**Type d'offre :** Laboratory offer

**Post date:** 14.11.25

Laboratoire IBISC (Université Evry Paris-Saclay)

Internship Offer Uncertainty-informed
multimodal fusion pour la
segmentation du
thrombus et des lésions
ischémiques en IRM

# Informations générales

**Contract type:** Stage

**Contract length:** 5-6 months

**Contact:** 

### Vincent Vigneron / Hichem Maaref / congej@yahoo.fr

**Starting date:** Sun 01/02/2026 - 12:00

Trade: Technicien

**Topic:** IHM et visualisation données

# Laboratoire IBISC (Université Evry Paris-Saclay) :

Research conducted at the <u>IBISC</u> laboratory focuses on the modeling, design, simulation, and validation of complex systems, whether living or artificial. The laboratory is organized into four teams (AROBAS, COSMO, IRA2, SIMOB), enabling two cross-disciplinary research areas to be defined: ICT & Life Sciences (computational biology, bioinformatics, personal assistance, signals and images for biomedicine) and ICT & Smart Systems (autonomous and intelligent systems, open and secure systems). IBISC not only has platforms referenced and supported by Genopole: <u>EVR@</u> (Virtual and Augmented Reality Environments) and the <u>EvryRNA</u> bioinformatics software platform, but also various platforms related to intelligent systems: two-wheeled vehicles, drones, robots.

# Détail de l'offre (poste, mission, profil) :

#### **Partners**

IBISC, South-Francilien Hospital Center (CHSF), Johns Hopkins University

**Duration:** 5-6 months

**Period:** February - August 2026 **Monthly allowance:** ~€670

# Title of the Internship

Uncertainty-informed multimodal fusion for thrombus and ischemic lesion segmentation on MRI in acute ischemic stroke

The project leverages **SWAN/PHASE**, **DWI/ADC**, and **TOF-MRA** sequences to synthesize hypoperfusion-relevant information and improve clinical decision support [1–5].

#### Context

Stroke is the leading cause of acquired disability in adults and the second leading cause of death worldwide [6].

In ischemic stroke, a thrombus blocks a cerebral artery, depriving downstream tissue of oxygen.

Treatment selection (thrombectomy or thrombolysis) requires:

- precise clot localization, and
- reliable estimation of the ischemic area from hyperacute multimodal MRI [1-5].

However, signal variability, partial redundancy across modalities, and low-contrast / high-noise regions create **segmentation uncertainty**, which limits clinical accuracy [7–9].

Recent cross-modal attention approaches demonstrate high thrombus detection rates ( $\approx$ 0.97) but only moderate segmentation performance (Dice  $\approx$ 0.65), highlighting the need to explicitly incorporate uncertainty into multimodal fusion.

# **Objectives of the Internship**

Design and implement an **uncertainty-aware multimodal segmentation system** to improve thrombus and ischemia segmentation.

# 1. Uncertainty map generation

Compute voxel-wise uncertainty maps (entropy, Bayesian variance) to highlight ambiguous regions such as thrombus boundaries:

```
U_{\text{entropy}}(x) = -\sum_{c(x) \leq p_c(x)}
```

Using Bayesian deep learning tools for calibrated uncertainty [7-9].

### 2. Uncertainty-guided attentive fusion

Inject uncertainty maps as attention masks to:

- reinforce cross-modal fusion in high-uncertainty areas,
- leverage complementary evidence from secondary modalities.

Compatible with modern biomedical backbones such as U-Net [10].

### 3. Localized diffusion regularization ("focused blurring")

Apply a Gaussian blur weighted by local uncertainty and train a diffusion model on blurred images to strengthen contextual learning around the thrombus:

```
[ I_{\text{blurred}}(x) = (I * G_{\sigma(x)})(x), \quad \sigma(x)  ] Using recent denoising diffusion frameworks [11].
```

### 4. Backbones & estimators

- 3D U-Net
- Cross-modal attention networks
- Diffusion models
- Uncertainty estimation: MC-dropout, deep ensembles, Bayesian learning [7-9]

• Information-theoretic analysis (Mutual information & PID) [12,13]

### 5. Experimental comparison

Compare focused vs. global blur; evaluate Dice, sensitivity, and clinical precision, with modality-specific contributions from SWI/PHASE, DWI/ADC, and TOF-MRA [1–5].

# **Applications & Expected Impact**

#### **Datasets & environment**

Multimodal MRI from stroke patients (SWAN/PHASE, DWI/ADC, TOF-MRA). Experiments on CHSF, MATAR, and ISLES2022 datasets. Environment: **PyTorch/Python, RTX 3090**, CHSF-IBISC collaboration.

## **Clinical utility**

Improved segmentation of thrombus and ischemic regions will:

- enable more reliable estimation of penumbral "mismatch,"
- support reperfusion triage when symptom onset is uncertain,
- enhance treatment benefit prediction.

#### **Deliverables**

- 1. Prototype of the uncertainty-guided multimodal segmentation model
- 2. Quantitative analysis linking uncertainty and mutual information
- 3. Visual reports of clinically high-uncertainty regions

4. Draft of a manuscript targeting IEEE TMI or Frontiers in Neuroinformatics

### **Expected outcomes**

- Functional prototype of the proposed model
- Statistical link between uncertainty and cross-modal information
- Visualization tools for uncertainty hotspots
- Manuscript preparation

#### **Candidate Profile**

We are seeking highly motivated candidates:

- 1. from mathematics, physics, computer science, or engineering programs
- 2. with a strong background in linear algebra, analysis, probability, statistics, machine learning, and deep learning
- 3. with solid programming skills (preferably Python)

Knowledge of medical imaging (especially MRI) is a plus, but not required. Basic knowledge of optimization is also appreciated.

### **Practical Information**

The intern will be mainly hosted at the **UFR Science & Technology** (40 rue du Pelvoux, Evry city center).

Some periods may take place at the **Corbeil Hospital**.

Monthly allowance: ~€670.

# **Application procedure**

Send your:

- motivation letter
- CV
- academic transcripts (from BSc Year 1 onward)

to: Vincent Vigneron / Hichem Maaref

#### What We Offer

- Hands-on experience with cutting-edge AI techniques for medical imaging
- Work on real-world, high-impact healthcare problems
- Close mentorship from experienced researchers at IBISC
- Opportunities to co-author publications and present at conferences
- Possibility to continue into a PhD

#### Références

[1] E Mark Haacke, S Mittal, Z Wu, J Neelavalli, and Y-CN Cheng. Susceptibility weighted imaging (swi). Magnetic Resonance in Medicine, 52(3):612-618, 2009.

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- [5] Martin R Prince and Jeffrey Link. 3d contrast in time-of-flight mr angiography. Journal of Magnetic Resonance Imaging, 12(5):776-783, 2000.
- [6] Valery L Feigin et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019. The Lancet Neurology, 20(10):795–820, 2021.
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- [11] Jonathan Ho, Ajay Jain, and Pieter Abbeel. Denoising diffusion probabilistic models. In NeurIPS, 2020.
- [12] Paul L Williams and Randall D Beer. Nonnegative decomposition of multivariate informa- tion. arXiv:1004.2515, 2010.
- [13] Amer Makkeh, Dirk O Theis, and Raul Vicente. Broja-2pid: A robust estimator for bivariate partial information decomposition. Entropy, 23(10):1274, 2021.

URL de l'offre : https://www.dataia.eu/sites/default/files/sujet\_stage-JPC.pdf

Lien vers l'offre sur le site dataia.eu :https://da-cor-

dev.peppercube.org/node/1460