# IS 698/800:
# Smart Home Health Analytics
# Spring 2020

**Times:** Tuesday 7:10pm – 9:40pm
**Location:** Information Technology 104
**Instructor:** Nirmalya Roy
**Instructor's Office Location and Hours:** ITE 421 Thursday 9:00 – 12:00 pm, or by appointment
**Instructor's Email:** nroy at umbc dot edu

**Course Webpage:** http://mpsc.umbc.edu/is698shhasp20/

**Course Descriptions:** This course will examine different machine learning methodologies, toolsets, wearable and ambient systems that are warranted to recognize, discover, and learn the human activities, behaviors, and their profound impact on human health and wellness in smart home environments. Human activity recognition is a growing field of research with its far-reaching impact on proactive health care, physical fitness, and healthy living. We will discuss different machine learning algorithms, evaluation metrics, and their application to human activity and behavior recognition. A special emphasize will be given to the techniques with respect to a variety of emerging smart environment contexts spanning across monitoring activities of daily living (ADLs), physiological signals (heart rate, galvanic skin response) and psychological behaviors (emotion, stress, depression, agitation) etc. These human signals can be sensed and measured using wearable and IoT (Internet-of-Things) technologies such as smart phones and wristwatches to keep people informed about their activity, life-style, health, mood, behavior, and surrounding. Students are required to do a group or individual project. The tools necessary to develop the project will be reviewed and made available in class, but students are expected to be comfortable with basic use of software, smart phones and smart watches and have an interest in using technology for smart home health monitoring, assessment, and intervention.

**Course Objectives:** The purpose of this course is to provide a comprehensive foundation to apply machine learning, data science, and statistical learning methodologies in solving problems in real life applications such as smart home healthcare. This course should enhance students' reasoning, problem-solving and modeling abilities, particularly in dealing with data science problems. More specifically, the course has the following objectives:

- Familiarize students with the concepts and applications of machine and statistical learning techniques to solve real life data science problems.

- Teach students how to think and formalize smart environments research problems with real data and what computational techniques to apply.

We will not assume any background beyond high school level mathematics and familiarity with programming concepts. However, students are expected to spend time in learning the concepts in this course, many of which will be covered in detail.

**Course Topics:**

- Gerontechnology
- Supervised Learning
- Bayesian Decision Theory
- Parametric Methods
- Decision Theory
- Machine Learning Evaluation
- Machine Learning Toolkits
- Activity Learning
- Smart Home Health Technologies
- Functional and Behavioral Health Assessment
- Qualitative and Quantitative Clinical Health Assessment Tools
- Applications

**Course Prerequisites:** Consent of the instructor.

**Instructional Materials:** Given that this is an interdisciplinary IS course cross cutting machine learning, data science, Internet of Things, smart home technologies and clinical psychology, there are no single textbook that fully cover the integrated aspects of the course material. At the first half of the course the instructor will discuss the core methodologies behind the course and in the second half the students will be reading various research articles to assimilate the emerging trend in the subject matter of smart home health analytics. A list of research articles will be made available at the course webpage. There are a few books that are relevant to this course are listed next.

**Recommended Textbooks (Optional):**

- Introduction to Machine Learning, Second Edition, by Ethem Alpaydin, MIT Press, 2010 (Amazon.com)
- Machine Learning, Tom Mitchell, McGraw Hill, 1997. (Amazon.com)
- Activity Learning: Discovering, Recognizing, and Predicting Human Behavior from Sensor Data by Diane J. Cook, Narayanan C. Krishnan, Wiley, 2015 (Amazon.com)

**Course Project:** Students are required to do a group project (individual or two students in each group) as part of this course work. Each team is required to propose a study hypothesis, collect their own datasets over a period of time using smartphones and smartwatches for a specific smart environments application as approved by the instructor and use of appropriate data analytics and machine learning methodology to recognize and evaluate the context of the users.

**Reading, Writing, and Oral Assignments:** Each student will be required to participate in the research reflection group discussion exercise in class, present individually one research paper and the group research project at the end of the semester. Each student is also required to write three critiques on three distinct research papers being presented by the fellow students in the class.

