MULTIPLE 2D AND 3D OBJECT EXTRACTION USING POINT PROCESS

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Abstract

We introduce a new probabilistic approach for multiple object extraction from still images, applied to 2D and 3D objects. A new model based on 3D scene simulation is applied to counting of penguins in colonies from images with perspective effects. In the 2D model, we introduce a new optimization method combining Multiple-Birth-and-Death and Graph-Cut. Our model is *object based* and embedded in a marked point process. A Gibbs energy is defined on the configuration space, taking into account both prior and data information, and we minimize it.

Context

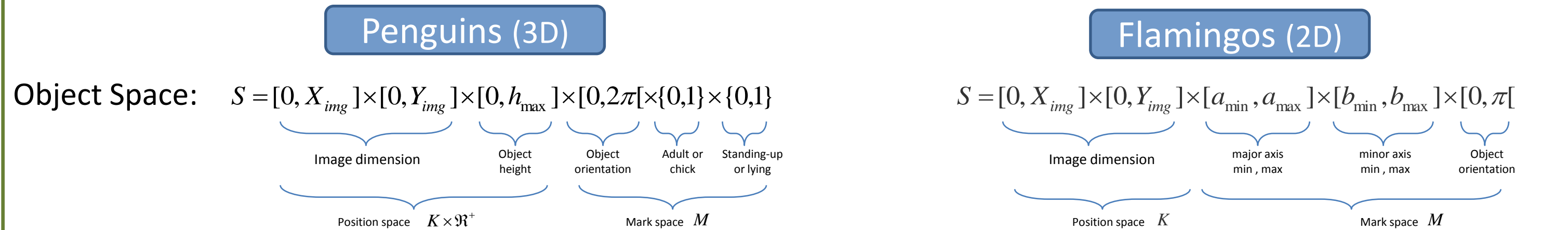**Aim**: Penguin and flamingo counting in colonies, for *Ecological* interest

Data: Images from ground using standard camera, (penguins) and aerial images (flamingos)
Ecologists of "Tour du Valat"

Proposed method:
Marked Point Process

Conclusion

3D model:
• The proposed algorithm gives promising results for *multiple object extraction* under *occlusion* and *perspective effects*.
• Simulation allows the use of accurate geometrical models (any object)

2D model:
Major advantages of the new optimization method are:
• reduces the number of the model parameters
• the model became highly parallelizable.

Acknowledge

Ecologists of "Tour du Valat":
• providing the images
• evaluating the flamingo counting results
• their contribution in the definition of an imaging acquisition protocol for the penguin colonies

Proposed model

Penguins (3D)

Object Space: $S = [0, X_{img}] \times [0, Y_{img}] \times [0, h_{max}] \times [0, 2\pi[\times \{0,1\} \times \{0,1\}$

- Image dimension
- Object height
- Object orientation
- Adult or chick
- Standing-up or lying

Position space $K \times \Re^+$ · Mark space M

Flamingos (2D)

$S = [0, X_{img}] \times [0, Y_{img}] \times [a_{min}, a_{max}] \times [b_{min}, b_{max}] \times [0, \pi[$

- Image dimension
- major axis min, max
- minor axis min, max
- Object orientation
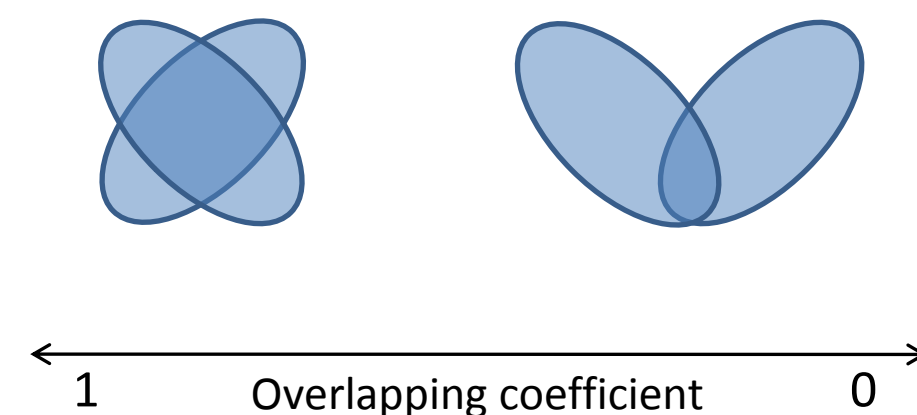
Position space K · Mark space M

