

SEAN GRIMES

PERSONAL INFORMATION

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phone (C) (610) 710 1036

WORK EXPERIENCE

*Department of
Computer Science*

2022–Present Asst. Teaching Professor, DREXEL UNIVERSITY

Developing and teaching lecture material across a wide variety of classes within the Computer Science Department.

*Department of
Computer Science*

2019–2022 Senior Teaching Assistant, DREXEL UNIVERSITY

Develop new lecture material, create exam material, assist with course management, teach lectures, hold regular office hours in the Department of Computer Science help center, and assist with grading assignments, exams, and course projects.

*Geometric
Biomedical
Computing Group*

2014–2022 Research Assistant, DREXEL UNIVERSITY

Individual and collaborative research efforts in the fields of biologically inspired A.I. and swarm A.I. Previous work includes developing a behaviorally accurate representation of the worm *C. elegans* and developing self-organizing swarms based on simulated chemical diffusion. My current research is focused on predicting specific future events through a combination of classification, multi-agent interactions, wisdom of crowds, and swarm intelligence. Individual agents are built around a central classifier, each trained on different features; agents then form into teams and participate in an interaction arena to facilitate intra-team information sharing. Finally, agents move into a swarm arena where an emergent opinion is allowed to form.

*Department of
Computer Science*

2015–2019 Teaching Assistant, DREXEL UNIVERSITY

Assisting the Computer Science department within the College of Computing and Informatics where I hold regular office hours, assist with grading, and provide general support to all Drexel University Computer Science students.

*Ecodren Research
LLC.*

2015–2018 Co-Founder, Ecodren Research

Ecodren Research, founded by three Computer Science Ph.D. students, is a custom computing company designed to bring A.I. solutions to every-day problems. Ecodren worked with area Universities to provide students with an app-based experience that allowed them, through the use of NLP, to provide feedback to specific departments / people without identifying the proper recipient of their feedback.

Irregex LLC.

2013–2015 Co-Founder, IRREGEX

Irregex was a computer and network technology startup focused on data mining, data-analysis, web / database design, development, implementation and management. At Irregex I was partially responsible for setting up a network of 5 CentOS / Ubuntu servers, providing XMPP, E-mail, VPN, SSH services, and worked on developing / maintaining websites for Irregex and it's main project, Corticus.

*Bioengineering
Department,
University of
Pennsylvania*

Summer 2011 **Research Intern**
Neuroscience research member of a multi-disciplinary team investigating the mechanical forces exerted by neurons on various substrates during locomotion using traction force microscopy.

*Neuroscience
Department,
Ursinus College*

Spring 2011 **Research Assistant**
Directed research in the study of Synesthesia in the field of applied cognitive neuroscience.

*Biology
Department,
Ursinus College*

Summer 2010 **Research Assistant**
Neurobiology research into the comparative studies of brainstem neural networks in weakly electric fish.

Baseball Instructor

2008–2013 **Individual Coaching**
Group and one-on-one baseball instruction for age ranges 9–18.

EDUCATION

*Doctor of
Philosophy*

2016–2023 **Drexel University**
Computer Science
College: College of Computing and Informatics
Related Coursework: Data Structures and Algorithms, High Performance Computing, Parallel Programming, Operating Systems, Computer Networks, Advanced A.I., Software Design, Dependable Software Systems
Research Interests: Swarm A.I., Strong A.I., Biologically inspired A.I.

Master of Science

2015–2018 **Drexel University**
Computer Science
College: College of Computing and Informatics

Bachelor of Science

2008–2012 **Ursinus College**
Neuroscience
Related Coursework: Behavioral Neuroscience, Cognitive Neuroscience, Cellular Neurobiology, Neuroanatomy, Organic & General Chemistry
Activities: Varsity Baseball

PUBLICATIONS

*Doctoral
Dissertation*

Apr. 2023 **WoC-Bots: Swarms of Biologically Inspired Prediction Agents**
This dissertation presents Wisdom-of-Crowds-Bots (WoC-Bots), biologically-inspired, simple, and modular agents which work together in a multi-agent environment to collectively make binary predictions. Building on the theoretical underpinnings of Wisdom of Crowds, WoC-Bots represent a knowledge-diverse crowd where each agent is trained on a subset of available information. A honeybee-derived swarm aggregation mechanism was developed to elicit a collective prediction with an associated confidence score. Due to the multi-agent architecture, WoC-Bots can be distributed across multiple compute nodes, reducing training and inference time. Importantly, this architecture demonstrates significant key advantages over traditional classification methods while maintaining comparable predictive performance. Specifically, new and previously unknown input features can be included in an

existing classification problem without retraining existing agents. New input features, combined with existing features, are encapsulated into newly generated agents before agents are injected into an existing classification task. Further development led to a “meta-swarm”, where an external prediction is used as the core belief of an agent, replacing a simple multi-layer perceptron network. The external prediction requires zero knowledge of source data, maintaining the localization and privacy of the data used to generate the prediction, enabling collaboration between institutions unable to share their data externally.

Citation: Grimes, S. (2023). WoC-Bots: Swarms of Biologically Inspired Prediction Agents [Doctoral Dissertation, Drexel University].

Jan. 2023 A Multi-Agent Approach to Binary Classification Using Swarm Intelligence

*Future Internet,
Modern Trends in
Multi-agent
Systems*

Wisdom-of-Crowds-Bots (WoC-Bots) are simple, modular agents working together in a multi-agent environment to collectively make binary predictions. The agents represent a knowledge-diverse crowd, with each agent trained on a subset of available information. A honey-bee-derived swarm aggregation mechanism is used to elicit a collective prediction with an associated confidence value from the agents. Due to their multi-agent design, WoC-Bots can be distributed across multiple hardware nodes, include new features without re-training existing agents, and the aggregation mechanism can be used to incorporate predictions from other sources, thus improving overall predictive accuracy of the system. In addition to these advantages, we demonstrate that WoC-Bots are competitive with other top classification methods on three datasets and apply our system to a real-world sports betting problem, producing a consistent return on investment from 1 January 2021 through 15 November 2022 on most major sports.

