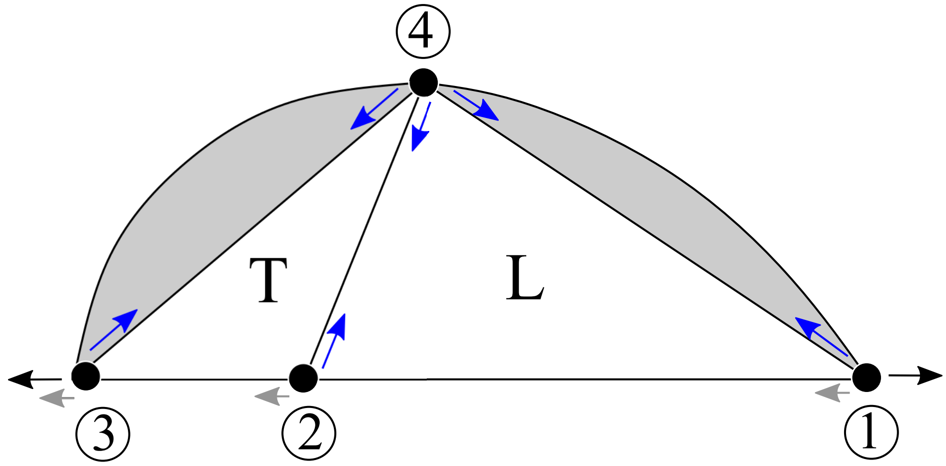


- Force balance @ nodes:

(1) $F_p - \xi_1 v_1 - t_L \cos\alpha_L = 0$ where $F_p = (1+f)\left(1 - \dfrac{t_L}{t_0+\tau}\right)$

(3) $F_r + \xi_3 v_3 - t_T \cos\alpha_T = 0$ where $F_r = (1-f)\left(1 - \dfrac{t_T}{t_0+\tau}\right)$

(2) $F_c \cos\gamma - \xi_2 v_2 = 0$

(4) $t_L \sin\alpha_L + t_T \sin\alpha_T + t_{cc}\cos(x+w) = \xi_4 x_{4y}$
$t_L \cos\alpha_L = t_T \cos\alpha_T + t_{cc}\sin(x+w) + \xi_4 x_{4x}$

<u>Move the points according to their velocity from the force balance</u>

This is the vertex model with 8 unknowns | if $v_1 = v_2 = v_3 = v_4 = \sqrt{v_{4x}^2 + v_{4y}^2} = v$ *then 5 unknowns.*

- Find <u>area of triangles</u> defined by nodes 1,2,4 (leader) and 2,3,4 (trailer) — done numerically.

- Due to <u>area conservation</u>, loop over θ, r combinations until $A_\Delta + A_{segment} > 1$

$$A_{segment} = \frac{\theta - \sin\theta}{2} r^2$$

Result of the loop: r_L , r_T , $(\alpha_L + \beta_L)$, and $(\alpha_T + \beta_T)$

- Find <u>center of circles</u>:
  Formula based on rhombus enclosed for two points (x_1, y_1) and (x_2, y_2) lie on a circle of radius r.