Configuration Space: $\Omega = \bigcup_{n=0}^{\infty} \Omega_{n,} \quad \Omega_n = \{\{\omega_1, ..., \omega_n\} \subset K \times M\}$
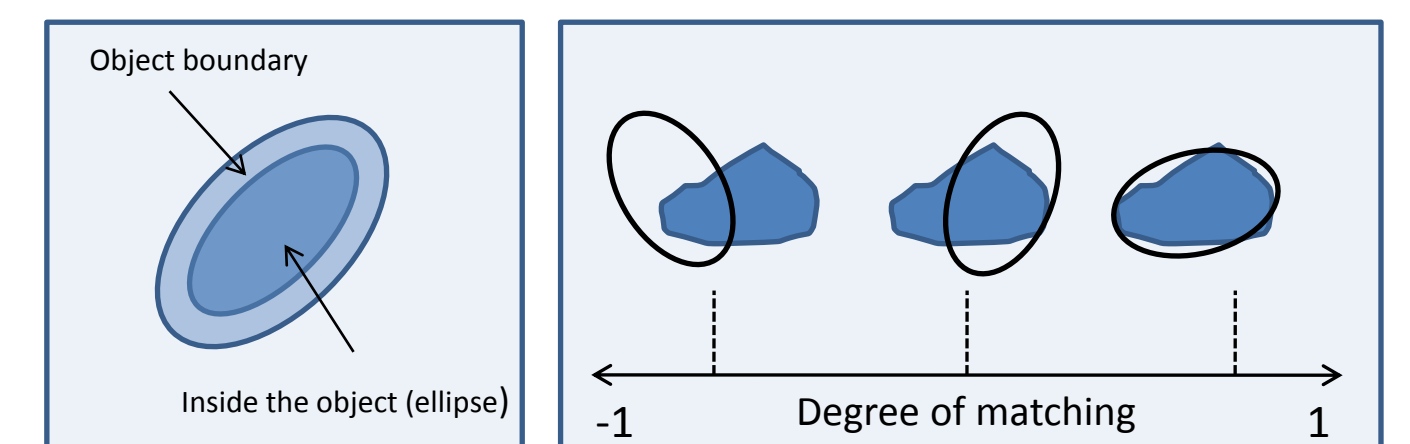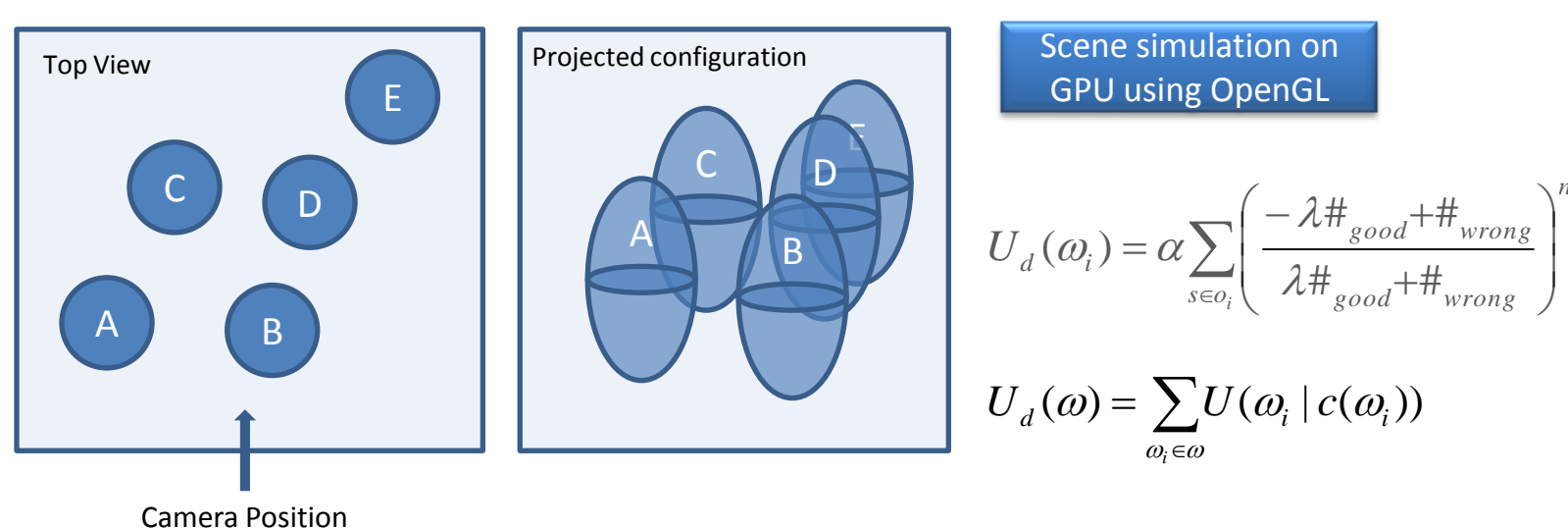
Gibbs density define on the configuration space: $h(\omega) = \dfrac{1}{Z} \exp -\{U_d(\omega) + \gamma_p U_p(\omega)\}$ (a prior energy and a data energy)

