Chloé Hiba ALQASIR

PhD in Artificial Intelligence

Computer Vision & Domain Adaptation

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Qualified to the functions of "maître de conférences" 2022, section 27 (Informatique)

Education

- **PhD in Computer Science**

  University of Lyon, ED SIS — December 2017 - November 2020
  In partnership with Bluecime — Saint-Étienne, France.

  Deep Learning for Chairlift Scene Analysis: Boosting Generalization in Multi-Domain Context

  Defended on December 17th, 2020
  Specialty: Computer Science
  Discipline: Computer Vision
  Conducted at: Jean Monnet University, Hubert Curien Laboratory.
  Thesis Advisor: Christophe Ducottet, Professor, Jean Monnet University, Hubert Curien Laboratory.
  Co-Advisor: Damien Muselet, Associate Professor, Jean Monnet University, Hubert Curien Laboratory.
  Jury Members:

Nicolas Thome	Professor, CNAM, Laboratoire Cédric	Reviewer
Joost van de Weijer	Senior Scientist, Universitat Autònoma de Barcelona, CVC	Reviewer
Michèle Rombaut	Professor, Université Grenoble Alpes, GIPSA-Lab	President
Elisa Fromont	Professor, Université de Rennes 1, IRISA/INRIA	Examiner
Raluca Debusschere	PhD, Bluecime	Examiner
Christophe Ducottet	Professor, Université Jean Monnet, Hubert Curien	Director
Damien Muselet	Associate Professor, Université Jean Monnet, Hubert Curien	Advisor

  Main objectives:

  - Develop a computer vision system using deep learning techniques to enhance the safety of chairlifts.
  - Classify the images of the chairlift boarding area according to the position of the safety bar, to assess the safety conditions.
  - Address specific challenges in image classification for chairlifts, including small details in cluttered backgrounds and the difficulty of obtaining manual annotations.
  - Propose solutions (such as object detection and Siamese networks) to highlight important areas of the safety bar and improve classification accuracy.
  - Reduce reliance on manual annotations by using unsupervised or semi-supervised learning techniques when labeled data is limited.
  - Identify the broader applicability of the contributions beyond the chairlift context, highlighting their potential for other problems in a multi-domain setting.
  - More details in the *Research Activities* section.

  Keywords: Deep learning, Object deletion, Image classification, Domain adaptation, Siamese networks, Generalization, Chairlift safety, Ski lifts – Safety equipment.

- **Master's degree in Computer Science**: Machine Learning and Data Mining (MLDM)

  Jean Monnet University — September 2015 - August 2017
  École Nationale Supérieure des Mines — Saint-Étienne, France.

  M2 Internship: **Texture synthesis: implementation of a CNN-based algorithm and performance assessment via a trained auto-encoder.**

  Supervisor: Thierry Fournel

  Main Objectives:

  – Provide a pedagogical introduction dedicated to Convolutional Neural Networks (CNNs). To offer an accessible explanation of the fundamental concepts and principles of CNNs.
  – Implement a texture synthesis algorithm based on CNN, and develop a method to discriminate between texture synthesis algorithms.

  M1 Internship: **Mathematical model to estimate energy consumption of the buildings at the scale of district.**

  Supervisor: Jonathan Villot

  Main Objectives:

  – Design a web crawler to extract buildings energy consumption from real estate portals, and subsequently analyze the retrieved data.
  – Tweak the methods of Regression, Kriging, and MissForest and apply them to the study area (Saint-Étienne) to reconstruct energy consumption, and compare the results with the dataset extracted from the web.

- **Engineering degree**: Information Systems and Software Engineering

  University of Damascus — September 2010 - August 2015
  Faculty of IT Engineering — Damascus, Syria.

  Final project: **A model for "gamifying" an online learning content application on a strategic game.**

  Supervisor: Ammar Kheirbek

Professional experience

- Temporary Research and Teaching Associate (**A**ttaché **T**emporaire d'**E**nseignement et de **R**echerche (ATER))

  Jean Monnet University, Hubert Curien Laboratory — December 2020 - August 2022
  Télécom Saint-Étienne Écoles d'ingénieurs

- PhD candidate

  University of Lyon, ED SIS — December 2017 - November 2020
  In partnership with Bluecime

  Deep Learning for Chairlift Scene Analysis: Boosting Generalization in Multi-Domain Context

- Research Intern

  Jean Monnet University, Hubert Curien Laboratory — March 2017 - July 2017

  Texture synthesis: implementation of a CNN-based algorithm and performance assessment via a trained auto-encoder.

