Application for Faculty Development Program

FACULTY SUMMER FELLOWSHIP

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Project Title:
Postcards from the Invisible cities – exploring the contentious potential of Artificial Intelligence for the production and fruition of art

Short Project Description:
Generative algorithms such as General Adversarial Networks (GANs) [1] use a combination of Artificial Intelligence (AI) and Machine Learning (ML) systems to learn from existing data and produce new content that mimics the key features of the original data. When applied to text, images, and sound, the results are astonishing: generative AIs enables computers to be creative and produce new content, including art, from scratch [2] [3].

As part of my research on GANs, the proposed project will focus on using generative AI to create visual representations that translate literary masterpieces into collections of images that can be utilized to evaluate the user experience of content generated with GANs, improve the performance of generative algorithms, and gain more insight into the potential of ML and its impact on society. Specifically, the project will initially focus on Italo Calvino's book "the Invisible Cities", because 2023 marks the 100th anniversary of the author's birthday. The project will involve an interdisciplinary community of researchers and artists and result in: (1) four scholarly papers discussing specific aspects of the work, (2) the production of a website and book with a selection of images from the project, and (3) an exhibition featuring the best images.

Nicholas Caporusso — signature*

October 3rd, 2022 — date

* By typing your name or pasting your signature in the space provided you are allowing this application to be reviewed by the Faculty Benefits Committee for a possible award. The applicant is also aware that failure to comply with the instructions may result in this proposal not being reviewed.

1. GOALS AND CRITERIA

The goal of the project is to continue my research in the context of AI and GANs [1] and explore the use of AI-based systems for the production of visual content as a novel tool for producing art, to achieve something that has never attempted before in the context of GANs, gain insight into the user experience of content generated with AI, advance the current state of the art of generative algorithms.
To this end, I will apply GANs to generate images representing a literary masterpiece of Italo Calvino, one of the most influential Italian writers.

The outcomes and deliverables of the proposed project are the following:

1. A complete collection of visual representations of "the invisible cities". To this end, I will utilize systems based on GANs such as Dall-E, MidJourney, and Stable Diffusion, to generate at least five images visualizing the salient aspects of each of the 55 cities, plus pictures describing the general theme of the book, for a total of at least 300 images. This will provide me with the opportunity to realize comparative studies. In accomplishing this goal, I will involve NKU students and researchers and artists worldwide, who will be able to contribute to the project by submitting their research and creative work.
2. A website and a book documenting the research project and describing the work and its value to an audience of researchers and artists interested in Computer Science and AI, visual arts, and in Calvino's work. The website will provide external contributors with the possibility of submitting their images and, simultaneously, will enable visitors to rank and comment the artwork, which will enable me to collect data for my research.
3. A virtual showcase and, potentially, a physical exhibition of the collection. All the material will be showcased in a virtual gallery on the website. Nonetheless, I am already in contact with a curator who is interested in hosting an exhibition in Italy at the end of Summer 2023, as part of the celebrations for Calvino's 100th birthday anniversary. Also, the fellowship will give me the opportunity to explore collaborations with galleries in the greater Cincinnati area and in the United States.

In addition, the activities realized in the context of the proposed project will produce the following deliverables in the form of scholarly articles:

1. A review of generative systems for image production and produce a survey paper that provides me and other researchers in the field with a comprehensive understanding of the current state of the art.
2. An evaluation of content generation algorithms in which I will discuss the performance of the algorithms from a quantitative and qualitative standpoint based on feedback collected from users.
3. An improved architecture for current generative models that takes into account qualitative features based on the human experience of art.
4. A study of about the impact of the use of AI systems in art in which I will analyze how GANs and other ML-based systems are expected to change the scenario of art production and fruition.

Finally, the project will enable me to create teaching material that I will leverage in my Human-Computer Interaction course as well as in other courses that I teach, to demonstrate the use of different ML systems and foster discussions on the relationship between technology and society.

2. DETAILED PROJECT DESCRIPTION

Artificial Intelligence is considered one of the most contentious technologies of all times because its great potential to enhance human tasks is completely changing the world as we know it. In the last decade, AI and, specifically, Machine Learning, has mainly been utilized to develop systems that learn from existing data and autonomously make decisions. Nowadays, we see the applications of years of this type of research. For example, classification algorithms immediately alert us about an email being spam and we can unlock the screen of our smartphones using our face thanks to image recognition systems, and robots can learn how to stand, walk, and realize sophisticated tasks in increasingly challenging environments thanks to the marvels of AI. However, the introduction of a new strain of ML systems, that is, "generative" algorithms such as General Adversarial Networks [1], has changed the scenario of AI entirely, because the latest generative ML technology enables computers to be creative and produce an infinite amount of new content, including art, with an incredible level of detail [2]. In my work, I specifically focus on images, though GANs can be applied to any type of data, including text and sound. For instance, as shown in Figure 1, GANs learn the main components of an image from a very large collection of real samples (e.g., they extract the salient features of a human face from a series of headshots). Then, a "generator" algorithm tries to produce the image of a face (i.e., "fake") containing the same features and, thus, resembling a real face. Finally, a "discriminator" algorithm evaluates whether the produced image is accurate enough to mimic a real one and optimizes it to make it look more realistic. As a result of this processing, the system is able to fine-tune its results and produce fake images that are almost impossible to distinguish from real ones. Combined with Natural Language Processing (NLP), modern systems such as MidJourney, Dall-e, and others, translate a textual prompt (e.g., a sentence) into images that represent it with different degrees of photorealism [3] [4].

