Bay of Biscay Project

# Erosion and Image Contractor And Platooning Approach to form a chain

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# Summary

- Ellipse Strategy
- Erosion OpenCV
- Image contractor
- Platonning

# Presentation


# Presentation

- Two problems:
  - Find a strategy to cover all the area
    → Ellipsoid strategy
  - Define a criteria to validate the strategy algorithm
    → Interval Analysis

# Formalism of the problem

The secure zone is represent by this State Equation:

$$\mathbb{X}(t) = \mathbb{G} \cap \mathbb{F}_\delta(\mathbb{X}(t-\delta)) \cap \bigcap_i g_{a_i(t)}^{-1}([d_i(t), \infty])$$

Where $\mathbb{X}(t)$ represents the complementary of the secure zone

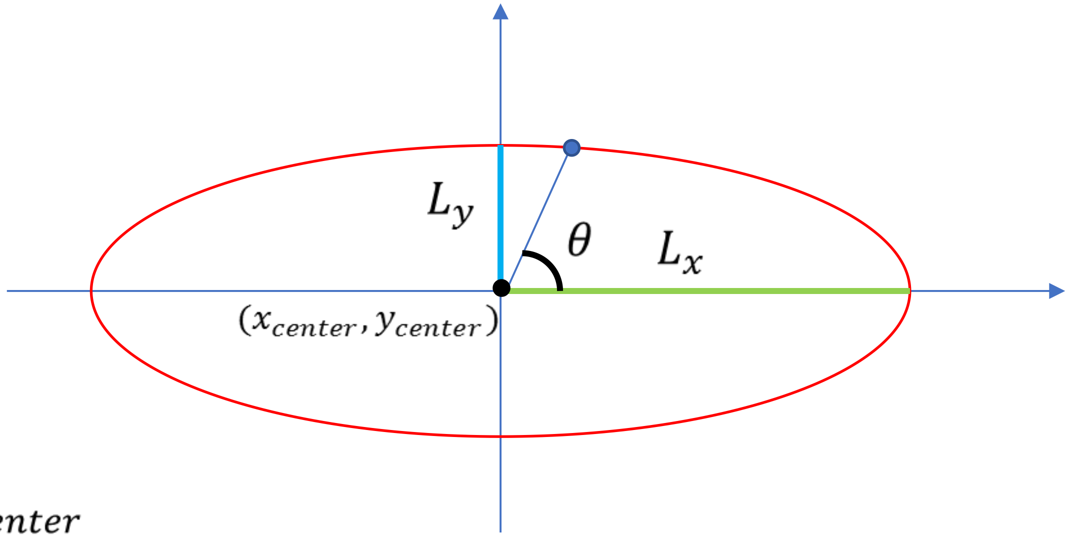
Where $\mathbb{G}$ reprensents the Bay of Biscay

Where $\mathbb{F}_\delta(\mathbb{X}(t-\delta))$ represents the potential ennemy

Where $\bigcap_i g_{a_i(t)}^{-1}([d_i(t), \infty])$ represents the instantaneous complementary secure zone.

# Ellipsoid Strategy

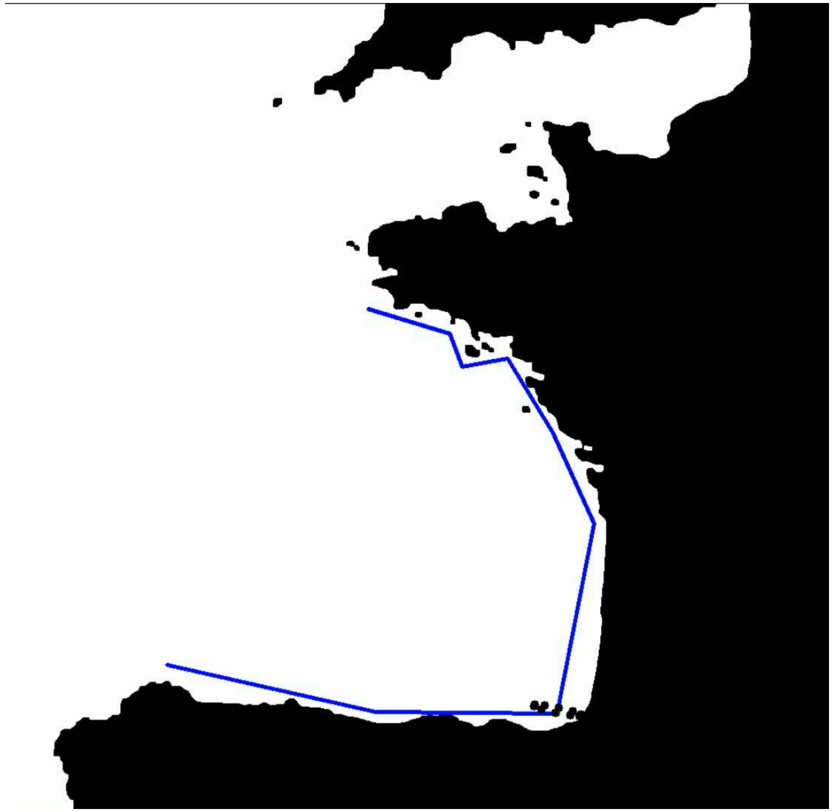
$$\begin{cases} x = L_x \cos(\theta(t)) + x_{center} \\ y = L_y \sin(\theta(t)) + x_{center} \end{cases}$$