- Research Intern

  École Nationale Supérieure des Mines — April 2016 - September 2016

  Mathematical model to estimate energy consumption of the buildings at the scale of district.

Research activities

- **RoboTwin: Combining Digital Twin and Artificial Intelligence Domains for Controlling Robots in Industry 4.0.**

  2022-2023

  One of the main challenges in Industry 4.0 is the supervision and coordination of heterogeneous robots at runtime, especially when they have a certain level of autonomy, as seen in Autonomous Mobile Robots. In addition, autonomous robots and their digital twins are designed by private manufacturers, and their code is often inaccessible. In this study, we present a solution to anticipate and control the behavior of robots by combining Digital Twin (DT) and Artificial Intelligence (Multiagent System and Machine Learning (ML)) models and technologies in a non-intrusive way. Using DT technologies we reproduce the action model of the robot as an autonomous agent behavior, treating the robot and its DT as black boxes. We apply existing ML techniques on the logs of its actions in various situations to predict the robot actions in the near future. We illustrate the use of our framework with a conflict resolution situation for a new AMR in a factory.

  Keywords: Digital Twin, Machine Learning, Multiagent Systems, Multi-robot Coordination, Industry 4.0.

  Programming language: python, deep learning API: Keras

  Paper: Balbo Flavien ... Alqasir Hiba et al. "RoboTwin: Combining Digital Twin and Artificial Intelligence domains for controlling robots in Industry 4.0" *Conference: 17th International KES Conference - Agents and Multiagent Systems : Technologies and Aplications (AMSTA)* 2023.

- **Communication-wise Comparison of the Online Resource Allocation Methods in CAV Fleets.**

  2022-2023

  Deploying fleets of Connected Autonomous Vehicles (CAVs), with limited peer-to-peer communication ranges, in order to provide On-demand Transport (ODT) services, requires a careful choice and evaluation of solution methods for resource allocation problems. We adopt in this paper a multiagent approach consists of: 1) defining a generic model to ODT's dynamic resource allocation problem in connected autonomous vehicle fleets, taking into account the limited connectivity and communication constraints, 2) behavior abstraction of AV Agents, and 3) abstracting the solution methods as Coordination Mechanisms (CMs) to define the characteristics of a solution method and its requirements to implement the corresponding planning sub-behavior. Using this methodology, we were able to compare the performance of a variety of solution methods with a set of evaluation criteria, namely for the solution Quality of Service (QoS) and Quality of Business (QoB). In this work, we focus on the communication-wise evaluation criteria, such as connectivity and network load.

  Keywords: Intelligent Transport Systems, Connected Autonomous Vehicles, On-demand Transport, Multiagent Resource Allocation.

  Programming language: python, deep learning API: Keras

  Paper: Daoud Alaa, Picard Gauthier, Alqasir Hiba et al. "Communication-wise Comparison of the Online Resource Allocation Methods in CAV Fleets." *The 14th International Conference on Ambient Systems, Networks and Technologies (ANT)* 2023.

- **Introducing Shape Priors in Siamese Networks for Image Classification.**

  Hubert Curien Laboratory 2021-2022

  As the efficiency of deep neural networks increases, so does the amount of annotated data required to train them. We propose a solution to improve the learning process of a classification network with less labeled data. Our approach consists in informing the classifier of the features it should focus on to make its decision by providing it with shape priors. These shape priors are expressed as binary masks, giving an approximate idea of the shape of the relevant features for a given class. We use a Siamese architecture and provide it with image/mask pairs. By inserting shape priors, only relevant features are retained. This gives the network significant generalization power without requiring a domain-specific adaptation step.

We conducted experiments on three different contexts to evaluate the generalization capability of our proposed system.

- Video surveillance for the safety of chairlifts.
- Cross-domain digit recognition with *MNIST, MNISTM, USPS,* and *SVHN* datasets.
- Cross-domain digit recognition with *Rotated MNIST* dataset.