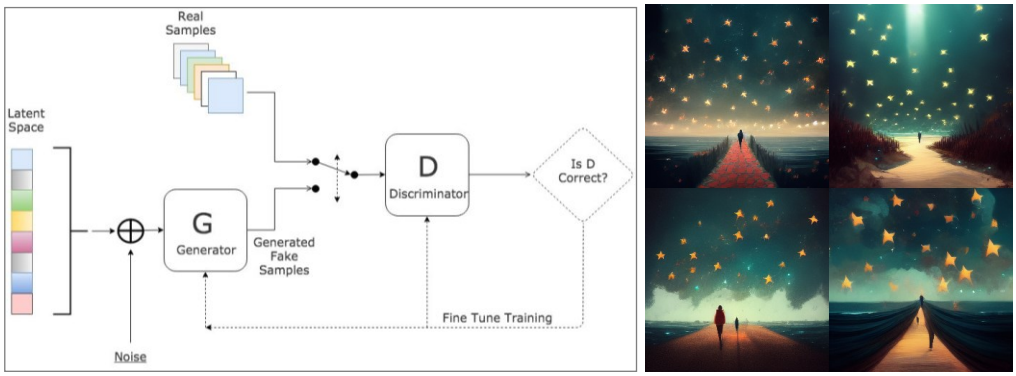

Figure 1. Architecture of a General Adversarial Network (left). Images produced by MidJourney based on the prompt "walking in a literal sea of stars" (right).

My research area is Human-Computer Interaction and I am particularly interested in investigating the relationship between technology and society. Specifically, one of my research foci is the user experience of content generated by AI, which enables exploring how we can leverage AI - and technology in general - to generate new experiences and improve existing ones. Recently, I started studying the relationship between generative AI and the production and fruition of art, with specific regards to visual art. Questions that my research addresses include: How can we enhance human creativity using technology? Can generative algorithms create artwork that elicits emotions? What are the applications of artwork generated by AI? Can we consider AI-generated art as art? What is the relationship between generative AI and the concept of singularity?

The proposed project aims to answer these questions, explore GANs and NLP, and study the applications and implications of AI on our society in more detail:

- It will enable me to study and compare the different techniques for content generation based on AI, contribute to the development of a specific technique in generative systems called “style transfer” (used to reproduce the style of an artist) [2], and implement three new concepts that I am working on, that is, “appraisal loop” (i.e., using human response to images to refine the results even further), “deep labeling” (i.e., ways to associate images and text with greater detail), and “discriminator curation” (i.e., a component of the ML pipeline that evaluates and increases the likelihood the artistic content of an image produced by AI). The work will be documented in scholarly articles that I will publish in academic journals and scientific conferences.
- Representing literature into images is a perfect interdisciplinary framework for studying the technological (machine) aspects, the perceptual/cognitive (human) side, and the (interaction) dynamics involved in the production and perception of art. To this end, “the Invisible Cities”, one of Italo Calvino's literary masterpieces, provides the perfect framework. Calvino’s novel narrates Marco Polo’s travel reports to Emperor Kublai Khan through the description of fifty-five fantastic cities visited by the explorer. In his tales, the explorer tries to convey to the ruler the most intimate essence of each city. In addition to the structure of the city and its architectural style and history, he describes the emotions that the cities arouse through the depiction of sounds, scents, picturesque scenes of everyday life, and sensations. Thus, each city takes shape and life as the metaphor for a concept, leaving plenty of space to the interpretation of the reader. It becomes a fairy-tale and dreamy tangle consisting of phantasmagoric scenes, details, symbols, and archetypes through which Calvino's language renders the urban landscape an inherent allegory of the fundamental themes that characterize the novel. Using convoluted and vivid descriptions of details with a strong visual impact, the author underlines that Marco Polo’s stories cannot represent the reality of the cities he visited. Instead, they narrate the memory of his personal

experience of what he perceived in each city. As a result, producing a collection of images representing the book is a great tool for studying how the different generative system interpret and represent text in a visual format. Also, it enables investigating the semiotic relationship between textual and visual languages and translate words into images eliciting emotions, with and without human intermediation.

Figure 2. The phantasmagoric marvel of the architecture described in a scene from one of the Invisible cities that I represented using AI.

The project focuses on topics that are at the core of the current discussion in the scientific community of AI. Also, the urgency of the project is that 2023 marks the 100th birthday anniversary of Italo Calvino. Also, 2022 was the 50th anniversary of the publication of the Invisible cities, and many events are being organized in many cities worldwide to celebrate the genius of the writer. The project will benefit from the wave of initiatives being realized and, simultaneously, will add value and content to them. Moreover, as generative systems are expected to explode in the next year in the scientific debate but also in conversations among the greater public, the project will enable me to establish my profile in the field, as discussed below.

The project will be realized according to the following timeline:

- January-March 2023
    - I will begin reviewing the most relevant generative AI systems, in preparation for the project and for my Honors course (HNR 220) titled "*Learning from Dall-e: how innovation is shaping our relationship with art*", in which I will introduce and use these tools to the students.
    - I will create and publish a website for the initiative. The website will detail the project and contain a "call for proposals" dedicated to artists and scientists working with AI.