Prior energy: $U_p(\omega) = \sum_{\omega_i \sim \omega_j \in \omega_i \sim \omega_j} \max O(\omega_i, \omega_j)$

1 ——— Overlapping coefficient ——— 0

Data energy:

Top View · Projected configuration · Scene simulation on GPU using OpenGL

$U_d(\omega_i) = \alpha \sum_{s \in \omega_i} \left(\dfrac{-\lambda \#_{good} + \#_{wrong}}{\lambda \#_{good} + \#_{wrong}} \right)^n$

$U_d(\omega) = \sum_{\omega_i \in \omega} U(\omega_i \mid c(\omega_i))$

Camera Position

Object boundary · Inside the object (ellipse)

-1 ——— Degree of matching ——— 1

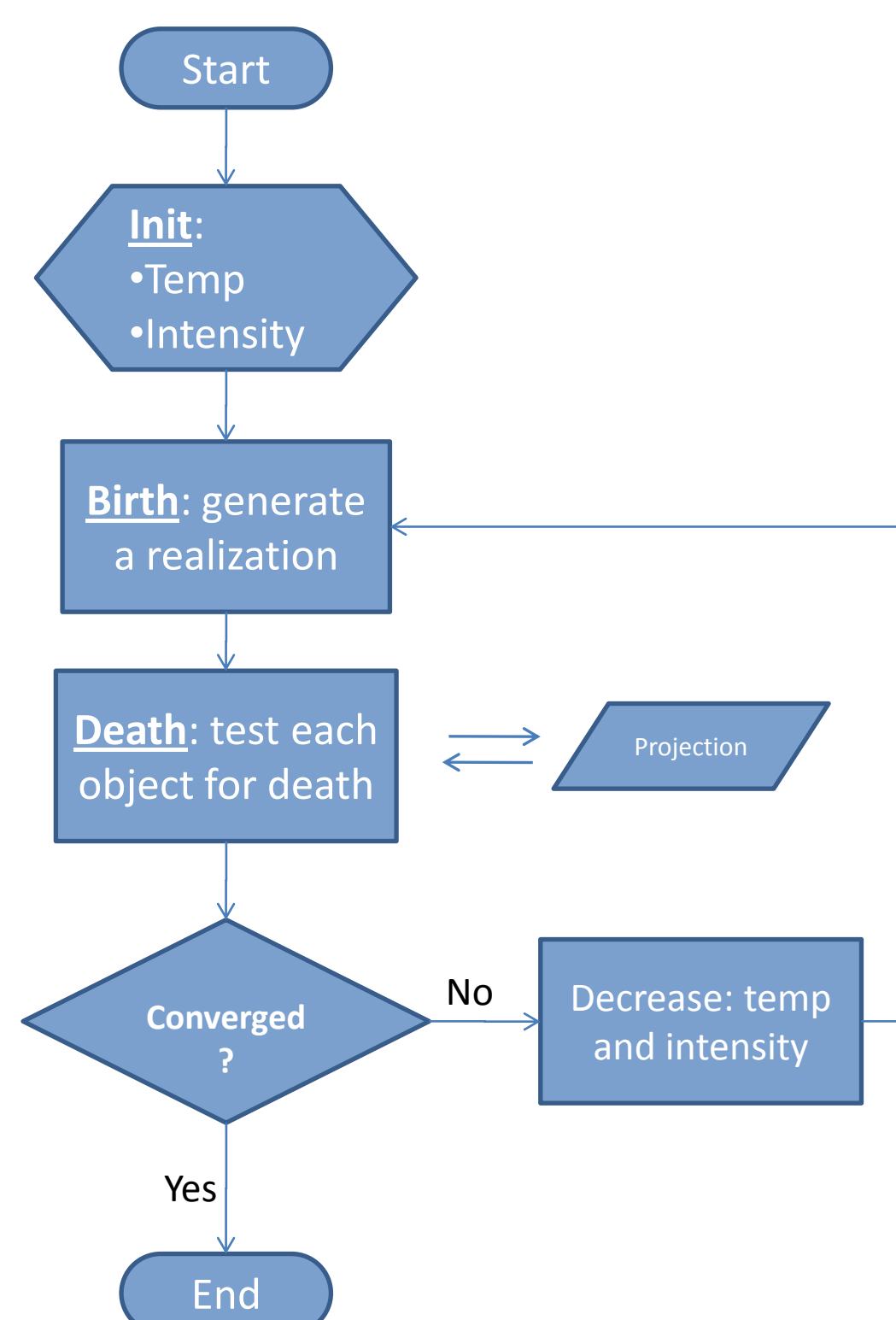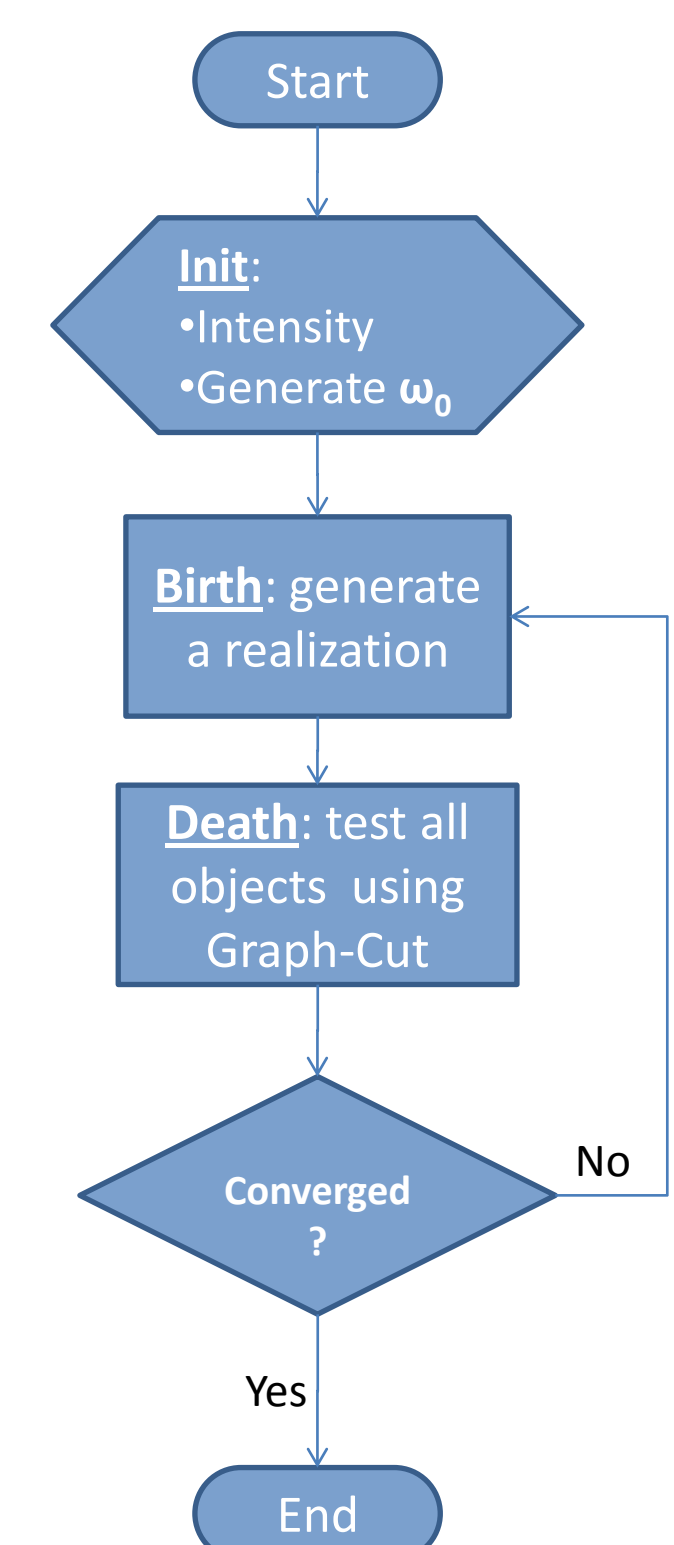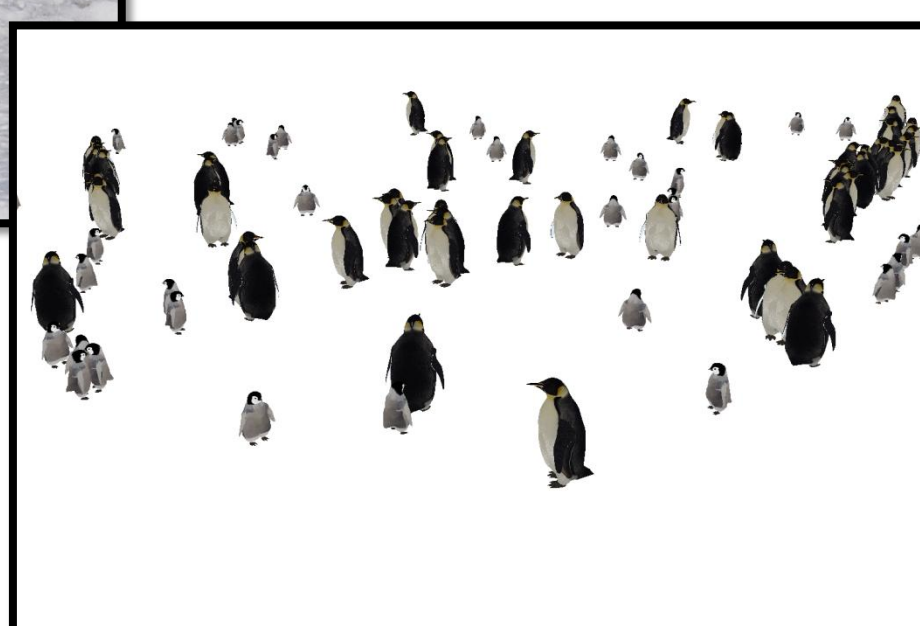*Bhattacharya distance* between the object and its boundary

