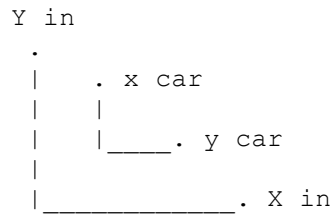


## EX. Inertial navigation

### Description:

A vehicle is moving in the 2D X-Y *inertial planar system*. Two accelerometers and a gyroscope are mounted on the vehicle. The accelerometers measure the accelerations in X, Y *Body system*; the gyroscope measures the angular velocity w.r.t. the Z-axis.



### Input data:

- File "Inertial\_data.dat" containing:
  - $t$  = observation epoch [s]
  - $ax\_car$  = acceleration in the x direction (in the *vehicle system*) [ $m/s^2$ ]
  - $ay\_car$  = acceleration in the y direction (in the *vehicle system*) [ $m/s^2$ ]
  - $\omega_{gaz}$  = angular velocity in x-y plane (in the *vehicle system*) [rad/s]
- $\alpha_0 = 0$  asset angle of the vehicle at first epoch [rad]
- $vx_0, vy_0, vz_0 = [0, 0]$  velocities of the vehicle at first epoch [m/s]
- $x_0, y_0, z_0 = [100, 100]$  coordinates of the vehicle at first epoch (in the *inertial system*) [m]

In this dataset, observation are simulated without errors!

- File "Inertial\_data\_errors.dat" containing same observations with realistic errors (see theory)

### Exercise:

Compute the trajectory of the vehicle in the *inertial system* and plot it (highlight in the plot the start and end points).

### Guidelines:

- 1) compute X Y velocities and Delta X Y positions between epochs in the *Body system* for each epoch from observed accelerations
- 2) compute asset angles  $\alpha$  for each epoch

- 3) for each epoch, use the asset angle  $\alpha$  to convert Delta X Y from the *Body system* to the *Inertial system*,
- 4) compute and plot the estimated trajectory of the vehicle in the *Inertial system* (in 2D).

Note for Delta computation in BS: general law of motion

$$x(t) = x_0 + \int_{t_0}^t v(\tau) d\tau, \text{ in case constant acceleration: } x(t) = x_0 + v_0(t - t_0) + \frac{1}{2}a(t - t_0)^2$$

Apply to the interval  $[t-1, t]$  and simplify, considering constant acceleration in  $[t-1, t]$ :

$$x_t = x_{t-1} + v_{t-1}\Delta t + \frac{1}{2}a_t\Delta t^2$$

Note for Alpha computation from BS to IS: same hypothesis on constant angular rate

$$\alpha(t) = \alpha_0 + \int_{t_0}^t \omega(\tau) d\tau \quad \Rightarrow \quad \alpha_t = \alpha_{t-1} + \omega_t\Delta t$$

##Next year add notes for R