    - I will promote a UR-STEM project and encourage undergraduate students to work with me on the project over the Summer.
- April 2023
    - I will prepare a “demo” gallery that will serve as a teaser for the project, and I will start organizing dissemination initiatives (e.g., having the project featured in the media). Also, I will discuss the project during my Six@Six talk scheduled for April 5th (https://bit.ly/3LWQ3A4).
- May 2023
    - I will finish reviewing the state of the art and I will condense my findings in a scholarly paper that I will submit for publication to a scientific journal or academic conference.
    - I will start collaborating with students who will choose to work with me in the context of my UR-STEM project. To this end, helping me review scholarly works will be a great way to start contributing to the project.
    - I will start working on the content production of my “postcards” collection using generative AI systems. This will enable me to collect data about the performance of the different systems in terms of accuracy, resolution, time, fidelity, and other qualitative indicators.
    - Simultaneously, the website will collect works from other scientists and artists, who will be able to submit their galleries of images until May 31st.
- June 2023:
    - I will finish working on content production using generative AI systems and report my results in a scholarly paper that I will submit for publication to a scientific journal or academic conference.
    - A committee of curators will select the best submissions and will compile a collection that will represent the initiative in exhibitions and events. Simultaneously, I will compile my own collection and publish it as a self-published book.
    - Based on the results of the generation phase, I will start designing and implementing improvements to the generative AI systems as discussed above.
- July 2023:
    - I will realize and participate in initiatives for disseminating the content produced in the project to the public, via the website and in-presence exhibitions. In addition to promoting the work, this will enable me to realize qualitative and quantitative studies and collect data from users that I will report in a scholarly paper that I will submit for publication to a scientific journal or academic conference.
    - I will continue designing and implementing improvements to generative AI systems as discussed above and finalize the research work.
- August 2023
    - I will wrap up the project by finalizing scholarly articles that will detail my improvements to generative AI systems and the qualitative and quantitative evaluation based on the public reaction to the content produced in my work.

3. VALUE OF THE PROJECT

The proposed project is in continuity with my research interests and with my work on GANs [5] and, more generally, on the relationship between HCI and AI/ML. Nevertheless, the summer fellowship would enable me to expand my research into a new, current, and more interdisciplinary direction at the intersection of computer science, visual arts, and literature. Specifically, the project will enable me to focus on this item of my research agenda and: (1) conduct quantitative and qualitative studies about generative ML systems, (2) develop improvements to algorithms such as GAN and style transfer, and (3) introduce and implement new concepts in generative AI. This will benefit my scholarly and professional profile in terms of publications, recognition in the field, and citations, especially considering that generative systems are a trending topic in the scientific community discussing AI. Simultaneously, the project will enable me to explore my creative side, which is a very important aspect of my work balance that has enormous impact of my teaching as well.

The project is extremely current and relevant to the scholarly community because new developments in generative systems are expected to bring a revolution in the context of AI as we know it today. The ability to be creative represents an unprecedented aspect of AI and is raising many questions that scholars are trying to address worldwide. My contribution to the scientific debate will be two-fold: (1) I will introduce improvements from a technical standpoint and evaluate their performance; (2) from a human perspective, I will investigate the impact of new dynamics in AI on society.

Furthermore, the project will result in new and compelling material for the courses that I teach at NKU, including my Human-Computer Interaction course, for my Honors courses, and for the First Year Research Exposure program, which I currently coordinate and am the instructor of record of. In this regard, the project will help develop content that makes AI more accessible to our students and that enables them to use and see it in action without requiring any programming knowledge, which will be incredibly beneficial for our students and my teaching. Furthermore, in addition to being able to create content using text prompts, my improvements will provide students with a number of configuration options they can use to fine-tune their results and, simultaneously, understand the logic of the different components of generative systems better. Also, the project will enable entertaining class discussions and elicit reflections about the value of AI-generated art.

The project is in line with the objectives of the School of Computing and Analytics and is a perfect demonstration of the interdisciplinary nature of the College of Informatics. Furthermore, the proposed work is at the forefront of the research in ML, and will help present the School, College, and NKU in general, in outreach initiatives dedicated to inspiring students with current, impactful research work that is also easy to understand. Moreover, the proposed project will also give continuity to the work realized during Spring and Fall 2022 with Dr. Wallace from

the Department of English, which has resulted in the development of a Content Management System for Dr. Wallace's Melville's Print Collection Online project (https://www.melvillesprintcollection.org/). My project will leverage the same Content Management System and will give me the opportunity to make improvements and add new features.

Finally, the initiative will incorporate outreach initiatives open to the community. First, the website will promote a call for proposals where AI experts, artists, and individuals who are passionate about Calvino's work will be able to submit their entries and add them to the collection. Then, a committee will select the best artworks for a digital and in-person exhibition that will be open to the general public. To this end, I already am in contact with an art collective and two curators, and we are discussing the possibility of hosting an exhibition in a gallery in Bologna or Bari. Furthermore, I would be glad of replicating the initiative at NKU, as a way to promote the recent changes in the College of Informatics, or in a gallery in the greater Cincinnati area.

4. BACKGROUND OF APPLICANT RELEVANT TO THIS PROJECT

I joined NKU in Fall 2019 as an assistant professor of Computer Science. Prior to joining NKU, I was an assistant professor in Computer Science at Fort Hays State University (Hays - KS, USA) and a Marie Skłodowska-Curie fellow in robotics and automation at the University of Salford (Manchester, UK), and a Fulbright Fellow in Technology Entrepreneurship at Santa Clara University (California, USA).

I hold a Ph.D. in Computer Science and Engineering from IMT – Institute for Advanced Studies (Lucca, Italy) and my research area is Human-Computer Interaction (HCI) and User eXperience (UX). Throughout my career, I co-authored and published over 80 peer-reviewed scholarly articles and 3 patents. In 2019, I began doing research on Machine Learning (ML) and, specifically, on generative AI and General Adversarial Networks (GANs). I am particularly interested in evaluating the user experience of content produced using GANs and in using information about user dynamics to improve ML algorithms. In the past years, I co-authored and published 11 papers focusing on the use ML in a variety of contexts, including healthcare and cybersecurity. Throughout my career, I have given several talks on HCI and on ML from an HCI perspective. More recently, I have used ML systems in the context of face-geometry detection and eye-tracking, with the aim of replacing eye-tracking hardware devices with more accessible alternatives (i.e., standard webcams).