Extensive tests show that our mask-guided Siamese approach outperforms the classical classifier and generates a good latent space with less training data.

Keywords: Siamese Networks, Image classification, Generalization, Shape priors.

Programming language: python, deep learning API: Keras, data visualization technique: tSNE.

Paper: Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Introducing Shape Priors in Siamese Networks for Image Classification." 2022.

- **Towards explainable recommendations of resource allocation mechanisms in on-demand transport fleets**

  Hubert Curien Laboratory 2020-2021

Multi-agent systems can be considered a natural paradigm when modeling various transportation systems, whose management involves solving hard, dynamic, and distributed allocation problems. Such problems have been studied for decades, and various solutions have been proposed. However, even the most straightforward resource allocation mechanisms lead to debates on efficiency vs. fairness, business quality vs. passenger's user experience, or performance vs. robustness. We aim to design an analytical tool that functions as a recommendation system for on-demand transport (ODT) authorities. This tool recommends specific allocation mechanisms that match the authority's objectives and preferences to solve allocation problems for particular contextual scenarios. The paper emphasizes the need for transparency and explainability of resource allocation decisions in ODT systems to be understandable by humans and move toward a more controllable resource allocation. We propose in this preliminary work a multi-agent architecture and general implementation guidelines towards meeting these requirements.

Keywords: Multi-agent systems, Explainable Artificial Intelligence, Intelligent transport systems, Resource allocation.

Paper: Daoud Alaa, Alqasir Hiba, Mualla Yazan, et al. "Towards Towards explainable recommendations of resource allocation mechanisms in on-demand transport fleets" *3rd International Workshop on EXplainable and TRAnsparent AI and Multi-Agent Systems (EXTRAAMAS).* 2021.

- **MIVAO**

  Hubert Curien Laboratory 2017 - 2020
  In partnership with Bluecime

The French start-up Bluecime has developed a computer vision system called Sivao to help lift operators detect anomalies when people are boarding chairlifts, alerting users to dangerous situations and preventing accidents. The system comprises a camera, a computer, and an alarm. The camera records the boarding scene, and images from the video are processed in real-time using non-learning-based image processing techniques to detect the occupancy of the chairlift and the position of the safety bar. If a dangerous situation is detected, *i.e.*, the chairlift is occupied, and the safety bar is not completely closed, an alarm is triggered. The system's decisions are very accurate, but manual configurations are time-consuming and expensive, making it difficult to install for new chairlift.

To improve Sivao's performance and reduce costly manual adjustments in different environments and circumstances, the Mivao project proposes using deep learning techniques.

- The project's first contribution is to apply a CNN-based object detection method to all chairlift data to evaluate its ability to detect the safety bar and people in the image and identify potentially risky situations. Faster R-CNN object detector is used to detect the essential elements in the scene, i.e., the

safety bar (open/closed), and people (adult/child). The object detector guides the network to the crucial areas of the image, and at test time, it can be used as a classification model, ignoring the bounding box's location. The results show a good performance when the evaluation is carried out without domain shift and a strong degradation of the results otherwise. The potential for improving classification accuracy by precisely locating objects in images is promising. However, this requires costly instance-level annotation.

Keywords: Image classification, Object detection, Faster R-CNN, Chairlift safety, People detection.
Programming language: python, deep learning API: Caffe.

- The project's second axis is "domain adaptation for object detection", which focuses on finding a solution that automatically adapts to new unannotated data. The question we concentrate on is which characteristics should be adapted in an object detector to improve its generalization from a source domain to a target domain. Few works explicitly address the problem of unsupervised domain adaptation for object detection. Existing approaches have added contradictory training elements to the classic Faster R-CNN detector, both globally and at the instance level, without adapting the region proposal network (RPN), resulting in residual domain shift. After analyzing the entire workflow of the classic Faster R-CNN detector, we propose adapting the features extracted from this network at two different levels: globally in the RPN and locally for each bounding box returned by the RPN. We show that these two adaptations are complementary and provide very good detection results. For the domain adaptation, we rely on a classical adversarial cost function. We conduct extensive experiments in two different application contexts: autonomous driving and the problem of chairlift safety.

