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## **LA et Deep Learning** Applications dans la Sécurité Routière

### IA et deep Learning

• Deep neural networks (DNNs) have enabled significant progress in many application domains

- Computer vision, Natural Language Processing (NLP), Industry 4.0
- Design of DNNs has proven to be critical
- Currently employed DNN architectures have mostly been developed manually by human experts
  - Time-consuming
  - Error-prone process
  - Prevents finding new architectures that go beyond the human domain knowledge
- Growing interest in Automated Neural Architecture Search (NAS) and Hyperparameters Optimization (HPO)
  - Accuracy (Precision)
  - Latency (Inference time), Hardware cost, ...



SYSTEMS

### IA et deep Learning

- Machine learning
  - Gives computers the ability to learn without being explicitly programmed
  - Supervised, unsupervised, semi-supervised
- Neural network
  - Features Big unstructured data (images, text, video, ...)
  - Learn the mapping between features and predicted classes
  - Extract high-level features from low-level ones
  - High-performance accuracy
- Deep Neural Networks (DNNs)
  - Feed-forward / Recurrent
  - Convolution CNN
  - Transformers
  - Graph Neural Networks (GNN)
  - Generative Adversarial Networks (GAN)
  - ...



Class Probabilities





# Al-powered software to support road management



Spreading transportation intelligence

### **Artificial Intelligence to support road management**

Cyclope.ai is a **software publisher** specialized in artificial intelligence applied **to image processing video and analysis**. It develops, designs and markets software solutions for **road infrastructure operators and traffic managers**.



### Facing the challenges of road operations



A unique expertise to maximize the use of cameras already installed



#### FROM OBSERVATION

unstructured image data, difficult for the operator to handle...

>

#### **TO UNDERSTANDING**



...towards qualified information for decision making

#### **SA**FETY

For safer roads

### INTELLIGENCE

Enhanced decision making

**SA**VINGS

Cost effective solutions

### **EFF**ICIENCY

Automation and simplified processes

#### **FL**UIDITY

Optimized management of flows in real time

### Scientific expertise to design technological bricks

Cyclope.ai has developed several technological bricks, which it then assembled to build robust and industrialized solutions

#### **Functions**



# Produits et Réalisations

# PROJET SAM : DEVELOPPEMENT SOLUTION 12V



Dans le cadre du consortium SAM (Sécurité Acceptabilité de la conduite et de la Mobilité Autonome), Cyclope développe une solution temps réel de données trafic, incidents et infrastructure extraites des caméras et redirigées vers des véhicules autonomes.





## EUROVIA UK : POC CLASSIFICATION DEFAUTS DE ROUTE 24



Classification de type de défaut sur la route pour le compte de Ringway (Eurovia UK). Le but est de classifier automatiquement les photos envoyées par le public selon leur type et leur gravité, afin d'éviter un travail de vérification manuel par les inspecteurs.





### VCG : CLASSIFICATION DU MARIN TUNNELIER





cvclope ai

24

• détection du tapis qui déborde

# **Tunnel Watch**

Actuellement en prod

### INCIDENT DETECTION PROBLEM FOR TUNNELS The origin





The Mont Blanc tunnel fire broke out between 24 and 26 March 1999. It was caused by a semi-trailer refrigerated truck that caught fire around 11 am , about 7 km from the French entrance to the tunnel. The fire that followed **killed 39** people and caused the tunnel to close for 3 years.

It lasted nearly 53 hours and caused the destruction of 24 heavy vehicles, 9 light vehicles and 1 motorcycle, without taking into account the two emergency vehicles immobilized in the tunnel without being able to intervene. The following trial established that **emergency procedures and security measures had not been followed for many years**.

## **INCIDENT DETECTION PROBLEM FOR TUNNELS**

Specifications of an Automatic Incident detection system for tunnels

Incident Category	Performance	Detection time	Maximum False Alarm (FA) rates FA/Cam/day
Stopped vehicles	> 97%	< 10sec	<1 FA/cam/12days
Wrong way vehicles	> 97%	< 5 sec	<1 FA/cam/12days
Pedestrian	> 90%	< 20sec	<1 FA/cam/12days
Smoke/visibility	> 95%	< 10sec	<1 FA/cam/12days
Congestions	> 90%	< 20sec	<1 FA/cam/12days
Objects (debris)	> 80%	< 10sec	<1 FA/cam/3days
Slow vehicles	> 90%	< 15sec	<1 FA/cam/2days

As an additional constraint, at most 16 FA might be risen per 24 hours per tunnel



### Illustration: Vehicle, Human and Small objects

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- **Requirements:** Real-time detection; detection of big and small objects
- Network architecture: a pruned and finetuned YOLO based model
- Entity classes: Vehicle (i.e. car, motorbike, truck etc.), Human and Small Object (traffic cone, warning triangle, plastic bag etc.)



## TRACKING: MULTI-OBJECTS



Example: Tracking in the tunnel

## EXAMPLE OF WRONG WAY VEHICLE





# Projet SAM

Actuellement en prod

## **Roadside perception : the missing link to support** autonomous mobility

Various elements of the roadway infrastructure could help the autonomous vehicle in its localization, > navigation, and collision avoidance tasks

Possible contributions from the infrastructure







Cyclope.ai expertise



**Teleoperation** 



# Al can provide the vehicle with a comprehensive understanding of its surroundings

Dynamic data and vehicle profiling

#### Automatic incident detection

- Vehicle type
- Turn signals
- Emergency brake light
- Brakes
- Speed





- Stopped Vehicle
- Congestion
- Slow vehicle
- Wrong-way
- Pedestrian
- Object
- Smoke
- ...

### Lane segmentation and positioning

Automatic detection of the road lanes



## A need for V2X connectivity

Connectivity is the technical mean allowing assistance for autonomous mobility by linking infrastructure and vehicles. Lots of V2X connectivity technologies are available but several issues must solved :



# VCG : CLASSIFICATION DU MARIN TUNNELIER

Vinci Construction Grands Projets

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### **Deployment of the API**

Tunnelfactory deployement setup



Salle de contrôle et suivi chantier - Ivry - Vinci Construction



Server Room de la ligne 15 - Ivry - Vinci Construction

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### Illustration

Results



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### Why it works

T-Distributed Stochastic Neighbor Embedding (t-SNE) is an unsupervised, non-linear technique primarily used for data exploration and visualizing high-dimensional data.

The T-SNE gives you a feel or intuition of how the data is arranged in a high-dimensional space.



# **Road Damage classification**

Ringway UK (Eurovia)

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### Context

• Ringway Eurovia operates many roads in the Hertfordshire.

- On these roads, defects can occur like potholes or trip hazards. If not detected on time, these defects can grow and may present a risk for the members of the public.
- Depending on the type of the defect, an intervention can be mandatory sometimes in a very short amount of time.
- In this context, Ringway's main goal is to avoid incidents that could involve members of the public, and therefore detect and fix as quickly as possible the defect.
- $\rightarrow$  defects are being detected and reported through two different ways:
- Members of the publics reporting the defect through an online form available on the council website, with an attached photograph in most of the cases.
- Inspectors driving the network detect and report the defects.

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## Illustration of the data



All the examples below illustrate the CPH defect from public photos:



Timeline 🔀

# Perspectives

- AI and ML growth may not be sustainable
- Neuromorphic computing
- Spiking neural networks
  - Energy-aware neural networks (biologically plausible)

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Binary

input

- Brains do it Billions of neurons 10w
- Training GPT-4
  - 1 Trillion of paramters
  - 62,318,750 KWh
  - \$4.6 million to train



# Merci

pour votre attention