I have a track record of successes in terms of teaching, scholarly productivity, fund raising, and service. Since I joined NKU, increased my teaching evaluations from 4.3/5 to 4.5/5, involved 21 students and 5 faculty from 4 different departments in my interdisciplinary research projects, published 28 papers in academic conferences and scientific journals, received two best-paper awards, secured over $115.000 in internal and (primarily) external grants, and won four

business competitions for supporting technology transfer and academia-industry collaborations, and other entrepreneurial endeavors.

Although I do not have any formal background and training in arts, creating and experiencing art have always been a passion of mine. I started writing poetry at the age of 15, composing music at 17, writing short novels at the age of 19, and drawing and painting at 24. A couple of my musical compositions have been aired on national radios in Italy between 2002 and 2006; my poems and short novels received several awards and were featured in published collections and national radio and TV shows. I am working on a collection of my writings, which I plan to publish in March 2023.

Italo Calvino is one of the most translated Italian writers and my favorite author. Furthermore, "the Invisible Cities" is a literary masterpiece that inspired many artists worldwide, and one of my favorite books of all time. I have read the book several times in three languages (i.e., Italian, English, and Spanish) and I have been evaluating the possibility of using AI to represent its content since Summer 2021. In Summer 2022, I produced over 70 images describing ten cities to test the feasibility of the proposed project.

I have been invited to present my preliminary work in the context of WAMC's and NPR's Academic Minute podcast (https://www.npr.org/podcasts/564572329/the-academic-minute - https://academicminute.org/) and I am going to host a presentation about the project as part of NKU's Six@six series https://bit.ly/3LWQ3A4).

I am already integrating my experience into my academic work. In the past academic year, I have worked with Dr. Wallace (Department of English) on implementing an online platform for archiving and showcasing Melville's collection of almost 500 prints in different digital formats, including an immersive 3d environment where the user can navigate Melville's collection using the browser and Virtual Reality headsets. The platform includes a Content Management System (CMS) designed to maximize the user experience of the curator and the visitor. As mentioned previously, the proposed project will leverage the platform for showcasing the work produced by me and others.

Furthermore, in Spring 2023 I will teach an Honors course titled "Learning from Dall-e: how innovation is shaping our relationship with art", in which the students and I will explore the use of technology for enriching the creation and fruition of art. The course will be an opportunity to introduce students to generative AI, explore currently available ML tools for creating art, and share and discuss my project with the students. Also, it will incorporate a Meyerson Student Philantropy project in which AI-based systems will be utilized to produce art for non-profit organizations and help them organize fund raisers.

Finally, the timeline of the proposed project perfectly aligns with my commitments and current endeavors: I am expected to end two collaborative research and development initiatives in Spring 2023, which will give me the opportunity to commit full-time to the proposed project in Summer 2023.

5. OTHER SUPPORT AND COMMITMENTS

I haven't applied for or received any other funding for this project, yet. However, in the past years, I have been successful in applying for and securing internal and external grants for other projects. Therefore, I plan to use the summer fellowship and devote part of my time to apply to notification of funding opportunities from external sources, including grants focusing on AI/ML research as well as organizations focusing on art such as ArtsWave.

Moreover, although I will not be applying to other internal sources of funding for this project, I asked the Director of the School of Computing and Analytics to use the computing resources available at the School, that is, the Graphical Processing Unit (GPU) cluster, which will be utilized in research projects and for improving open-source generative ML systems.

Finally, this project will leverage resources that I produced thanks to other grants: I will utilize the Content Management System realized in the context of the CINSAM project grant secured with Dr. Bob Wallace. This, in turn, will serve as an additional case study for the CMS and will provide me with opportunities to keep improving the platform.

References

1. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., Courville, A. and Bengio, Y., 2020. Generative adversarial networks. Communications of the ACM, 63(11), pp.139-144.
2. Luan, F., Paris, S., Shechtman, E. and Bala, K., 2017. Deep photo style transfer. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 4990-4998).
3. Reviriego, P. and Merino-Gómez, E., 2022. Text to Image Generation: Leaving no Language Behind. arXiv preprint arXiv:2208.09333.
4. Buraga, A.P., 2022. The Emergence of the Type-Generated AI Art Community: A Netnographic and Content Analysis Approach.
5. Caporusso, N., Zhang, K. and Carlson, G., 2020, June. Using Eye-tracking to Study the Authenticity of Images Produced by Generative Adversarial Networks. In 2020 International Conference on Electrical, Communication, and Computer Engineering (ICECCE) (pp. 1-6). IEEE.

Nicholas Caporusso (Ph.D.in Comp.Eng., Fulbright scholar, Marie Curie fellow)

Education

- **PhD in Computer Science and Engineering** at Institutions, Market, Technologies (IMT) - Institute for Advanced Studies (Italy). Thesis title: *Issues, Challenges and Practices in Advancing Pervasive Human-Computer Interaction for People with Combined Hearing and Vision Impairments*. Dec 2012.
- Fulbright Certificate in **Technology Entrepreneurship** at Santa Clara University (Santa Clara, CA, US). Jun 2011.
- **MS in Computer Science (Magna cum Laude)** with specialization in Interactive systems at University of Bari (Italy). Thesis title: *Multimodal Feedback for Portable Brain-Computer Interfaces*. Mar 2007.
- **BS in Informatics and Digital Communication (Magna cum Laude)** at University of Bari (Italy). Thesis title: *System for enabling deafblind people to communicate using the Malossi method*. Jul 2004.

