Circle placement in a triangle

Solve the following optimization problem

Allocate N circles with known radiuses in a minimum surface triangle without overlapping each other
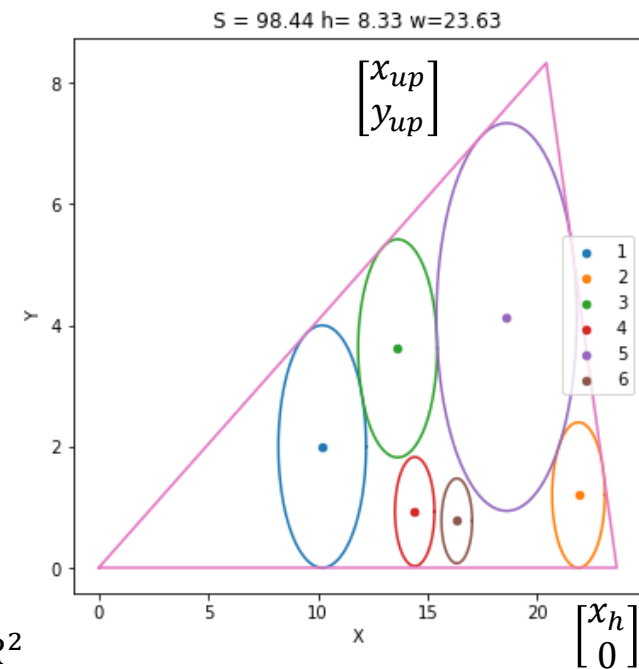
$$\min 0.5 y_{up} x_h$$

$$\forall_{i,j} \qquad \left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2 \geq \left(r_i + r_j\right)^2$$

$$\forall_i \qquad y_i x_{up} - x_i y_{up} \leq 0$$

$$\forall_i \qquad y_i(x_h - x_{up}) + y_{up}(x_i - x_h) \leq 0$$

$$\forall_i \qquad \left(y_i x_{up} - x_i y_{up}\right)^2 \geq \left(x_{up}^2 + y_{up}^2\right)^2 R^2$$

$$\forall_i \quad \left(y_i(x_h - x_{up}) + y_{up}(x_i - x_h)\right)^2 \geq \left(\left(x_h - x_{up}\right)^2 + y_{up}^2\right)^2 R^2$$

Ex32B

S = 98.44 h= 8.33 w=23.63

$\begin{bmatrix} x_{up} \\ y_{up} \end{bmatrix}$

$\begin{bmatrix} x_h \\ 0 \end{bmatrix}$

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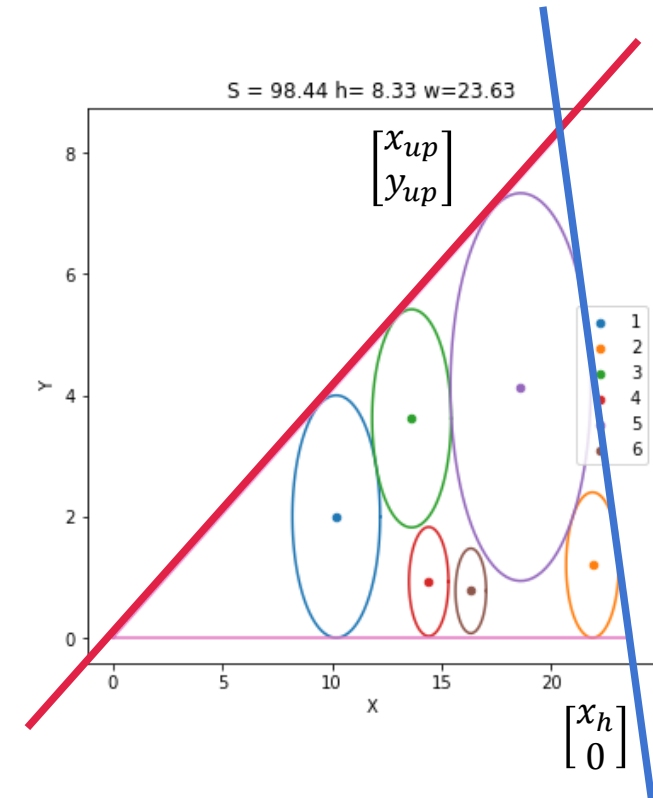
$$\min 0.5 y_{up} x_h$$

$$\forall_{i,j} \qquad (x_i - x_j)^2 + (y_i - y_j)^2 \geq (r_i + r_j)^2$$

$$y - y_{up} = (\frac{y_{up}}{x_{up}})(x - x_{up})$$

$$y - y_{up} = (\frac{y_{up} - 0}{x_{up} - x_h})(x - x_{up})$$

Ex32B

21

S = 98.44 h= 8.33 w=23.63

$\begin{bmatrix} x_{up} \\ y_{up} \end{bmatrix}$

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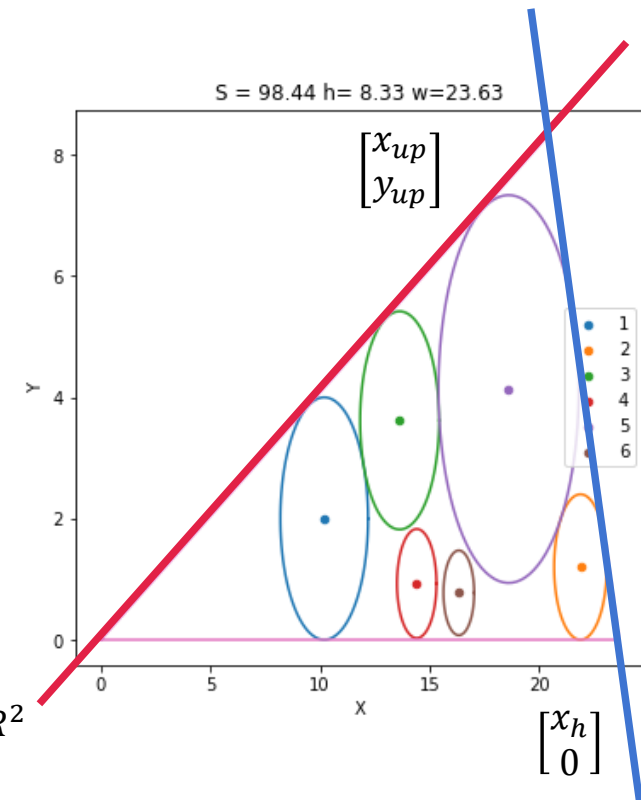
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$$\forall_i \quad (y_i x_{up} - x_i y_{up})^2 \geq (x_{up}^2 + y_{up}^2)^2 R^2$$

$$\forall_i \quad \left(y_i (x_h - x_{up}) + y_{up}(x_i - x_h) \right)^2 \geq \left((x_h - x_{up})^2 + y_{up}^2 \right)^2 R^2$$

Ex32B

22