**Course Requirements and Grading:**

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| Course Participation | 5% |
| Research Reflection | 5% |
| Individual Research Paper Presentation | 5% |
| Critique Writing | 5% |
| Homework (5) | 20% |
| 1 Midterm Exam | 25% |
| Group Research Project & Final Project Report | 35% |

**Schedule**

| Class | Day | Date | Topic | Readings | Due |
|---|---|---|---|---|---|
| 1 | Tue | 1/28/2020 | Course Introduction, Review of Probability & Statistics | | |
| 2 | Tue | 2/04/2020 | Machine Learning Introduction, Weka Tutorial | Alpaydin, Chap. 1 | |
| 3 | Tue | 2/11/2020 | Supervised Learning, Research Logistics & Reflection | Alpaydin, Chap. 2 | **HW1** |
| 4 | Tue | 2/18/2020 | Bayesian Decision Theory, Research Reflection Discussion | Alpaydin, Chap. 3 | **HW2** |
| 5 | Tue | 2/25/2020 | Parametric Methods, Research Reflection Discussion | Alpaydin, Chap. 4 | **HW3** |
| 6 | Tue | 3/03/2020 | Data Collection/Android Tutorial, Research Reflection Discussion | | |
| 7 | Tue | 3/10/2020 | Research Reflection Discussion | | |
| 8 | Tue | 3/17/2020 | Spring Break | | |
| 9 | Tue | 3/24/2020 | Decision Trees | Alpaydin, Chap. 9 | **HW4** |
| 10 | Tue | 3/31/2020 | Evaluation, Research Paper Presentation | Alpaydin, Chap. 19 | |
| 11 | Tue | 4/07/2020 | Research Paper Presentation | | **HW5** |
| 12 | Tue | 4/14/2020 | Research Paper Presentation | | |
| 13 | Tue | 4/21/2020 | Research Paper Presentation Exam Review | | |

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| 14 | Tue | 4/28/2020 | Exam | | |
| 15 | Tue | 5/05/2020 | Final Research Project Group Presentation | | |
| 16 | Tue | 5/12/2020 | Final Research Project Group Presentation | | |

**Course Resources:**

- WEKA Machine Learning Software
- RStudio – Statistical Computing
- SPSS – Statistical Analysis Software Package [IBM SPSS Analytics]
- UCI Machine Learning Database Repository
- www.KDnuggets.com – Analytics and Data Mining Resources

**Smartphone and Smartwatch Data Collection Apps:**

iPhone Users:

- Activity Learning (AL)
- PowerSense

Android Users:

- Activity Learning (AL)
- Sensor Kinetics
- Androsensor

**Just In Case:** Diminished mental health can interfere with optimal academic performance. The source of symptoms might be related to your course work; if so, please speak with me. However, problems with other parts of your life can also contribute to decreased academic performance. UMBC provides cost-free and confidential mental health services through the Counseling Center to help you manage personal challenges that threaten your personal or academic well-being.

Remember, getting help is a smart and courageous thing to do -- for yourself and for those who care about you. For more resources get the Just in Case mental health resources Mobile and Web App. This app can be accessed by clicking http://counseling.umbc.edu/justincase

The UMBC Counseling Center is in the Student Development & Success Center (between Chesapeake and Susquehanna Halls). Phone: 410-455-2472. Hours: Monday-Friday 8:30am-5:00pm.

**Student Support Services:** UMBC is committed to eliminating discriminatory obstacles that disadvantage students based on disability. Student Support Services (SSS) is the UMBC department designated to receive and maintain confidential files of disability-related documentation, certify eligibility for services, determine reasonable accommodations, develop with each student plans for the provision of such accommodations, and serve as a liaison

between faculty members and students regarding disability-related issues. If you have a disability and want to request accommodations, contact SSS in the Math/Psych Bldg., room 213 or at 410-455-2459. SSS will require you to provide appropriate documentation of disability. If you require accommodations for this class, make an appointment to meet with me to discuss your SSS-approved accommodations.

**Academic Integrity:** Cheating in any form, will be subject to discipline according to university regulations. Projects that contain plagiarized materials will receive an automatic letter grade of 'F'. Multiple violations will be handled according to university regulation. Please refer to Academic Integrity for more information.