Work experience *(selected list)*

Tenure-Track Assistant Professor of Computer Science at Northern Kentucky University (Highland Heights, KY - US) **Aug '19 - present day**

- Director of the Bachelor's degree Program in Applied Software Engineering
- Course coordinator of INF286 - Introduction to Web Development
- Instructor of 7 graduate- and undergraduate-level courses on campus and online
- Instructor of 2 Honors College courses
- Representative of the College of Infomatics in the University Research Council
- Raised 20k USD in research grants for working with undergraduate students
- Raised 70k USD in grants for international projects

Tenure-Track Assistant Professor of Informatics at Fort Hays State University (Hays, KS - US) **Aug '17 - May '19**

- Taught 9 graduate-level courses on campus and online
- Published 16 peer-reviewed conference papers with students and faculty
- Nominated to 7 and received 5 best faculty awards
- Received Entrepreneurship Faculty Fellow Award
- Secured stage 1 for a 650k USD grant from the National Institute of Standards and Technology
- Secured 2 Undergraduate Research Experience Grants on Augmented/Mixed Reality and Computer Vision (10k USD)
- Secured an Open Textbook Grant (3k USD)
- Organized "*Kansas start-up*" and the "*Faulkner challenge*", and awarded 10k+ USD in grants

Marie Skłodowska Curie Experienced Researcher at the University of Salford (Manchester, UK) **May '17 - Oct '17**

- Helped revise Intellectual Property strategy and technology transfer pipeline
- Supervised grant applications (550k GBP total) for the Defence Science and Technology Laboratory
- Contributed to a 12mln GBP application for a Research hub in robotics and automation
- Completed course on Robot Operating Systems

Researcher and teaching adjunct at Polytechnic of Bari (Bari, Italy) **May '15 - May '17**

- Responsible for 1,5mln EUR project involving 8 partners
- Published 9 papers, including 1 best paper award
- Supervised 2 magna cum laude master theses and 1 bachelor thesis

Co-founder & CEO at INTACT srl (Bari, Italy) **May '13 - Dec '16**

- Raised 500k EUR in grants and increased company staff by 160%
- Led to profitability in 18 months, increased revenues by 185% after 1 year
- Managed 12 people with different backgrounds in 3 company departments
- Sold Intellectual Property to an acquirer and exited the company

List of Selected Publications since 2017

1. N.C., J.Zhou, Y.Tao, B.Thaman, T.Cao, A.Oassey, A.Shrestha, *A Machine Learning Dataset and Pipeline for Web-based Gaze Tracking* submitted in August 2022 to the Journal of Universal Computer Science (JUCS).
2. B.Thaman, T.Cao, A.Aossey, A.Shrestha, N.C., *Evaluating the Correlation of Gaze and Mouse Interaction*, submitted in August 2022 to the Journal of Information Systems Applied Research (JISAR)
3. B.Thaman, T.Cao, A.Aossey, A.Shrestha, N.C., *Analysis of Research and User Experience with Eye-Tracking Technology*, submitted in August 2022 to the Advances in Science, Technology and Engineering Systems Journal (ASTESJ)
4. N.C., *An Improved PIN Input Method for the Visually Impaired*, to appear in the 44th International IEEE Convention on Information, Communication, and Electronic Technology, 2021. https://bit.ly/3gyQP7M
5. J. Niehaus, N.C., *An Infrastructure for Integrated Temperature Monitoring and Social Tracking*, to appear in the 44th International IEEE Convention on Information, Communication, and Electronic Technology, 2021. https://bit.ly/3BtxahR
6. J.Walden, N.C., L.Atnafu, *A Chatbot for Teaching Secure Programming*, to appear in the Proceedings of the 2022 International Conference of the Information Systems & Computing Academic Professionals | Education Special Interest Group (EDSIGCON + CONISAR 2022)
7. B.Thaman, T.Cao, N.C., *Face Mask Detection using Mediapipe Facemesh*, to appear in the Proceedings of the 45th International Conference on Information, Communication, and Electronic Technology (MiPro 2022)