  Keywords: Domain adaptation, Unannotated data, Generalization, Unsupervised domain adaptation, Object detection.
  Programming language: python, deep learning API: Tensorflow.
  Paper: Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Region Proposal Oriented Approach for Domain Adaptive Object Detection." *International Conference on Advanced Concepts for Intelligent Vision Systems.* Springer, Cham, 2020.

- Even annotating only the source domain is very expensive when it comes to delimiting boxes at the instance level. Furthermore, domain adaptation is not always satisfactory at the scale of dozens of different target domains; the most critical success factor of domain adaptation is the level of similarity between the source and target domains. For the subsequent contribution regarding the costs associated with bounding box annotations, we opted to use binary masks to guide a classifier. We focus on the following question: how to exploit geometric constraints as shape priors to design an image classifier and to train it on only a few annotated images? The main idea is to inform the classifier of the feature it should focus on in the image to make its decision, using a binary mask, which eliminates the need for bounding box annotations which are much more expensive. Using a Siamese architecture, we feed the CNN-based classifier with the image and and the binary mask, and force it to extract only the desired features from the image based on the binary mask.

  Keywords: Geometric constraints, Binary masks, Shape priors, Siamese networks.
  Programming language: python, deep learning API: Tensorflow.
  Paper: Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Mask-guided Image Classification with Siamese Networks." *International Conference on Computer Vision Theory and Applications.* 2020

- **Texture synthesis: implementation of a CNN-based algorithm and performance evaluation via an auto-encoder.**

  Hubert Curien Laboratory 2017

  This work focuses on leveraging Convolutional Neural Networks (CNNs) for texture synthesis tasks, with the first objective being to provide a pedagogical introduction dedicated to CNNs. The introduction aims to offer a comprehensive and accessible explanation of the fundamental concepts and principles of CNNs, particularly in the context of texture synthesis.

Another objective is to develop and refine a CNN-based algorithm for texture synthesis. By harnessing the power of CNNs, the aim is to achieve improved generalization and generate high-quality textures.

Additionally, traditional metrics such as Mean Square Error (MSE) and Structural Similarity Index (SSIM) often fall short in evaluating the fidelity of synthesized textures. Hence, the objective is to explore a new approach to discriminate between different texture synthesis algorithms. This approach involves considering the reconstruction error of an autoencoder (AE) as a fidelity measure. By training the AE on a reference set of similar texture data, synthesized samples with offsets can be identified as outliers.

Through this research, the performance of the developed CNN-based texture synthesis algorithm and the discrimination method for texture synthesis algorithms is evaluated. Traditional metrics like MSE and SSIM are compared with the proposed reconstruction error-based approach to assess their effectiveness in evaluating fidelity.

Keywords: Texture synthesis, Deep neural networks, Convolutional neural networks, Auto-encoder, Similarity metrics, Reconstruction error.

Programming language: python & matlab, deep learning API: MatConvNet & Caffe.

- **Mathematical model to estimate energy consumption of the buildings at the scale of district.**

  École Nationale Supérieure des Mines 2016

  The objective of this work is to develop a computer model that extract buildings energy consumption from real estate portals, and subsequently analyze the retrieved data. This includes the study of computer tools to capture, process and gather the targeted information, to provide a relevant model to meet the objectives and to provide a database compatible with GIS/WebGIS formats to represent the energy consumption of a city. To evaluate the models' capabilities, comprehensive testing has been conducted in a specific study area, to identify any limitations.

  The research program encompasses several key tasks. First, a thorough analysis of the current state of the art is conducted, followed by the development of a detailed specification. Methodological advancements are then pursued to build the model based on the methods of Regression, Kriging, and MissFores. A proof of concept tool is subsequently developed, which includes the creation of computer models designed to extract and track building information from the real estate portals. The model is then applied to reconstruct the energy consumption, and then it is validated within the designated study area (Saint Etienne).

  Keywords: Mathematical model, Building energy consumption, Web crawler, Kriging, MissForeast, Regression.

  Programming language and tools: Java & RStudio.

