ◀ *Arc2D*

type = MeasureArc2D
center
start
angle
height
key_object
key_label
method

2. **Method**

1 | construct

CO | *center* | *start* | *angle* | *height*

$[=] \begin{bmatrix} this \blacktriangleright center \\ center \end{bmatrix}$

$[=] \begin{bmatrix} this \blacktriangleright start \\ start \end{bmatrix}$

$[=] \begin{bmatrix} this \blacktriangleright angle \\ angle \end{bmatrix}$

$[=] \begin{bmatrix} this \blacktriangleright height \\ height \end{bmatrix}$

2 | arc | *Arc2D* of *this*

arc

RE **Arc2D** (*this* ▶ *center*, *this* ▶ *start*, *this* ▶ *angle*)

3 | center | center of *this*

center

radius = + [− [*this* ▶ *center*, *this* ▶ *start*], *height*]

angle = + [*this* ▶ [*center*, vector_angle(*this* ▶ *start*)], $\frac{1}{2}$ × *this* ▶ *angle*]

RE **xy** (*radius*, *angle*, polar)

4 | height_contact | height of *this* when *this* contacts *object*

height_contact | *object* | *type* = max

radius_this = | − [*this* ▶ *center*, *this* ▶ *start*] |

SW | *object* ▶ *type*

∨ [Label2D, Rectangle2D] | sublevel

4 1 ∨ [Label2D, Rectangle2D]

Rectangle = *object*

SW | *type*

max

heights = ∅

= [*Rectangle2D_vertices*, *Label2D* ▶ vertices]

FE | *Rectangle2D_vertices* | *vertex*

heights ≜ + [− [− [*this* ▶ *center*, *vertex*]], *radius_this*]

RE | max(*heights*)

1.9 Point2D

1. **Definition**

Point2D ◀ **xy**

type = Point2D

key

key_object

key_label

method

2. **Method**

1 | distance | distance between *this* and *object*

distance | *object*

SW | *object* ▶ *type*

Segment2D

Segment2D = *object*

= [*line*, *Segment2D* ▶ line]

RE | ⊹ [*ine* ▶ evaluation(*this*), √ [− [(*line* ▶ *a*)², (*line* ▶ *b*)²]]]

2 | interval_angle_forbidden | forbidden **Interval_angle** such that the halfline whose start point is *this* cannot pass

interval_angle_forbidden | *object*

SW | *object* ▶ *type*

Label2D / Rectangle2D

Rectangle2D = *object*

IF | $this \subseteq (Rectangle2D)^\circ$ | RE | **Interval_anlge** $\begin{pmatrix} 0 \\ 2\pi \\ 1 \\ \text{TR} \end{pmatrix}$

$= \begin{bmatrix} angles\_vertices \\ \emptyset \end{bmatrix}$

FE | *Rectangle2D* ▶ vertices | *vertex*

IF | $\neq \begin{bmatrix} this \blacktriangleright center \\ vertex \end{bmatrix}$ | $angles\_vertices \overset{+}{=} this \blacktriangleright \begin{bmatrix} center \\ \text{vector\_angle}(vertex) \end{bmatrix}$

$= \begin{bmatrix} angle\_difference\_min \\ 0 \end{bmatrix}$

$= \begin{bmatrix} angle\_difference\_max \\ 0 \end{bmatrix}$

FE | *angle_vertices* | *angle*

$angle\_difference = \text{polar} \begin{pmatrix} -\begin{bmatrix} angle \\ angles\_vertices[0] \end{bmatrix} \\ -\pi \end{pmatrix}$

$angle\_difference\_max = \max \begin{pmatrix} angle\_difference\_max \\ angle\_difference \end{pmatrix}$

$angle\_difference\_min = \min \begin{pmatrix} angle\_difference\_min \\ angle\_difference \end{pmatrix}$

$size = -\begin{bmatrix} angle\_difference\_max \\ angle\_difference\_min \end{bmatrix}$

RE | **Interval_angle** $\begin{pmatrix} +\begin{bmatrix} angles\_vertices[0] \\ angle\_difference\_min \end{bmatrix} \\ size \end{pmatrix}$

3 | number_directions_measure | the number of different directions of measures that contain *this*

number_directions_measure | *Measure2Ds*

$= \begin{bmatrix} Measure2Ds\_contained \\ \emptyset \end{bmatrix}$

FE | *Measure2Ds* | *Measure2D*

IF | $\neq \begin{bmatrix} Measure2D \blacktriangleright height \\ 0 \end{bmatrix}$

$= \begin{bmatrix} Segment2D \\ Measure2D \blacktriangleright segment \end{bmatrix}$

IF | $this \subseteq Segment2D$ | $\pm \begin{bmatrix} Measure2Ds\_contained \\ Measure2D \end{bmatrix}$