8. D.Ferman, N.C., *The Role of Social Media during the COVID-19 Pandemic*, to appear in the 13th International Conference on Applied Human Factors and Ergonomics (AHFE 2022)
9. B.Thaman, T.Cao, N.C., *A Landmark Detection and Iris Prediction Dataset for Gaze Tracking Research*, to appear in the Proceedings of the 7th International Conference on Human Interaction and Emerging Technologies (IHIET 2022)
10. N.Samuel, N.C., *A systematic assessment of the impact of the pandemic on academic and scientific conferences*, to appear in the 13th International Conference on Applied Human Factors and Ergonomics (AHFE 2022)
11. B.Thaman, T.Cao, N.C., *Improving Eye-Tracking using RGB Cameras for Large-Scale Human-Machine Applications*, to appear in the 5th International Conference on Intelligent Human Systems Integration: Integrating People and Intelligent Systems (IHSI 2022)
12. T. Farber, L. Christen, N.C., *Incorporating Human Factors in Solutions for Pandemics*, to appear in 12th International Conference on Applied Human Factors and Ergonomics, 2021. https://bit.ly/2UNzfoU
13. L. Christen, T. Farber, N.C., *Face Masks as Awareness and Engagement Platforms*, to appear in 12th International Conference on Applied Human Factors and Ergonomics, 2021. https://bit.ly/3Dk2HEm
14. J.Clark, N.C., *A Dedicated Platform for Health-Safety Reviews*, to appear in 12th International Conference on Applied Human Factors and Ergonomics, 2021. https://bit.ly/2XQfluA
15. N.C., K.Zhang, G.Carlson, *Using Eye-tracking to Study the Authenticity of Images Produced by Generative Adversarial Networks*, in 2nd International Conference on Electrical, Communication and Computer Engineering (ICECCE), 2020. https://bit.ly/3ixTCg3
16. A.Miller, J.Miller, N.C., *Enhancing Webpage Navigation with a Novel Scrollbar*, in 11th International Conference on Usability & User Experience, 2020. https://bit.ly/2XRKN8W
17. A.Peralta, N.C., *The Impact of Social Media in Military Recruiting*, in 11th International Conference on Social & Occupational Ergonomics, 2020. https://bit.ly/33SiJWY
18. J.Esparza, N.C., *Addressing Human Factors in the Design of Cyber Hygiene Self-Assessment Tools*, in 6th International Conference on Human Factors in Cybersecurity, 2020. https://bit.ly/2PIBDav
19. A.Legleiter, N.C., *Flat-Design Icon Sets: a Case for Universal Meanings?*, in 11th International Conference on Usability & User Experience, 2020. https://bit.ly/33TRSd0
20. N.Elleman, N.C., *A Platform for Tracking Teacher-Student Interaction*, in 6th International Conference on Human Factors in Training, Education, and Learning Sciences, 2020. https://bit.ly/3gWIYPO
21. N.C., *Deepfakes for the Good: a Beneficial Application of Contentious Artificial Intelligence Technology*, in 3rd International Conference on Human Factors in Artificial Intelligence and Social Computing, 2020. https://bit.ly/33PMQOI
22. N.C., N.Elleman, S.Cho, *Interface Digital Twins: Rendering Physical Devices Accessible to People who are Blind*, in 43rd International Convention on Information, Communication and Electronic Technology, 2020. https://bit.ly/3BdsKLz
23. N.C., *An Experiential Learning Approach to Research Methods in Computer Science based on SMART Goals*, in 43rd International Convention on Information, Communication and Electronic Technology, 2020. https://bit.ly/2PYDZlP
24. S.Cho, T.Farber, C.Schultz, N.C., M.Song, *SMIILE: Smart Module Integration for IoT Programming Logic and Environment*, in 20th IEEE International Conference On Electro Information Technology, 2020. https://bit.ly/3ahcpcC
25. N.C., N.Elleman, S.Cho, I.Perilli, *A Digital Platform for Improving Accessibility in Physical User Interfaces*, in 6th IEEE International Conference on Information Management, 2020. https://bit.ly/3ajhOzS
26. S.Li, N.C., *Investigating Transparency and Accountability in User Interfaces for Data Visualization: a Case Study on Crowdfunding*, in International Conference on Human Interaction & Emerging Technologies, 2019. https://bit.ly/2GDppfd
27. N.C., K.Zhang, G.Carlson, D.Patchin, D.Jachetta, N.Vaughn, S.Romeiser, *User Discrimination of Content Produced by Generative Adversarial Networks*, in International Conference on Human Interaction & Emerging Technologies, 2019. https://bit.ly/2YB4j78
28. N.C., A.Walters, D.Patchin, N.Vaughn, D.Jachetta, S.Romeiser, M.Ding, *Comparative User Experience Analysis of Pervasive Wearable Technology*, in 3rd International Conference on Human Factors and Wearable Technologies, 2019. https://bit.ly/2KeZv2l
29. N.C., T.Helms, P.Zhang, *A Meta-Language Approach for Machine Learning*, in 2nd International Conference on Human Factors in Artificial Intelligence and Social Computing, 2019. https://bit.ly/2Ov4i52
30. T.Fandakly, N.C., *Beyond Passwords: Enforcing Username Security as the First Line of Defense*, in 8th International Conference on Human Factors in Cybersecurity, 2019. https://bit.ly/2ytd0FY
31. M.Stainbrook, N.C., *Comparative Evaluation of Security and Convenience Trade-offs in Password Generation Aiding Systems*, in 8th International Conference on Human Factors in Cybersecurity, 2019. https://bit.ly/2Gzns3l
32. N.C., G.Carlson, M.Ding, P.Zhang, *Immersive Virtual Reality beyond Available Physical Space*, in 8th International Conference on Human Factors in Game Design and Virtual Environments, 2019. https://bit.ly/2YB4kYK
33. N.C., *An Interactive Device for Reducing Risk of Infusion Therapy and Blood Transfusions*, in 8th International Conference on Human Factors and Ergonomics in Healthcare and Medical Devices, 2019. https://bit.ly/2ytc98e
34. N.C., K. Udenze, A. Imaji, S. Romeiser, Y. Cui, Y. Li, *Accessibility Evaluation of Automated Vending Machines*, in 4th International Conference on Design for Inclusion, 2019. https://bit.ly/336Ysu3
35. X.Xiao, N.C., *Comparative Evaluation of Cyber Migration Factors in the Current Social Media Landscape*, in IEEE International Symposium on Social Networks and Applications, 2018. https://goo.gl/QdJvFQ
36. M.Clarke, G.Carlson, N.C., C.Jacobs, *Filmmaking without a Frame - Virtual Reality and 360 Degree Video*, in 72nd Annual Conference of the University Film and Video Association, 2018.
37. G.Carlson, M.Clarke, N.C., A.Perez, C.Jacobs, M.Ding*Best of Both Worlds: Combining 360 Video and Augmented Reality for Understanding and Creating Narrative*, in Digital Frontiers conference, 2018.
38. N.C., L.Biasi, G.Cinquepalmi, V.Bevilacqua, *An Immersive Environment for Experiential Training and Remote Control in Hazardous Industrial Tasks*, in 9th Intl Conf. on Human Factors and Wearable Technologies, 2018. https://goo.gl/roiqw2
39. N.C., M.Ding, M.Clarke, G.Carlson, V.Bevilacqua, G.F.Trotta, *Analysis of the Relationship between Content and Interaction in the Usability Design of 360° Videos*, in 9th Intl Conf. on Usability and User Experience, 2018. https://goo.gl/FnZm7w