Citation: Grimes, Sean, and David E. Breen. 2023. “A Multi-Agent Approach to Binary Classification Using Swarm Intelligence” *Future Internet* 15, no. 1: 36. <https://doi.org/10.3390/fi15010036>

Dec. 2021 An agent-based approach to predicting lymph node metastasis status in breast cancer

*IEEE International
Conference on
Bioinformatics and
Biomedicine
(BIBM)*

We present a flexible, multi-agent approach to predictive classification problems which uses simple, modular agents that interact and share information socially in an arena with a variable number of participants. Opinion aggregation is accomplished using a honey-bee-derived optimization algorithm that improves accuracy and reduces variance compared with existing weighted and unweighted voter mechanisms. Confidence metrics may be derived from the agent interactions. We apply our system to a data set of 483 de-identified breast cancer patients to predict node-positive or node-negative disease with over 78.5% accuracy in general. When eliminating low-confidence predictions, which leaves 79.5% of patients, classification accuracy improves to 84.5%.

Citation: Grimes, S., Zarella, M. D., Garcia, F. U., & Breen, D. E. (2021, December). An agent-based approach to predicting lymph node metastasis status in breast cancer. In *2021 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)* (pp. 1315-1319). IEEE.

Oct. 2019 WoC-Bots: An Agent-Based Approach to Decision-Making

*MDPI Journal of
Applied Sciences*

We present a flexible, robust approach to predictive decision-making using simple, modular agents (WoC-Bots) that interact with each other socially and share information about the features they are trained on. Our agents form a knowledge-diverse crowd, allowing us to use Wisdom of the Crowd (WoC) theories to aggregate their opinions and come to a collective conclusion. Compared to traditional multi-layer perceptron (MLP) networks, WoC-Bots can be trained more quickly, more easily incorporate new features, and make it easier to determine why the network gives the prediction that it does. We compare our predictive accuracy with MLP networks to show that WoC-Bots

can attain similar results when predicting the box office success of Hollywood movies, while requiring significantly less training time.

Citation: Sean Grimes & David E. Breen (2019) WoC-Bots: An Agent-Based Approach to Decision-Making, *MDPI Journal of Applied Sciences*, Vol. 9, Article 4653, October 2019., DOI: 10.3390/app9214653.

June 2018 Directing chemotaxis-based spatial self-organisation via biased, random initial conditions

International Journal of Parallel, Emergent and Distributed Systems

Inspired by the chemotaxis interaction of living cells, we have developed an agent-based approach for self-organising shape formation. Since all our simulations begin with a different uniform random configuration and our agents move stochastically, it has been observed that the self-organisation process may form two or more stable final configurations. These differing configurations may be characterised via statistical moments of the agents' locations. In order to direct the agents to robustly form one specific configuration, we generate biased initial conditions whose statistical moments are related to moments of the desired configuration. With this approach, we are able to successfully direct the aggregating swarms to produce a desired macroscopic shape, starting from randomised initial conditions with controlled statistical properties.

Citation: Sean Grimes, Linge Bai, Andrew W.E. McDonald & David E. Breen (2018) Directing chemotaxis-based spatial self-organisation via biased, random initial conditions, *International Journal of Parallel, Emergent and Distributed Systems*, DOI: 10.1080/17445760.2018.1469630

Sept. 2017 Ortus: an Emotion-Driven Approach to (artificial) Biological Intelligence

The European Conference on Artificial Life

Ortus is a simple virtual organism that also serves as an initial framework for investigating and developing biologically based artificial intelligence. Born from a goal to create complex virtual intelligence and an initial attempt to model *C. elegans*, Ortus implements a number of mechanisms observed in organic nervous systems, and attempts to fill in unknowns based upon plausible biological implementations and psychological observations. Implemented mechanisms include excitatory and inhibitory chemical synapses, bidirectional gap junctions, and Hebbian learning with its Stentian extension. We present an initial experiment that showcases Ortus' fundamental principles; specifically, a cyclic respiratory circuit, and emotionally driven associative learning with respect to an input stimulus. Finally, we discuss the implications and future directions for Ortus and similar systems.

Citation: A. W. E. McDonald, S. Grimes, D.E. Breen, "Ortus: An emotion-driven approach to (artificial) biological intelligence," *Proc. Eur. Conf. On Artificial Life*. Vol. 14, pp. 537-544, 2017.

PRESENTATIONS

May 2021 WoC-bots: A Multi-agent Approach to Predicting Lymph Node Metastasis from Primary Breast Tumors

Presented at Pathology Informatics Summit with Mark D. Zarella, Fernando U. Garcia, and David E. Breen.

COMPUTING LANGUAGES

<i>Basic</i>	BASH, MAKE, AWK, LISP, PROLOG, SWIFT
<i>Intermediate</i>	C, D, PYTHON, OPENGL, OPENCL, PHP, JAVASCRIPT, CSS, HTML, XML, L ^A T _E X
<i>Advanced</i>	KOTLIN, C++, JAVA

OTHER INFORMATION

Awards

- 2023 · Computer Science Outstanding Graduate Research Award
- 2019 · CCI Teaching Excellence - Graduate
- 2019 · Upsilon Pi Epsilon Honor Society for the Computing and Information Disciplines
- 2006–2008 · All-League, Pitching
- 2007–2008 · All-County, Pitching
- 2008 · All-County, Designated Hitter
- 2008 · MVP, Main Line Legion

July 22, 2023