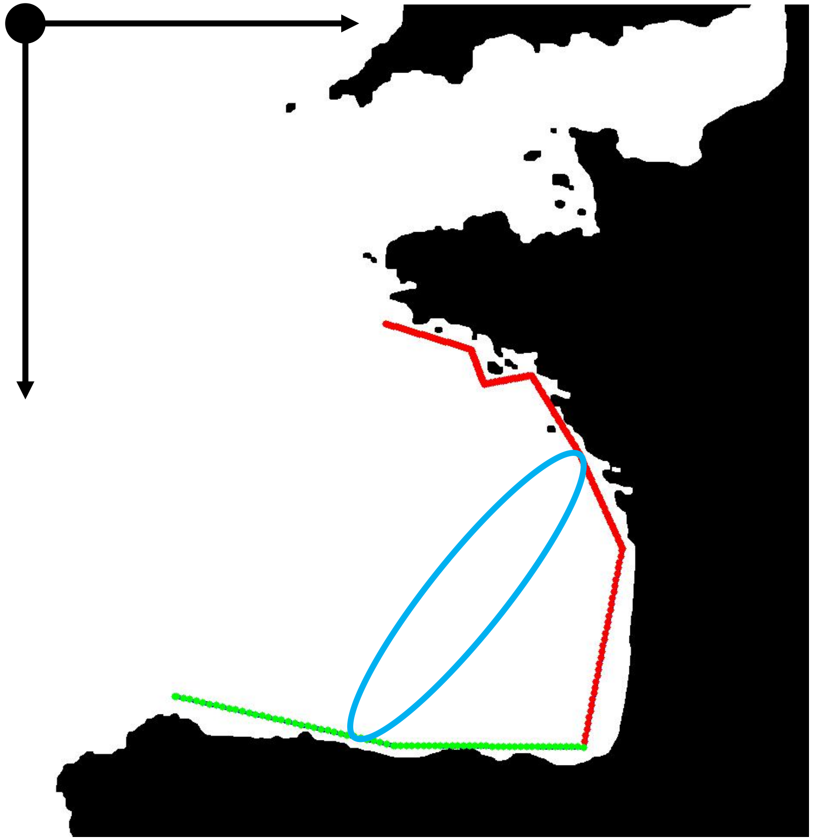



For the i-th robot,

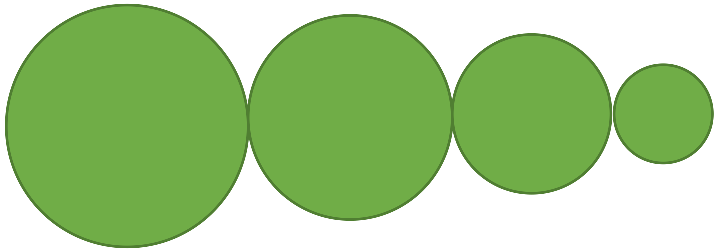
$$\begin{cases} x = L_x \cos\left(\theta(t) + \frac{2\pi i}{n_{robots}}\right) + x_{center} \\ y = L_y \sin\left(\theta(t) + \frac{2\pi i}{n_{robots}}\right) + y_{center} \end{cases}$$