$number\_directions = 0$

sublevel

RE | *number_directions*

FO $0 \leq i < |Measure2Ds\_contained|$

$angle\_i = Measure2Ds\_contained[i] \blacktriangleright \begin{bmatrix} start \\ \text{vector\_angle}(Measure2D\_contained[i] \blacktriangleright end) \end{bmatrix}$

$= \begin{bmatrix} sign\_i \\ \text{sign}(Measure2Ds\_contained[i] \blacktriangleright height) \end{bmatrix}$

3 1 FO $0 \leq j < i$

$angle\_j = Measure2Ds\_contained[j] \blacktriangleright \begin{bmatrix} start \\ \text{vector\_angle}(Measure2Ds\_contained[i] \blacktriangleright end) \end{bmatrix}$

$= \begin{bmatrix} sign\_j \\ \text{sign}(Measure2Ds\_contained[j] \blacktriangleright height) \end{bmatrix}$

$= \begin{bmatrix} number\_directions\_different \\ 0 \end{bmatrix}$

IF $\wedge \begin{bmatrix} angle\_i \neq angle\_j \\ angle\_i \neq -angle\_j \end{bmatrix}$ $\overset{+}{+} number\_directions\_different$

$\wedge \begin{bmatrix} angle\_i \equiv angle\_j \\ sign\_i \neq sign\_j \end{bmatrix}$ $\overset{+}{+} number\_directions\_different$

$\wedge \begin{bmatrix} angle\_i \equiv -angle\_j \\ sign\_i \equiv sign\_j \end{bmatrix}$ $\overset{+}{+} number\_directions\_different$

IF $\equiv \begin{bmatrix} number\_directions\_different \\ i - 1 \end{bmatrix}$ $\overset{+}{+} number\_directions$

1.10 Rectangle2D

1. **Definition**

Rectangle	*type* = Rectangle2D
	center
	size
	rotation
	method

2. **Method**

1 construct

CO

center	*size*	*rotation*

$= \begin{bmatrix} this \blacktriangleright center \\ center \end{bmatrix}$

$= \begin{bmatrix} this \blacktriangleright size \\ size \end{bmatrix}$

$= \begin{bmatrix} this \blacktriangleright rotation \\ rotation \end{bmatrix}$

2 interval **Interval** of given *axis*

interval | *axis*

SW | *axis*

x | RE | **Interval** $\left(\begin{bmatrix} -\left[\begin{array}{l} this \blacktriangleright \begin{bmatrix} center \\ x \end{bmatrix} \\ \frac{1}{2} \times this \blacktriangleright \begin{bmatrix} size \\ x \end{bmatrix} \end{array} \right] \\ +\left[\begin{array}{l} this \blacktriangleright \begin{bmatrix} center \\ x \end{bmatrix} \\ \frac{1}{2} \times this \blacktriangleright \begin{bmatrix} size \\ x \end{bmatrix} \end{array} \right] \end{bmatrix} \right)$

y | RE | **Interval** $\left(\begin{bmatrix} -\left[\begin{array}{l} this \blacktriangleright \begin{bmatrix} center \\ y \end{bmatrix} \\ \frac{1}{2} \times this \blacktriangleright \begin{bmatrix} size \\ y \end{bmatrix} \end{array} \right] \\ +\left[\begin{array}{l} this \blacktriangleright \begin{bmatrix} center \\ y \end{bmatrix} \\ \frac{1}{2} \times this \blacktriangleright \begin{bmatrix} size \\ y \end{bmatrix} \end{array} \right] \end{bmatrix} \right)$

3 | rotation | rotate arround $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ with *angle*

rotation | angle

this_rotated = *this*

$center\_rotation = \mathbf{xy} \begin{pmatrix} 0 \\ 0 \end{pmatrix}$

$this\_rotated \blacktriangleright center = this \blacktriangleright \begin{bmatrix} center \\ \text{rotation} \begin{pmatrix} center\_rotation \\ -this \blacktriangleright rotation \end{pmatrix} \end{bmatrix}$

$this\_rotated \blacktriangleright target = this \blacktriangleright \begin{bmatrix} target \\ \text{rotation} \begin{pmatrix} center\_rotation \\ -this \blacktriangleright rotation \end{pmatrix} \end{bmatrix}$

$\begin{bmatrix} + \\ - \end{bmatrix} \begin{bmatrix} this\_rotated \blacktriangleright angle \\ angle \end{bmatrix}$

RE | *this_rotated*

4 | translation | translate with *vector*

translation | *vector*

this_translation = *this*

$this\_translated \blacktriangleright center = \begin{bmatrix} + \end{bmatrix} \begin{bmatrix} this \blacktriangleright center \\ vector \end{bmatrix}$

$this\_translated \blacktriangleright target = \begin{bmatrix} + \end{bmatrix} \begin{bmatrix} this \blacktriangleright target \\ vector \end{bmatrix}$