Funding *(selected list)*

- 2021: Department of State - US-Italy Mission grant, 60.000 USD
- 2019: Student/Faculty Development award, 4.500 USD
- 2019: Summer Project Research Grant, 6.000 USD
- 2018: Entrepreneurship Faculty Fellows on Digital Matchmaking, 4.000 USD
- 2018: Undergraduate Research Experience Grant on Wearable eye tracking, 5.000 USD
- 2018: NIST, EQUIPS, 750.000 USD (awarded phase 1)
- 2018: InnoNetwork, T-Care, 1.250.000 EUR
- 2018: InnoLabs, EpiC, 650.000 EUR
- 2017: Undergraduate Research Experience Grant on Immersive Video, 5.000 USD
- 2017: Verso Technologies (Equity), 180.000 EUR
- 2017: Start&Go, Verso Technologies, 380.000 EUR
- 2015: InnovateUK, dbGLOVE, 120.000 GBP
- 2015: Sisal Pay GoBeyond, dbGLOVE, 50.000 EUR
- 2014: Berlin IoT, dbGLOVE, 50.000 EUR
- 2013: InnoLabs, SmartEnergy, 650.000 EUR
- 2013: InnoLabs, Carehub, 420.000 EUR
- 2012: European Regional Development Fund - European Commission, Laboratori dal Basso, 2,400.000 EUR
- 2012: Valore Assoluto, dbGLOVE, 120.000 EUR
- 2009: Principi Attivi - dbGLOVE, 25.000 EUR

Awards *(selected list)*

- 2021: Best paper award at the 1st Conference in Human Factors in Disease Control and Pandemic Prevention
- 2020: Best paper award at the 6th International Conference on Information Management
- 2019: "Pilot Award" Nomination as best faculty at Fort Hays State University
- 2019: "University Outstanding Scholar Award" at Fort Hays State University
- 2019: "1st prize Faculty Research Award" at SACAD
- 2019: "Entrepreneurship Faculty Fellows Award" at Fort Hays State University
- 2018: "Pilot Award Nomination as best faculty
- 2018: "Fischli's Excellence in Higher Education Award" at Fort Hays State University
- 2018: "Faculty of the year Service award" at Fort Hays State University
- 2018: "Graduate School's Outstanding Research Mentor" at Fort Hays State University
- 2018: 1st place at "Innovation Party" start-up competition
- 2017: Best paper award at the International Conf. on Applied Human Factors and Ergonomics
- 2017: Marie Curie Fellowship
- 2016: Best paper award at the International Conf. on Recent Trends in Image Processing & Pattern Recognition
- 2016: 1st prize at the "Make to care" challenge as best start-up
- 2016: 1st prize at "Heroes - meet in Maratea" as best start-up
- 2016: 1st prize at "Charité Venture Summit" as best technology for healthcare
- 2015: 1st prize at "Cuore digitale" as best technology with social impact
- 2015: 1st prize at "GoBeyond" as best start-up
- 2015: 1st prize at "InnovateUK" as best wearable technology for accessibility
- 2015: MIT Technology Review - Italian chapter - "Innovators Under 35" award
- 2015: 1st prize at "Internet of Things accelerate Berlin" as best IoT start-up
- 2014: 1st prize at Job&Orienta as best innovation project
- 2014: 1st prize at AlternAttiva as best school innovation project
- 2014: 5th place winner at Future in Research (1250 applications)
- 2014: 1st prize at Focus innovation prize in media and communication
- 2014: 1st prize at Lamarck Prize for INTACT srl
- 2014: 2nd prize at Lamarck Prize for IVE360 - Immersive Video Experience
- 2013: Mario Tchou award for best PhD dissertation by AICA
- 2012: 1st place at Valore Assoluto by Camera di Commercio di Bari
- 2011: L'innovazione tecnologica per la gestione del rischio in sanità by Gutenberg - Healthcare safety
- 2011: 1st prize at James Dyson Award - Italian edition
- 2010: Fulbright scholarship from the United States Department of State, Bureau of Educational and Cultural Affairs
- 2009: 1st place at Principi Attivi as best technology with social impact (1600 applicants)
- 2008: Best thesis award by CINEAS
- 2008: Best master thesis award by AICA

PREVIOUS FBC AWARDS

2019-2020: Summer Fellowship, 6.000 USD
The Fellowship supported research on a system that can improve the accessibility of User Interface (UI) of physical devices (e.g., vending, ticketing, and ATM machines, as well as appliances) to render them usable to individuals with disabilities, with specific regard to blind and deaf-blind people.

Specifically, the project focused on creating a system for implementing an Interactive Digital Twin, that is, a digital replica of the product user interface (e.g., touchscreen displays, keypads, knobs, and buttons) on users' smartphones, so that individuals can leverage the accessibility features of their phone (i.e., text-to-speech) to be able to easily navigate the interface and understand how to use the vending machine. The project accomplished its main objective, achieving a working prototype that has been tested in a laboratory environment and is ready to be implemented in real-world scenarios. Moreover, the team rendered the solution affordable and immediately adoptable without requiring any changes to current devices.

The work has been realized in the context of a collaboration with a network of international partners and has resulted in two publications in international peer-reviewed scientific conferences, of which one has received a best paper award. Furthermore, the summer fellowship has created the opportunity to involve one NKU faculty and two NKU students in undergraduate research (including one UR-STEM project).

The Summer Fellowship supported a research project focusing on improving the accessibility of physical devices, with specific regard to publicly available vending machines, to people who are blind. Instead of requiring major changes to the physical interface of eVending, the goal of the project is to develop an interconnected platform that enables individuals who are blind to use their smartphone to easily download and access a digital replica of the user interface of the device. By doing this, they can navigate the options using the text-to-speech features, receive instructions and feedback on how to make their selection, and complete their task on the physical device (and, in the future, or on their smartphone).