# Ellipsoid Strategy

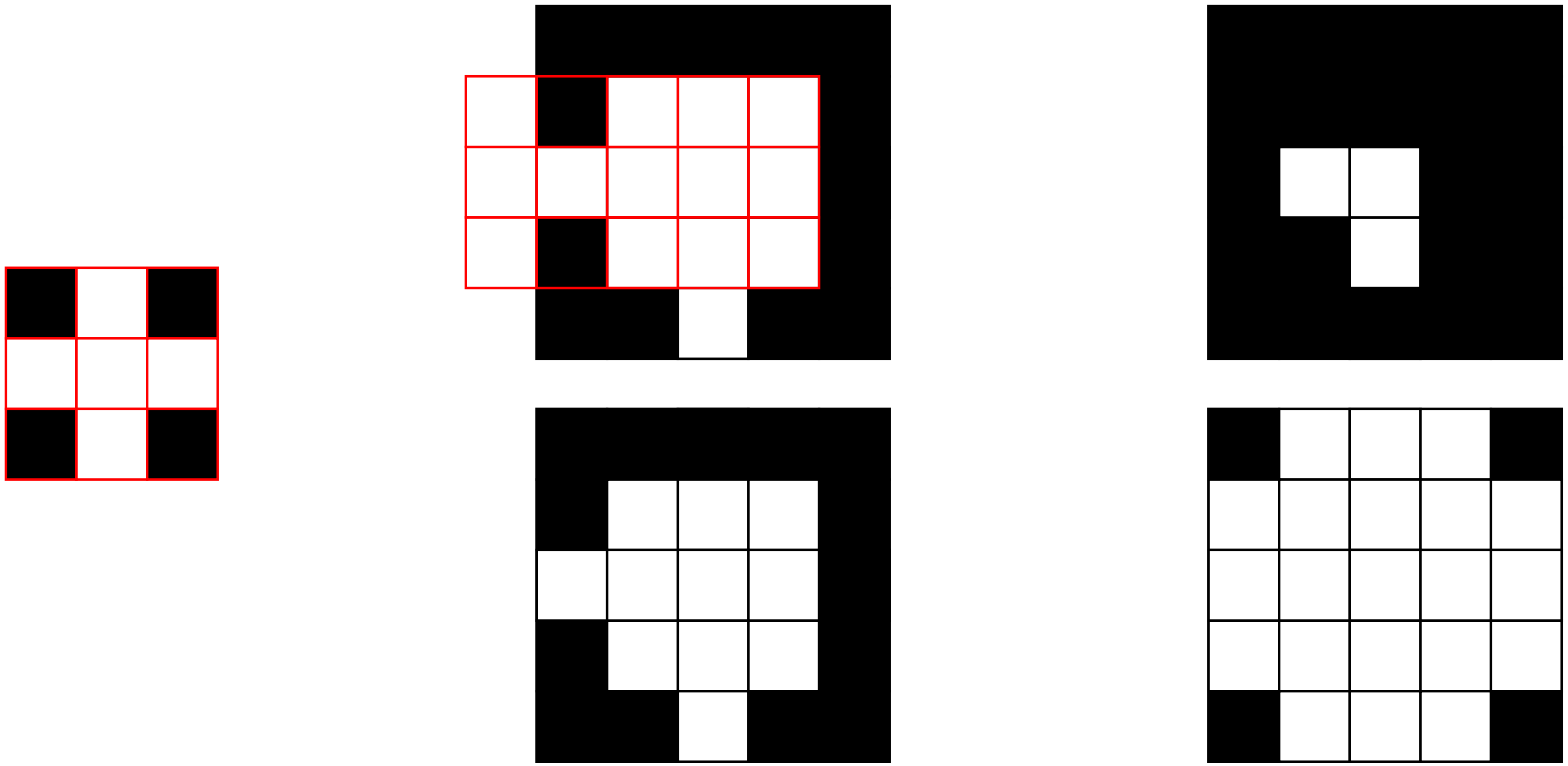




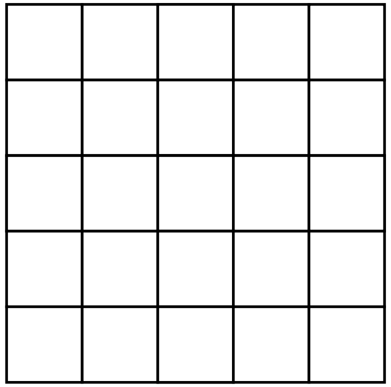
# Trail

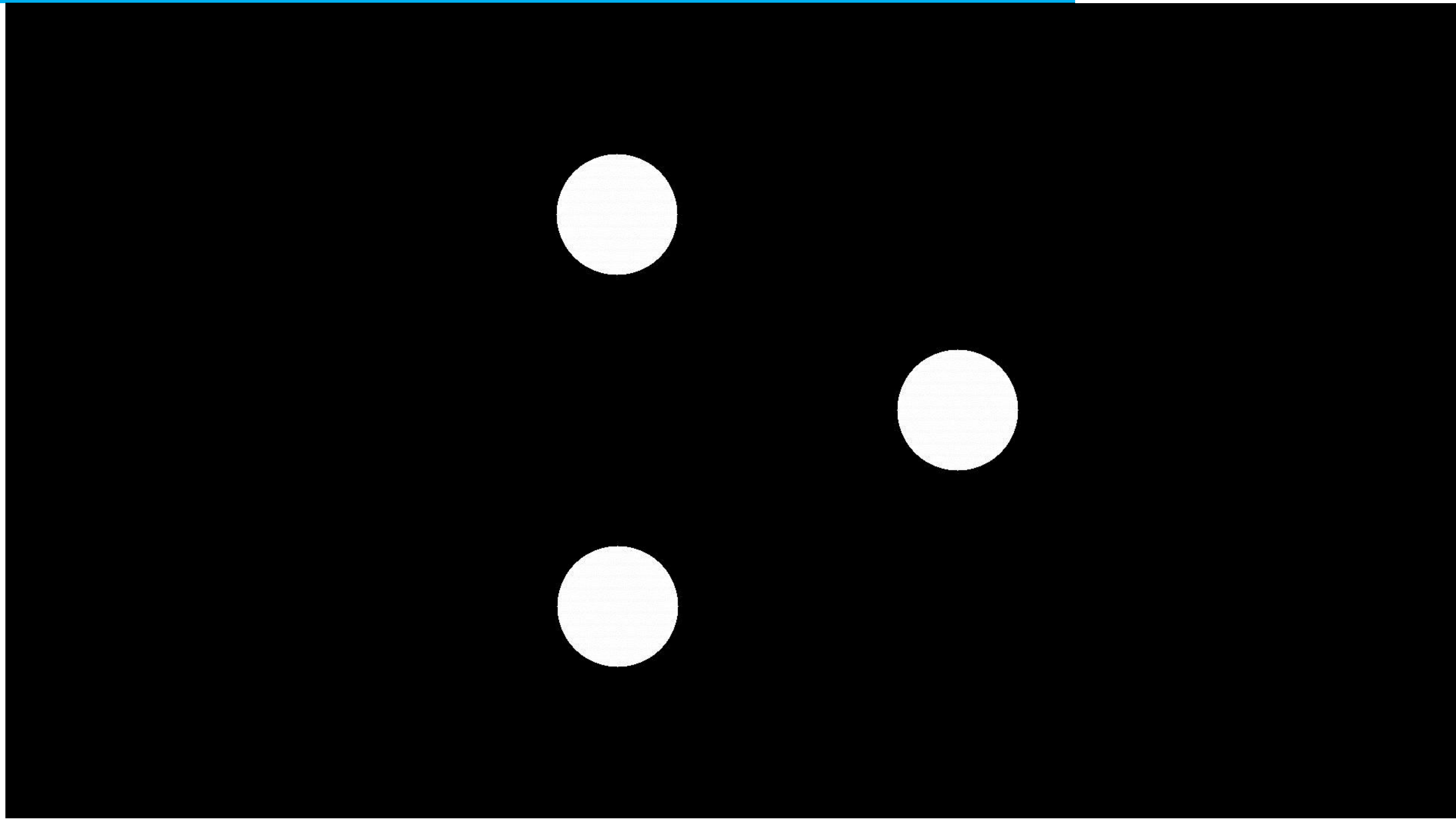


# Erosion

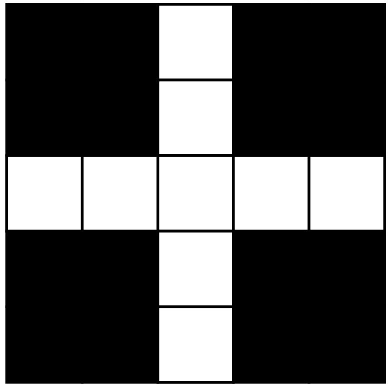


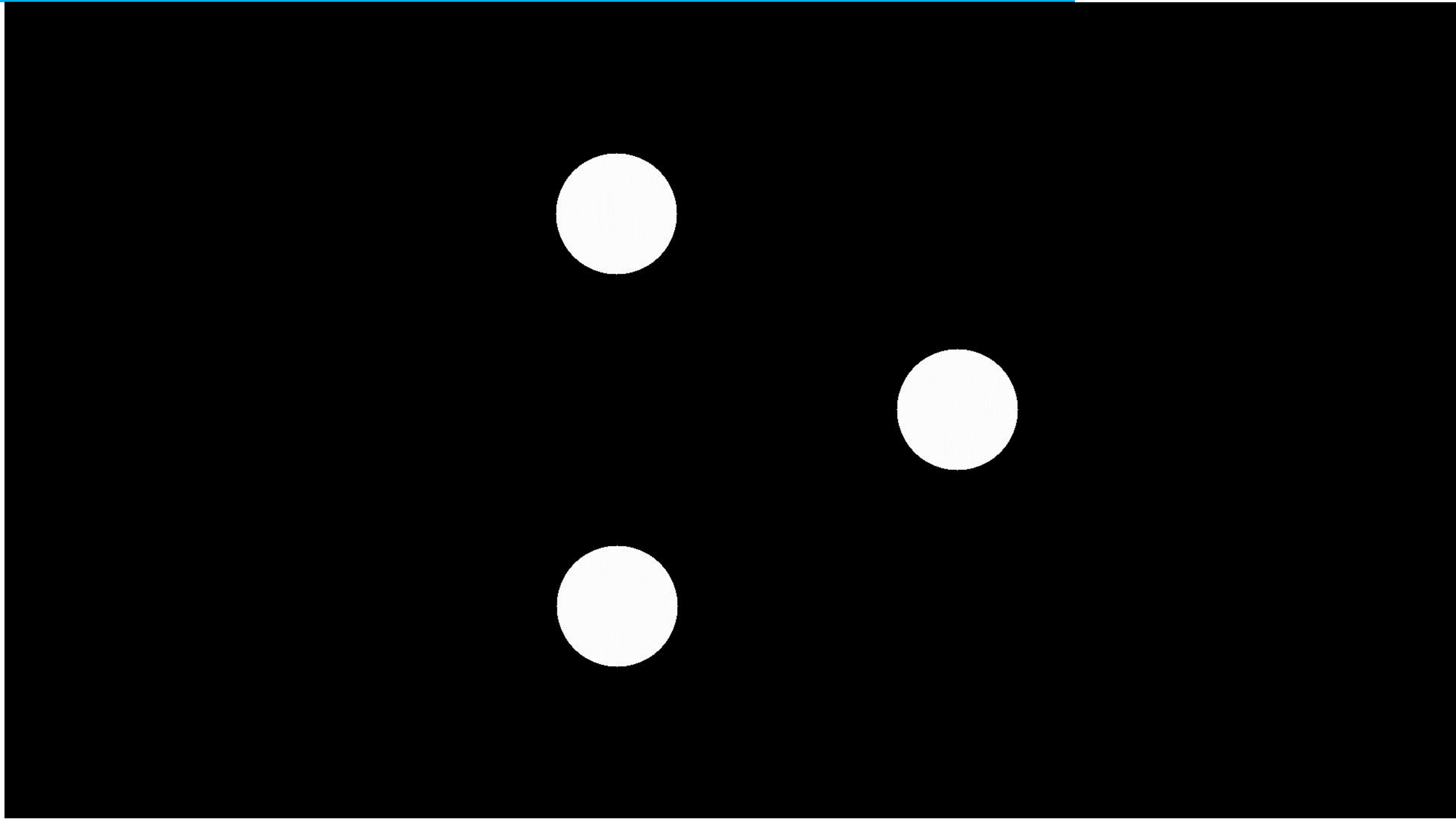
# Erosion Rectangle Kernel



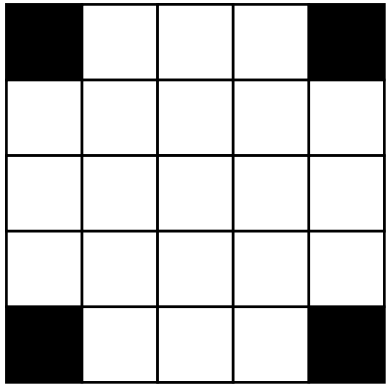