RE | *this_translated*

5 | vertices | vertices

vertices

$vertices.0 = \emptyset$

$$vertices.0 \overset{+}{=} \boxed{+} \begin{bmatrix} this \blacktriangleright center \\ \boxed{\times} \begin{bmatrix} t \begin{bmatrix} -\frac{1}{2} & -\frac{1}{2} \end{bmatrix} \\ this \blacktriangleright size \end{bmatrix} \end{bmatrix}$$

$$vertices.0 \overset{+}{=} \boxed{+} \begin{bmatrix} this \blacktriangleright center \\ \boxed{\times} \begin{bmatrix} \begin{bmatrix} -\frac{1}{2} & \frac{1}{2} \end{bmatrix} \\ this \blacktriangleright size \end{bmatrix} \end{bmatrix}$$

$$vertices.0 \overset{+}{=} \boxed{+} \begin{bmatrix} this \blacktriangleright center \\ \boxed{\times} \begin{bmatrix} \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \end{bmatrix} \\ this \blacktriangleright size \end{bmatrix} \end{bmatrix}$$

$$vertices.0 \overset{+}{=} \boxed{+} \begin{bmatrix} this \blacktriangleright center \\ \boxed{\times} \begin{bmatrix} \begin{bmatrix} \frac{1}{2} & -\frac{1}{2} \end{bmatrix} \\ this \blacktriangleright size \end{bmatrix} \end{bmatrix}$$

$vertices = \emptyset$

FE | $vertices.0$ | $vertex$

$$vertices \overset{+}{=} vertex \blacktriangleright \text{rotation} \begin{pmatrix} this \blacktriangleright center \\ this \blacktriangleright rotation \end{pmatrix}$$

RE | $vertices$

1.11 Sector2D

1. **Definition**

Sector2D

Sector2D
center
start
angle
method

2. **Method**

1 construct

CO | *center* | *start* | *angle*

$$\boxed{=} \begin{bmatrix} this \blacktriangleright center \\ center \end{bmatrix}$$

$$\boxed{=} \begin{bmatrix} this \blacktriangleright start \\ start \end{bmatrix}$$

$$\boxed{=} \begin{bmatrix} this \blacktriangleright angle \\ angle \end{bmatrix}$$

2 end | end

end

RE $this \blacktriangleright \begin{bmatrix} start \\ \text{rotation} \begin{pmatrix} this \blacktriangleright center \\ this \blacktriangleright angle \end{pmatrix} \end{bmatrix}$

3 radius | radius

radius

RE | $\boxed{-} \begin{bmatrix} this \blacktriangleright center \\ this \blacktriangleright start \end{bmatrix}$

4 rotation | rotate arround *center* with *angle*

rotation | *center* | *angle*

this_rotated = RE | *this*

$$this\_rotated \blacktriangleright center = this \blacktriangleright \begin{bmatrix} center \\ \text{rotation} \begin{pmatrix} this \blacktriangleright center \\ angle \end{pmatrix} \end{bmatrix}$$

$$this\_rotated \blacktriangleright start = this \blacktriangleright \begin{bmatrix} start \\ \text{rotation} \begin{pmatrix} this \blacktriangleright center \\ angle \end{pmatrix} \end{bmatrix}$$

RE | *this_translated*

5 | translation | translate with *vector*

translation | *vector*

this_translated = *this*

$$this\_translated \blacktriangleright center = [+] \begin{bmatrix} this \blacktriangleright center \\ vector \end{bmatrix}$$

$$this\_translated \blacktriangleright start = [+] \begin{bmatrix} this \blacktriangleright start \\ vector \end{bmatrix}$$

RE | *this_translated*

1.12 Segment2D

1. **Definition**

Segment2D
type = Segment2D
start
end
measure = ∅
key
key_object
key_label
method

2. **Method**

1 | construct

CO | *start* | *end* | *measure*

$$[=] \begin{bmatrix} this \blacktriangleright start \\ start \end{bmatrix}$$

$$[=] \begin{bmatrix} this \blacktriangleright end \\ end \end{bmatrix}$$

$$[=] \begin{bmatrix} this \blacktriangleright measure \\ measure \end{bmatrix}$$

2 | center | center

center

$$RE \quad [+] \begin{bmatrix} this \blacktriangleright start \\ this \blacktriangleright end \end{bmatrix} \times \frac{1}{2}$$

3 | coordinate | coordinate when other *axis value* is given

coordinate | *value* | *axis* = x

≡ [*line* ; *this* ▶ line]

coordinate = *line* ▶ coordinate (*value* ; *axis*)