Teaching activities

I have been involved in teaching activities during my PhD studies and after completing my doctorate as an ATER (Temporary Research and Teaching Associate). The materials I have used for teaching can be found on the link halqasir.github.io/teaching/. All of my teaching activities have been conducted so far at Télécom Saint-Étienne Écoles d'ingénieurs. The programs I have taught are listed below:

- Engineering degree at Télécom Saint-Etienne
  - Engineering degree program for apprentices (**F**ormation **I**ngénieur sous **S**tatut **A**pprenti (**FISA**)).
    - Specializations: **D**ata **E**ngineering (**DE**)
    - Specializations: **I**mage & **P**hotonique, **S**mart-**I**ndustries (**IPSI**)
  - Engineering degree program for regular students (**F**ormation **I**ngénieur sous **S**tatut **E**tudiant (**FISE**)).
- The **B**achelor in **G**lobal **C**ommunication & Digital **D**esign (**BGCD**).

Please refer to table 1 for further details.

Status	Academic year	Public	Level	Name of the subject	Time volume	Course type	Responsibilities	Materials
ATER	2021-2022	BGCD1	L1	Relational Databases	33	CM/TD/TP	course creation TP/TD topics exam	link
ATER	2021-2022	BGCD1	L1	Data storage	31.5	CM/TP	course creation TP topics exam	link
ATER	2021-2022	FISA-DE2	I2	Object-oriented programming (JAVA)	17	TD	TD topics exam	link
ATER	2021-2022	FISA-IPSI2	I2	Object-oriented programming (C++)	8	TP	TP topics exam	link
ATER	2020-2021	FISE1	I1	Mini-project	24	TD	TD topics	-
ATER	2020-2021	FISE1	I1	Object-oriented programming (C++)	45	TD	exam	-
ATER	2020-2021	FISA-IPSI2	I2	Event-driven programming	8	TP	-	-
ATER	2020-2021	FISE2	I2	Software Engineering	36	TD	exam	-
ATER	2020-2021	FISA-IPSI2	I2	Object-oriented programming (C++)	16	TP	TP topics exam	link
PhD candidate	2019-2020	FISE1	I1	Object-oriented programming (C++)	30	TD	exam	-
PhD candidate	2019-2020	FISE2	I2	Graphical user interface	30	TD	exam	-
PhD candidate	2018-2019	FISE1	I1	Object-oriented programming (C++)	30	TD	exam	-
PhD candidate	2018-2019	FISE2	I2	Graphical user interface	30	TD	exam	-
PhD candidate	2017-2018	FISE1	I1	Object-oriented programming (C++)	30	TD	exam	-
PhD candidate	2017-2018	FISE2	I2	Graphical user interface	30	TD	exam	-

Table 1: Teaching activities. The names of the courses are indicated in the text. I1 for first year in engineering school, and I2 for second year in engineering school.

List of publications

- Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Introducing Shape Priors in Siamese Networks for Image Classification." *Neurocomputing* Elsevier 2023.
- Daoud Alaa, Picard Gauthier, Alqasir Hiba et al. "Communication-wise Comparison of the Online Resource Allocation Methods in CAV Fleets." *The 14th International Conference on Ambient Systems, Networks and Technologies (ANT)* 2023.
- Balbo Flavien ... Alqasir Hiba et al. "RoboTwin: Combining Digital Twin and Artificial Intelligence domains for controlling robots in Industry 4.0" *Conference: 17th International KES Conference - Agents and Multiagent Systems : Technologies and Aplications (AMSTA)* 2023.
- Daoud Alaa, Alqasir Hiba, Mualla Yazan, et al. "Towards Explainable Recommendations of Resource Allocation Mechanisms in On-Demand Transport Fleets." *3rd International Workshop on EXplainable and TRAnsparent AI and Multi-Agent Systems (EXTRAAMAS).* 2021.
- Alqasir Hiba. "Deep Learning for Chairlift Scene Analysis: Boosting Generalization in Multi-Domain Context." Doctoral dissertation, Université de Lyon, 2020.
- Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Mask-guided Image Classification with Siamese Networks." *International Conference on Computer Vision Theory and Applications.* 2020
- Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Double adaptation de domaine pour la détection d'objets." *Conférence Nationale d'Intelligence Artificielle.* 2020.
- Alqasir Hiba, Damien Muselet, and Christophe Ducottet. "Region Proposal Oriented Approach for Domain Adaptive Object Detection." *International Conference on Advanced Concepts for Intelligent Vision Systems.* Springer, Cham, 2020.

*Sorted by the order of publication.