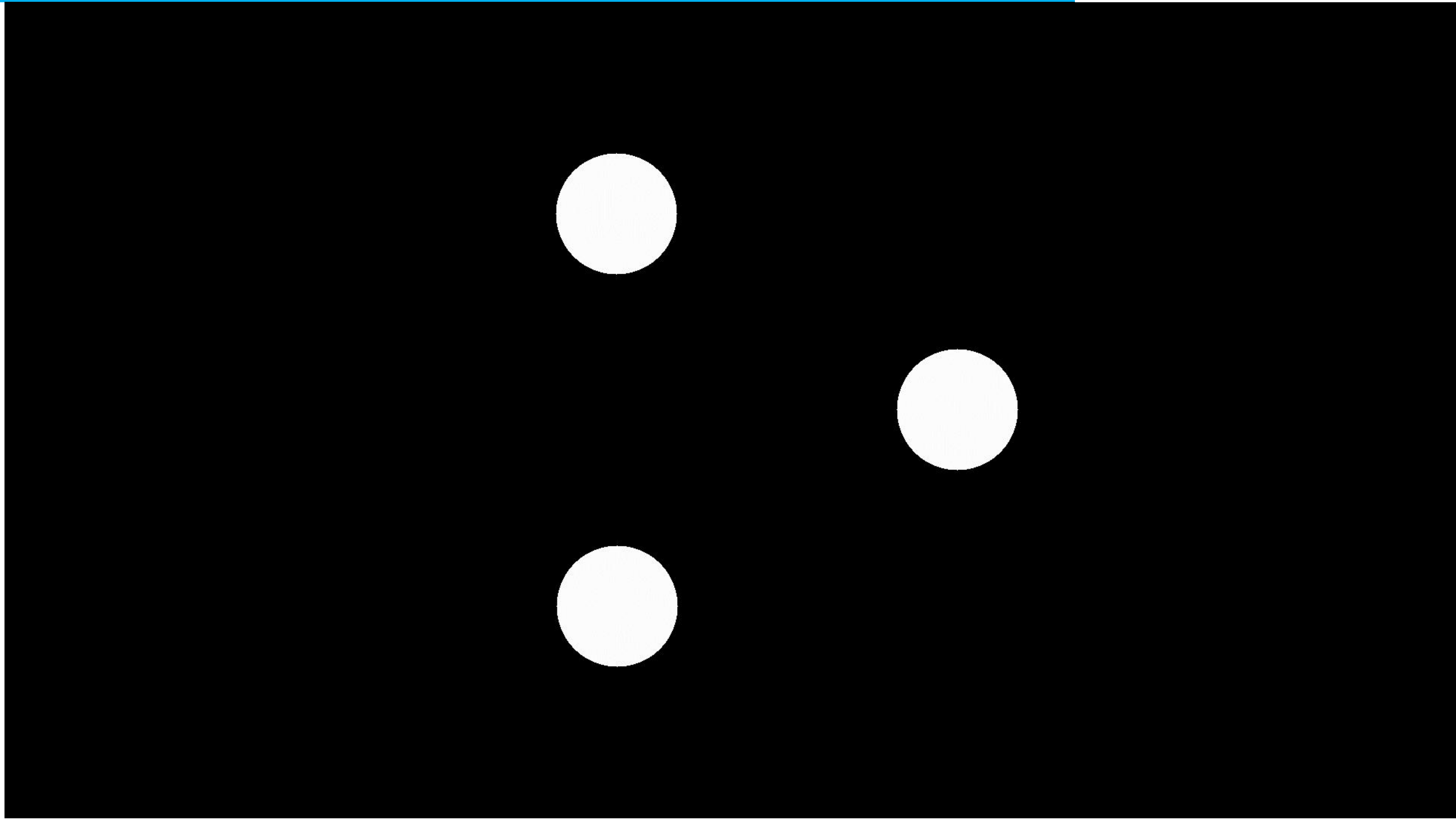
# Erosion Cross Kernel



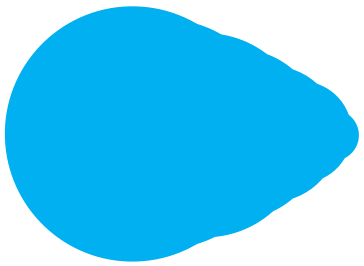


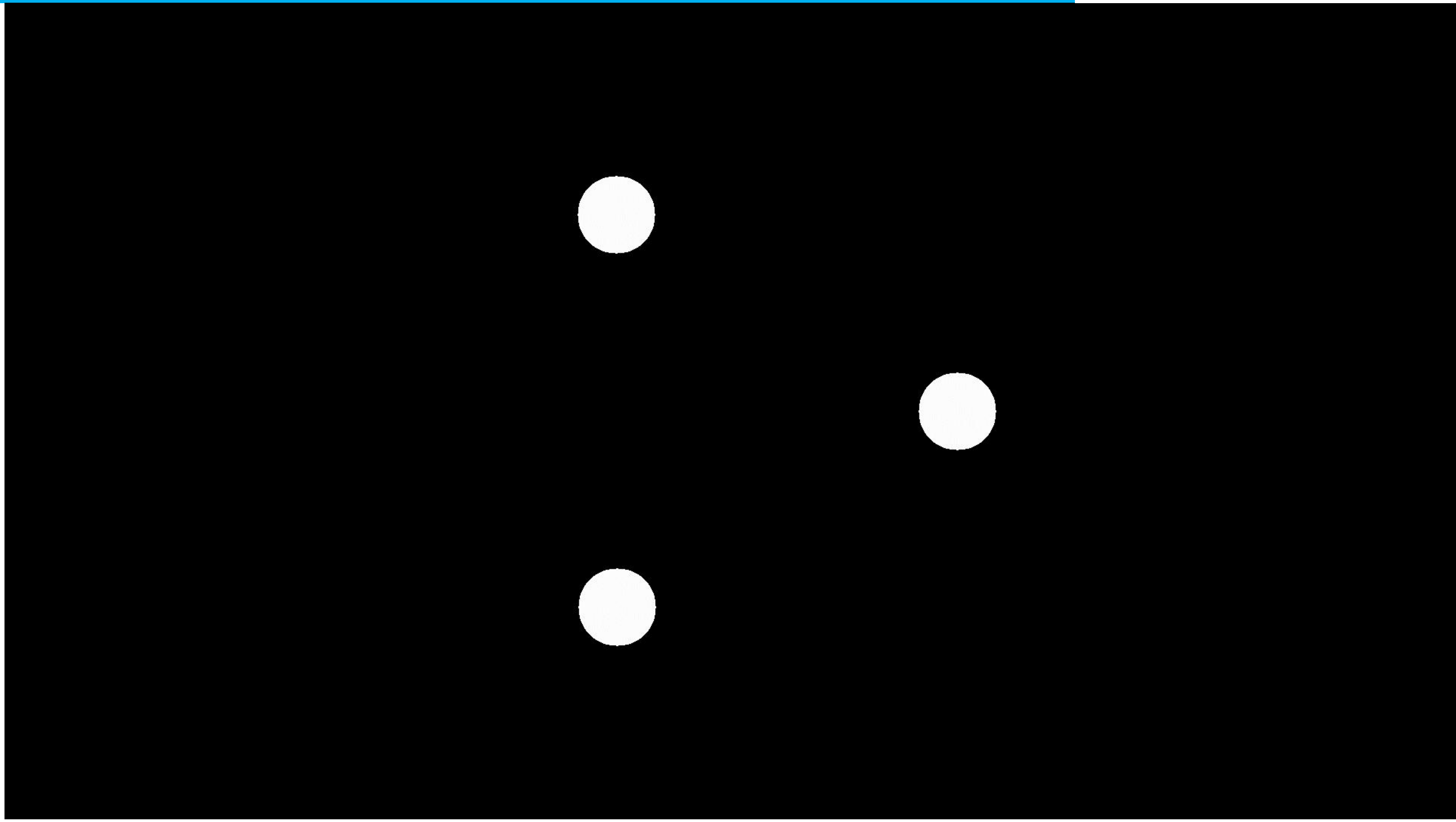
# Erosion Ellipse Kernel





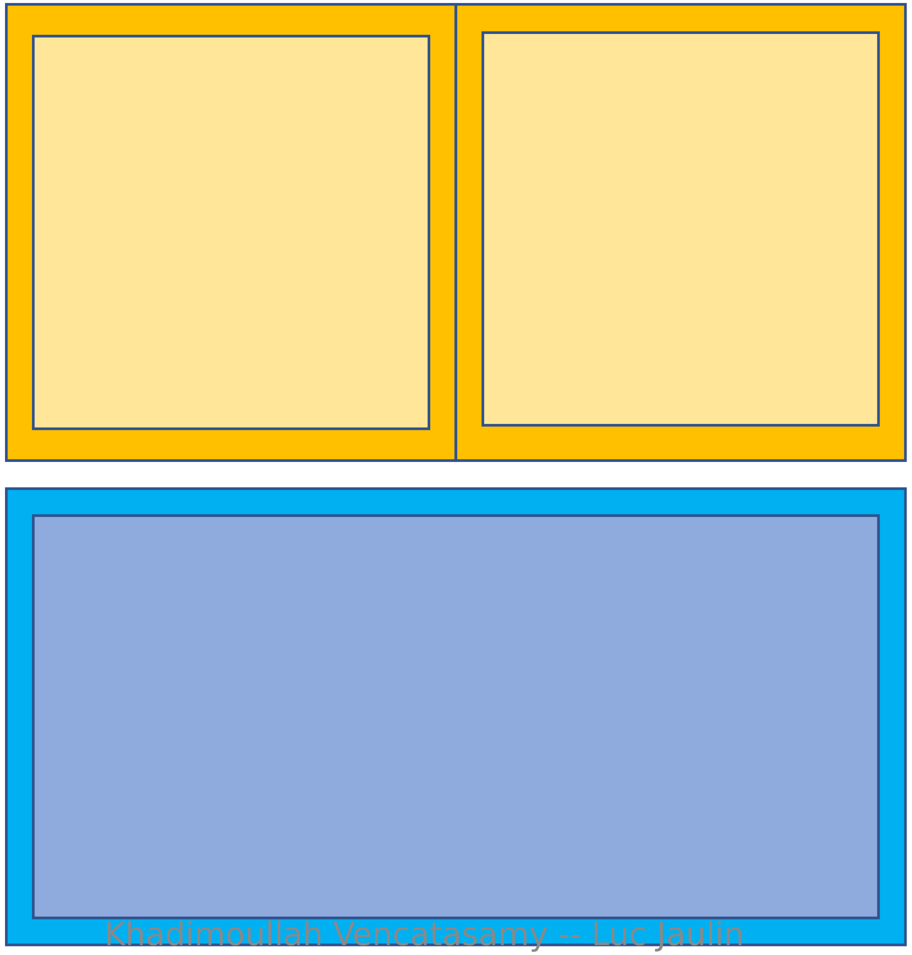
# Trail with Circles



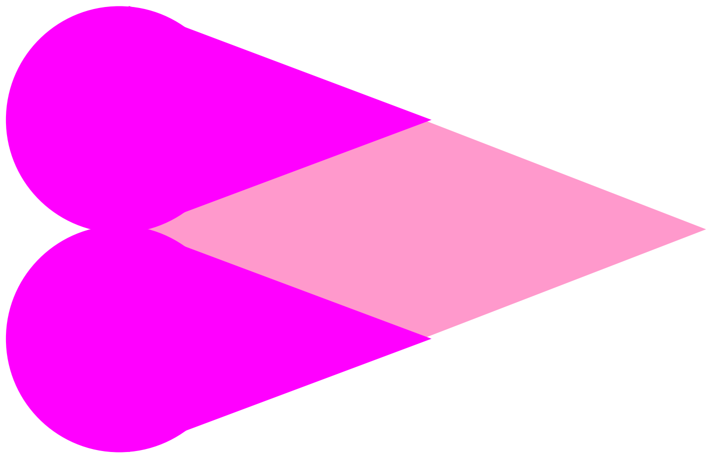