IF | *coordinate* ≡ ∅ | RE | *coordinate*

SW | *axis*

x

IF | ∉ [*coordinate* ; *this* ▶ interval(x)] | RE | ∅

RE | *coordinate*

y

IF | ∉ [*coordinate* ; *this* ▶ interval(y)] | RE | ∅

RE | *coordinate*

4 | interval | **Interval** for given *axis*

interval | *axis* = x

SW | *axis*

x

RE | **Interval** (min (*this* ▶ [*start* ; *x*] ; *this* ▶ [*end* ; *x*]) ; max (*this* ▶ [*start* ; *x*] ; *this* ▶ [*end* ; *x*]))

y

RE | **Interval** (min (*this* ▶ [*start* ; *y*] ; *this* ▶ [*end* ; *y*]) ; max (*this* ▶ [*start* ; *y*] ; *this* ▶ [*end* ; *y*]))

5 | is_chord | check if *this* is chord of *Arc2D*

is_chord	*Arc2D*
	distance_this_start = | − [*Segment2D* ▶ center *this* ▶ *start*] |
	IF ≠ [*Arc2D* ▶ radius *distance_this_start*] — RE | FA
	distance_this_end = | − [*Arc2D* ▶ *center* *this* ▶ *end*] |
	IF ≠ [*Arc2D* ▶ radius *distance_this_end*] — RE | FA
	angle_Arc2D_start = *Arc2D* ▶ [*center* vector_angle(*Arc2D* ▶ *start*)]
	angle_Arc2D_end = + [*angle_Arc2D_start* *Arc2D* ▶ *angle*]
	IF ≡ [*angle_Arc2D_start* *angle_Arc2D_end*] — RE | TR
	angle_this_start = *Arc2D* ▶ [*center* vector_angle(*this* ▶ *start*)]
	= [*interval_angle_Arc2D* *Arc2D* ▶ interval_angle]
	IF ∉ [*angle_this_start* *interval_angle_Arc2D*] — RE | FA
	angle_this_end = *Arc2D* ▶ [*center* vector_angle(*this* ▶ *end*)]
	RE ∈ [*angle_this_end* *inteval_angle_Arc2D*]

6 | is_equal_direction | check if vector directions of *this* and *Segment2D* are equal

is_equal_direction	*Segment2D*
	RE ≡ [*this* ▶ vector_angle *Segment2D* ▶ vector_angle]

7 | is_equal_direction | check if vector directions of *this* and *Segment2D* are opposite

is_opposite_direction	*Segment2D*
	RE ≡ [*this* ▶ vector_angle −*Segment2D* ▶ vector_angle]

8 | is_tangent | check if *this* and *object* are tangent

is_tangent	*object*		
	SW	*object* ▶ *type*	
		Arc2D	*Arc2* = *object*
			RE *Arc2D* ▶ is_tangent(*this*)

9 | line | **Line2D** containing *this*

line

$$a = \boxed{-} \begin{bmatrix} this \blacktriangleright \begin{bmatrix} end \\ y \end{bmatrix} \\ this \blacktriangleright \begin{bmatrix} start \\ y \end{bmatrix} \end{bmatrix}$$

$$b = \boxed{-} \begin{bmatrix} this \blacktriangleright \begin{bmatrix} start \\ x \end{bmatrix} \\ this \blacktriangleright \begin{bmatrix} end \\ x \end{bmatrix} \end{bmatrix}$$

$$c = \boxed{\times} \begin{bmatrix} -a \mid b \\ this \blacktriangleright start \end{bmatrix}$$

RE | **line** $\begin{pmatrix} a \\ b \\ c \end{pmatrix}$

10 | rotation | rotate arround *center* with *angle*

rotation | *center* | *angle*

this_rotated = *this*

$$this\_rotated \blacktriangleright start = this \blacktriangleright \begin{bmatrix} start \\ \text{rotation} \begin{pmatrix} center \\ angle \end{pmatrix} \end{bmatrix}$$

$$this\_rotated \blacktriangleright end = this \blacktriangleright \begin{bmatrix} end \\ \text{rotation} \begin{pmatrix} center \\ angle \end{pmatrix} \end{bmatrix}$$

RE | *this_rotated*

11 | translation | translate with *vector*

translation | *vector*

this_translated = *this*

$$this\_translated \blacktriangleright start = \boxed{+} \begin{bmatrix} this \blacktriangleright start \\ vector \end{bmatrix}$$

$$this\_translated \blacktriangleright end = \boxed{+} \begin{bmatrix} this \blacktriangleright end \\ vector \end{bmatrix}$$

RE | *this_translated*

12 | vector | vector

vector

RE | $\boxed{-} \begin{bmatrix} this \blacktriangleright end \\ this \blacktriangleright start \end{bmatrix}$

13 | vector_angle | angle of vector

vector_angle

RE | $this \blacktriangleright \begin{bmatrix} start \\ \text{vector\_angle} \end{bmatrix}$