Camera parameter:
• For the 3D scene, we manually approximate those parameters for the real images
• A new method for estimation based on stochastic grid will be integrated

Optimization algorithms

Multiple Birth and Death (MBD) (3D model)

Start → **Init**: •Temp •Intensity → **Birth**: generate a realization → **Death**: test each object for death ⇄ Projection → **Converged?** — No → Decrease: temp and intensity → (loop to Birth) / Yes → End

Combined MBD and Graph-Cut (2D model)

Start → **Init**: •Intensity •Generate ω_0 → **Birth**: generate a realization → **Death**: test all objects using Graph-Cut → **Converged?** — No → (loop to Birth) / Yes → End

Results

Penguins (3D)

Semi-synthetic image

Input © Ariana / INRIA
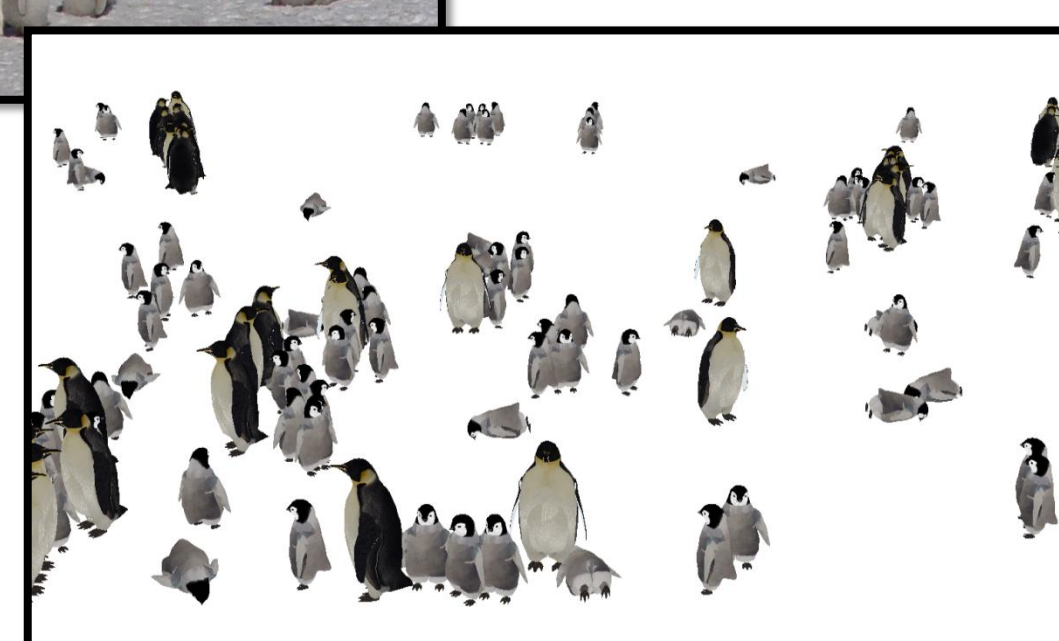

Output © Ariana / INRIA

Real image

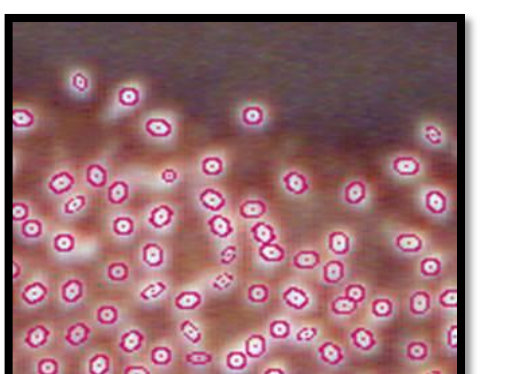Input © Tour du Valat

Output © Ariana / INRIA

Flamingos (2D)

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Flamingo colony in France
© *Tour du Valat*