# Erosion vs Trail With Circles

$\dot{M} \cup \dot{N} \subset (M \dot{\cup} N)$



# Erosion vs Trail With Circles

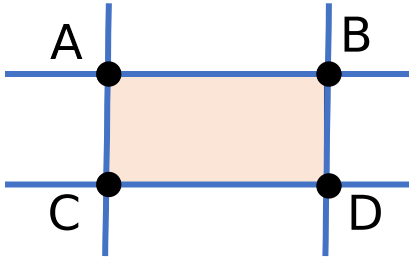


# Image Contractor

Binary Image → Compute the Integral Image → SIVIA → **Subpaving**

IN = White

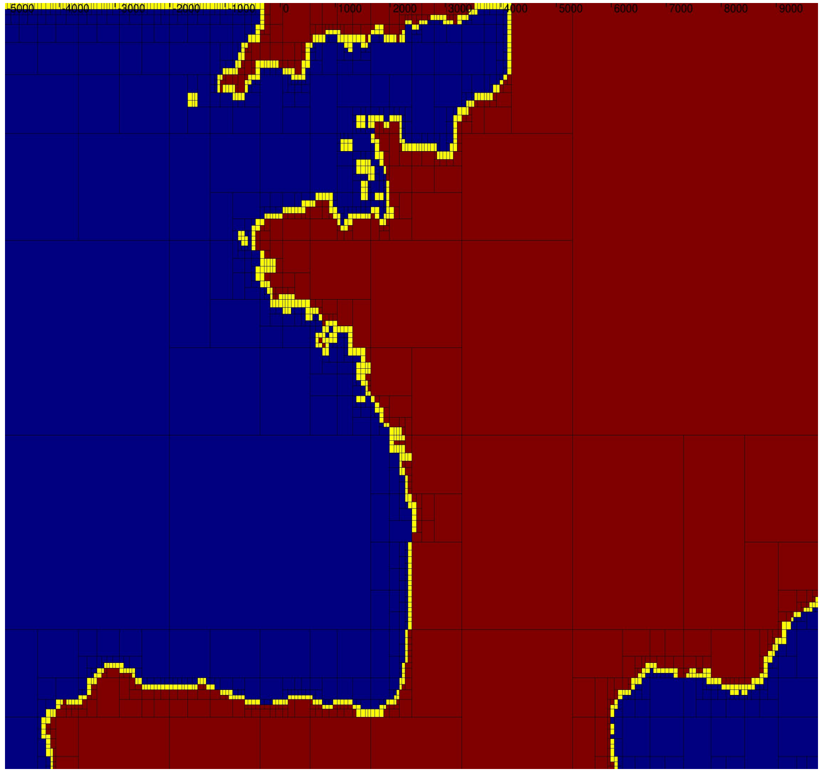