$$x_a = \frac{1}{2}(x_2 - x_1) \qquad y_a = \frac{1}{2}(y_2 - y_1)$$

$$x_0 = x_1 + x_a \qquad y_0 = y_1 + y_a$$

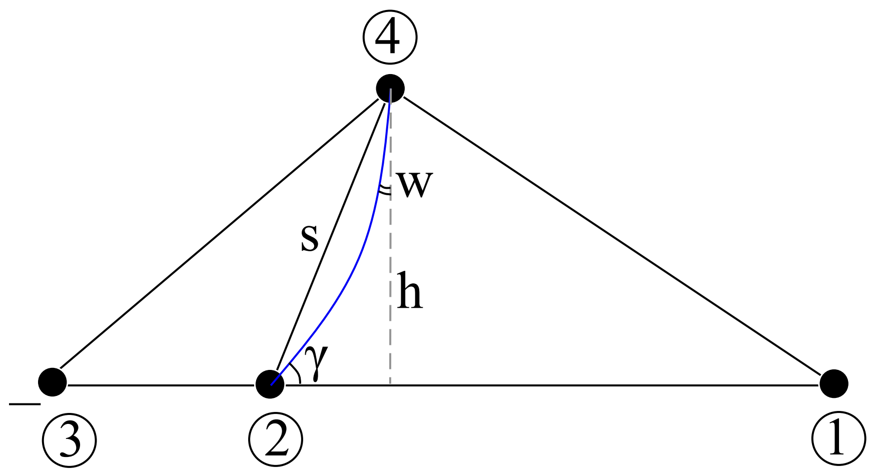
$$a = \sqrt{x_a^2 + y_a^2} \qquad b = \sqrt{r^2 - a^2}$$

$$x_c = x_0 \pm \frac{by_a}{a} \text{ and } y_c = y_0 \mp \frac{bx_a}{a}$$

- Find and isolate <u>angles</u> $\alpha_L, \alpha_T, \beta_L, \beta_T$ since

$$\sin \alpha_L = \frac{x_c - x_1}{r_L}$$

$$\sin \alpha_T = \frac{x_3 - x_c}{r_T}$$



- Compute the <u>cell-cell interface geometry</u>:

$$r_{cc} = \frac{t_{cc}}{t_T/r_T - t_L/r_L}$$

As above find the center of the circle defined by radius r_{cc} and nodes 2 and 4.

Lastly find the <u>angle of opening</u> (aka $2x$):

$$s^2 = 2r_{cc}^2 - 2r_{cc}^2 \cos(2x) = 2r_{cc}^2 \left(1 - \cos(2x)\right)$$

$$x = \frac{1}{2} \cos^{-1}\left(1 - \frac{s^2}{2r_{cc}^2}\right)$$

$\gamma = \ldots$ since $\sin(\gamma + x) = \dfrac{h}{s}$

$w = \ldots$ since $\dfrac{\pi}{2} = \gamma + w + 2x$

At this point the <u>morphology is known</u>.

- <u>Proceed</u> with the routine.

Example

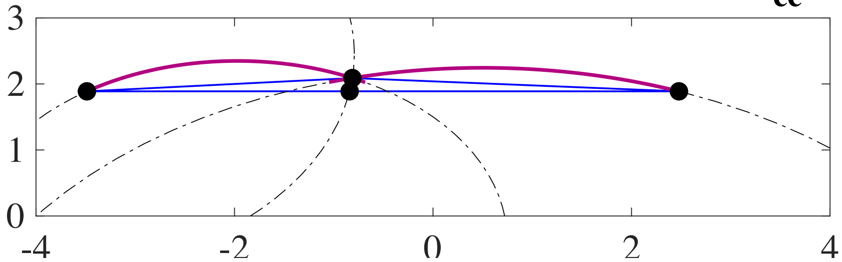
T = 0:

$\mathbf{r_L = 5.64, r_T = 2.72, r_{cc} = 3.4108}$

$\mathbf{t_L = 1, \alpha_L = 0.35753, \beta_L = 0.27847}$

$\mathbf{t_T = 1.2, \alpha_T = 0.59052, \beta_T = 0.49348}$

$\mathbf{x = 0.029604, \gamma = 1.4034, w = 0.10822, h = 0.2, t_{cc} = 0.9}$



$\mathbf{r_L = 6.84, r_T = 2.99, r_{cc} = 3.5275}$

T = 0.1:

$\mathbf{t_L = 1, \alpha_L = 0.31845, \beta_L = 0.21755}$

$\mathbf{t_T = 1.2, \alpha_T = 0.55406, \beta_T = 0.42994}$

$\mathbf{x = 0.03523, \gamma = 1.4574, w = 0.042919, h = 0.24774, t_{cc} = 0.9}$