We introduced the concept of Interface Digital Twin, that is, a completely digital replica of a User Interface specifically designed to exactly mimic the form, layout, and workflow of a physical device, product, or object (e.g., a device or a paper document) to render it accessible and help users learn it. IDTs aim at supporting multi-modal interaction via tactile icons and audible feedback without requiring a dedicated or external physical device. In addition to reproducing the original UI, the primary purpose of IDTs is to provide an additional information and interaction layer that improves usability and accessibility (e.g., by helping the

user locate controls using vibration patterns and by translating visual labels in audible form) and adds user customization. As a result, its layout and features are aimed at supporting alternative multi-modal content that results in a more effective interaction with the associated object or device. By doing this, they can build a mental model of the configuration of the physical interface of the actual device and learn how to operate it.

Publications:

1. N.Caporusso, N.Elleman, S.Cho, Interface Digital Twins: Rendering Physical Devices Accessible to People who are Blind, in 43rd International Convention on Information, Communication and Electronic Technology, 2020. Full text: https://bit.ly/3BdsKLz
2. N.Caporusso, N.Elleman, S.Cho, I.Perilli, A Digital Platform for Improving Accessibility in Physical User Interfaces, in 6th IEEE International Conference on Information Management, 2020. Full text: https://bit.ly/3ajhOzS

Awards:

1. N.Caporusso, N.Elleman, S.Cho, I.Perilli, A Digital Platform for Improving Accessibility in Physical User Interfaces, in 6th IEEE International Conference on Information Management, 2020. Full text: https://bit.ly/3ajhOzS

AY 2021-2022: Project Grant, 6.000 USD
The grant supported the development of “Cursor”, a software system that enables users to share the location of their mouse and gaze in real-time while screen-sharing in remote-conferencing sessions, to enhance interaction and render it more natural. The functionality of the system is similar to the collaboration features of Google Documents/Microsoft 365, which enable users to see where the others are editing. However, it works with any type of documents and applications, including clinical reports, source code, videos, within or outside the browser. To this end, it acquires the gaze and mouse input of the connected users using dedicated eye-tracking hardware as well as from standard webcams. Using the gaze results in a more immediate and natural interaction with content. By doing this, the system can be utilized for enhancing interaction between faculty and students, during 1:1 mentoring sessions, and for real-time remote collaboration and second opinion during clinical procedures and diagnoses.

The project team developed a software library that is able to replicate the functionality of a hardware eye-tracking device using just the webcam. To this end, the team used machine learning libraries and pipelines such as MediaPipe FaceMesh, and other Artificial Intelligence algorithms. In addition, the project grant provided me and the team members with the opportunity to expand our collaboration and involve other faculty and students who participated in a UR-STEM project over the summer. Together, we have explored other uses of our software system and library: for instance, we demonstrated how our algorithms can be applied to a variety of tasks, including mask detection.

Publications:
1. N.Caporusso, J.Zhou, Y.Tao, B.Thaman, T.Cao, A.Oassey, A.Shrestha, A Machine Learning Dataset and Pipeline for Web-based Gaze Tracking submitted in August 2022 to the Journal of Universal Computer Science (JUCS).
2. B.Thaman, T.Cao, A.Aossey, A.Shrestha, N.Caporusso, Evaluating the Correlation of Gaze and Mouse Interaction, submitted in August 2022 to the Journal of Information Systems Applied Research (JISAR)
3. B.Thaman, T.Cao, A.Aossey, A.Shrestha, N.Caporusso, Analysis of Research and User Experience with Eye-Tracking Technology, submitted in August 2022 to the Advances in Science, Technology and Engineering Systems Journal (ASTESJ)
4. B.Thaman, T.Cao, N.Caporusso, Face Mask Detection using Mediapipe Facemesh, to appear in the Proceedings of the 45th International Conference on Information, Communication, and Electronic Technology (MiPro 2022)
5. B.Thaman, T.Cao, N.Caporusso, A Landmark Detection and Iris Prediction Dataset for Gaze Tracking Research, to appear in the

Proceedings of the 7th International Conference on Human Interaction and Emerging Technologies (IHIET 2022)

6. B.Thaman, T.Cao, N.Caporusso, Improving Eye-Tracking using RGB Cameras for Large-Scale Human-Machine Applications, to appear in the 5th International Conference on Intelligent Human Systems Integration: Integrating People and Intelligent Systems (IHSI 2022)

Awards:

1. NKU Research Foundation Pitch Competition Award
2. Kentucky Commercialization Ventures IMPACT award
3. Vanderbilt Wondry award

FDA Summer Fellowship Evaluation Form for Chairs

***Instructions**: Please print or type in the following form. Comment length is limited to this page. Forward a copy to Faculty Senate Benefits Committee c/o Grace Hiles hilesg1@nku.edu*

Faculty applicant name: _____**Nicholas Caporusso**_____

Evaluations are based on criteria as defined in the Faculty Handbook **11. FACULTY DEVELOPMENT PROGRAMS** sections 11.1 through 11.4.

This individual qualifies for the proposed fellowship (tenured/tenure track, 3rd summer since prior award):

Yes _**X**_ No ____

Indicate your assessment of the following items from very low to very high:

	Very low	Low	Neutral	High	Very high
Overall quality of proposal					X
Ability of applicant to carry out project					X
Overall value of project					X
Value to the department				X	
Value to student learning					X
Value to the field of study				X	

General Comments:

This is a well written proposal that combines art and computer science in a novel way. The proposal is very applied and while the basic research component is somewhat limited, the interdisciplinary and the potential on creating novel art forms are very interesting.

The choice of the Calvino work is also very interesting, and brings back my personal childhood memories of reading about Marco Polo travels.

I strongly support this proposal for funding.

Dr. Caporusso has successfully completed all the requirements of the previous FBC grants.

Specific comments on any category ranked neutral, low, or very low:

Traian Truta
_____ 10 - 10 - 2022
_____

Name (typed or signed) Date

School: School of Computing and Analytics
_____