Out = Black

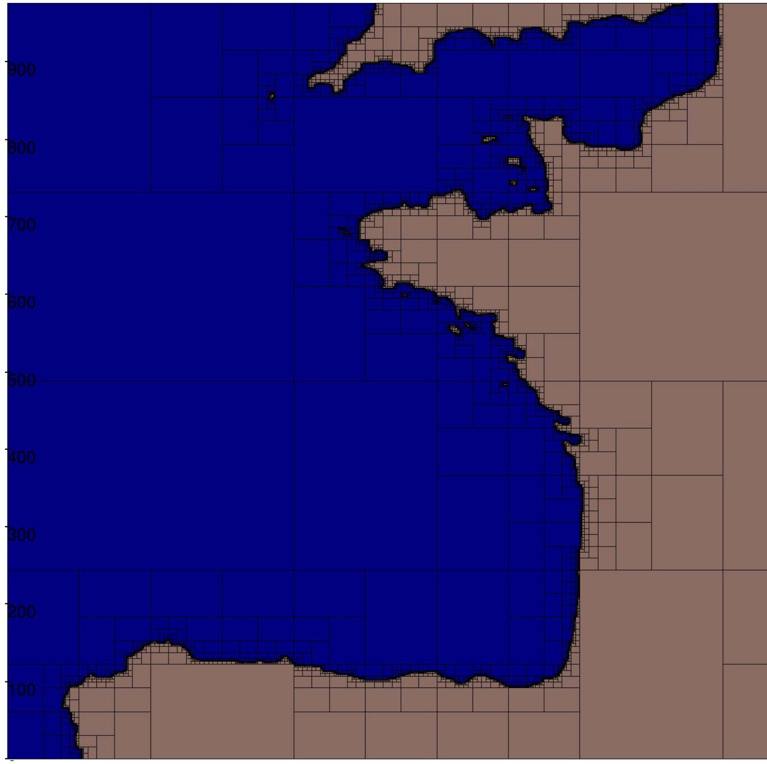



S = D - B - C + A

```
Test(S)
{
If S = 0:
    Then OUT
If S = NbPixelInRect :
    Then IN
Else:
     UNKNOWN
}
```

# Image Contractor





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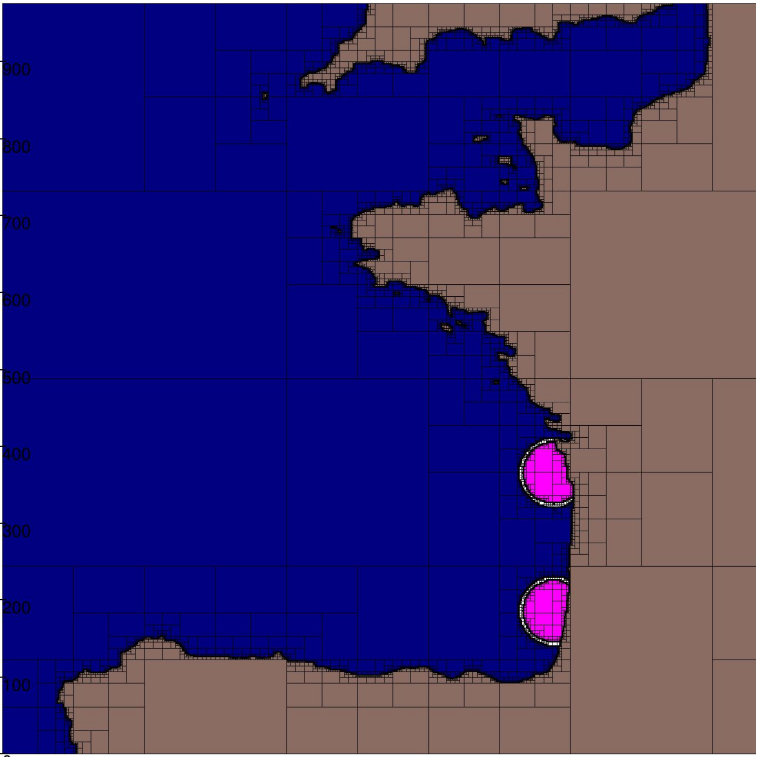

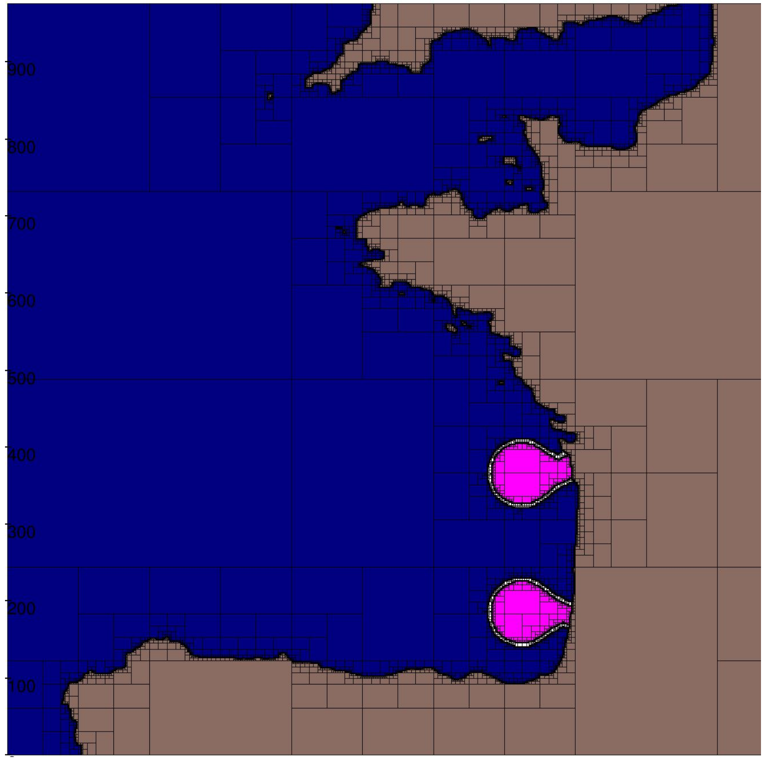

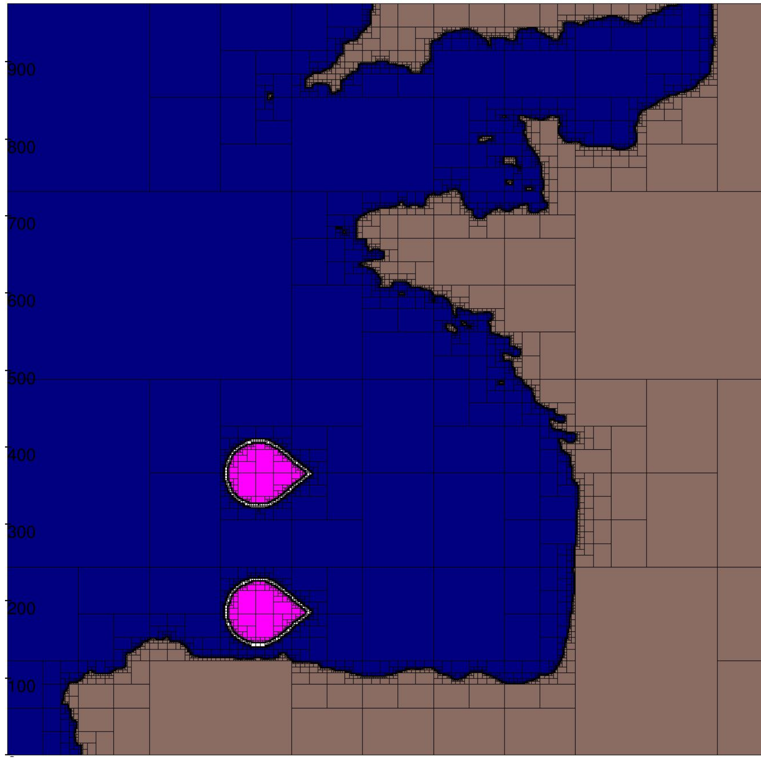

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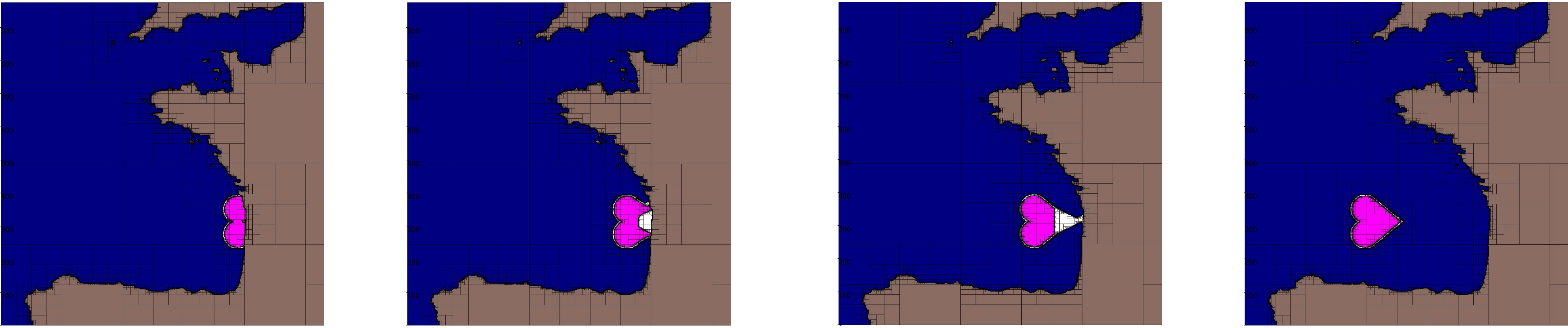
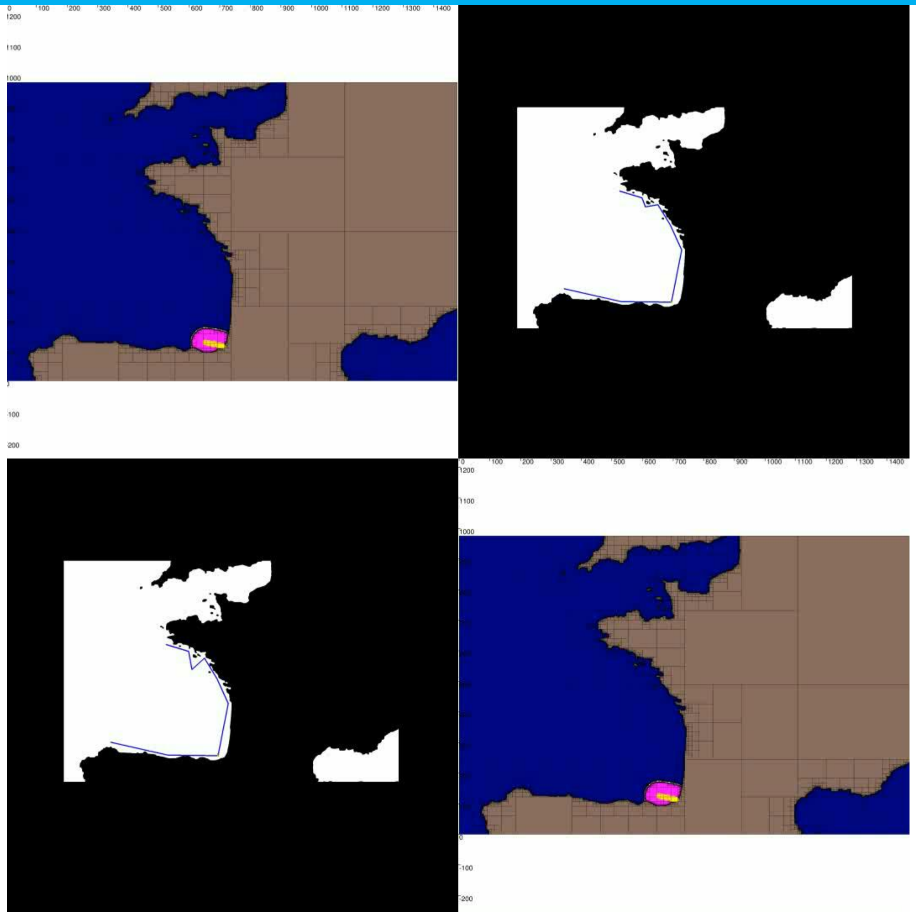


# Final Results



# Next Work

- Use dilate function in pyIBex instead of OpenCV
- Regulation of the robots
- Non causal case
- Intruder Interception
- Simulation / Experiment

# Next Work

Use dilate function in pyIBex instead of OpenCV

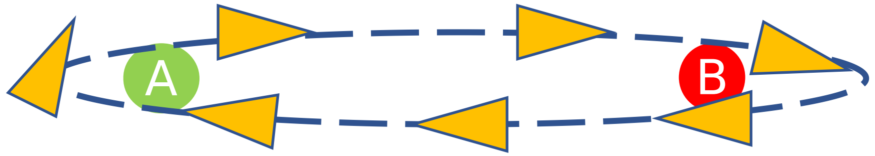
Regulation of the robots

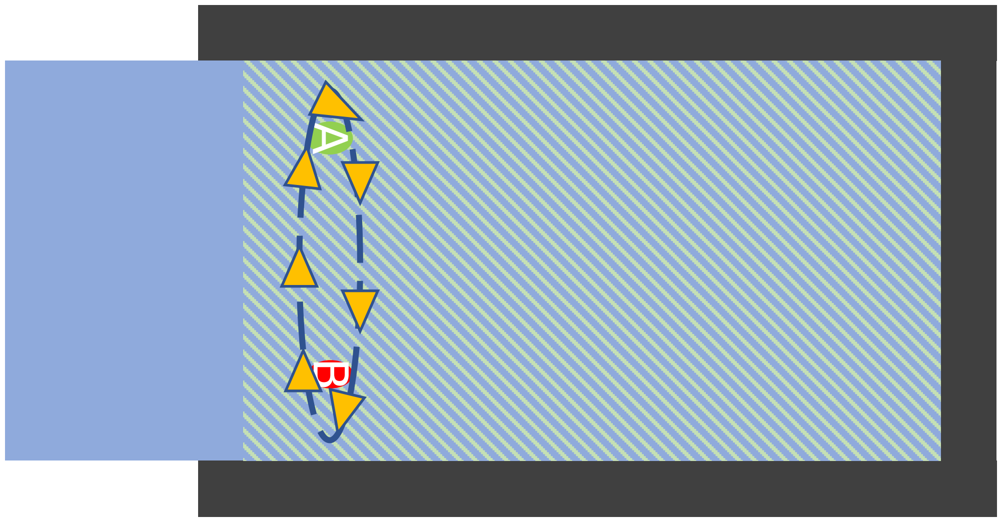
Non causal case

Intruder Interception

Simulation / Experiment

# Formation of a chain between two points



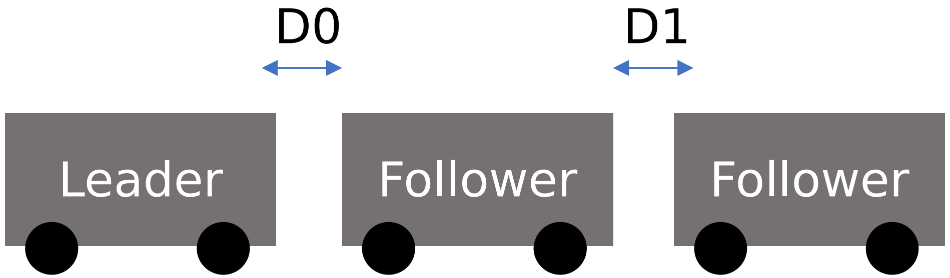



# Platooning

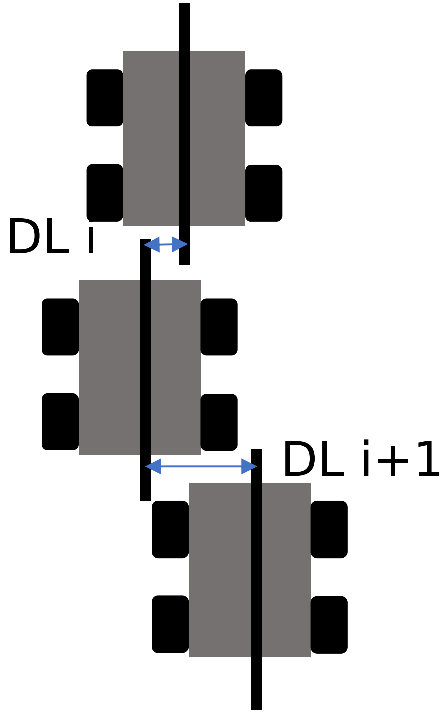

- The leader decides the path and communicate its position, speed, the path it has been chosen to all the followers.
- The follower got the data of the leader and the distance and speed of its predecessor.

# Platooning

- There is the longitudinale control




- There is the lateral Control



# Platooning

- Differents approaches exists which can be divided in two categories:
  - Local Approach
    - The robot does not rely on the other robots which increase the robustness of the system
    - The cost to regulate the robot is low
    - The stablitity is reduced due to the time to converge to the target position and the accumulation of the errors.
  - Global Approach
    - Need strong communication between each robots
    - Cost to regulate the system is high
    - Highly stable
    - Robustness is reduced, if one element of the platoon fails, the chain will break.

# Platooning

- We consider in our case that you could have a large number of robot and in our environment, communication could be a problem.
  - → We should adopt a local architecture
  - →Stability will be the main problem of the system
  - →Define a command law to avoid the oscillations
  - →Lyapunov function

# Platooning

- Two Scenarii
  - The robot maintain a distance considering its predecessor with a visual regulation and knowing the path it should follow
  - The robots are following their path and if they see and communicate rarely with the opposite coming robot