Department of Computational and Data Sciences

4400 University Drive, MS 6A12, Fairfax, Virginia 22030
Phone: 703-993-9298 Fax: 703-993-9300
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CSI 709/CSS 739

Verification and Validation of Models

1. General Information

Instructor:	Dr. Hamdi Kavak (hkavak@gmu.edu)
Backup Instructor:	Dr. William G Kennedy (wkennedy@gmu.edu)
Where:	ONLINE (See meeting details below)
When:	Mondays from 7:20 PM - 10:00 PM
Assignment submission:	The GMU Blackboard Website (https://blackboard.gmu.edu/)
Course website:	http://hamdikavak.com/course-v-and-v/
Credits:	3
Prerequisites:	-
Office Hours:	Fridays from 1:30 PM - 5:00 PM (email the instructor at hkavak@gmu.edu with your preferred meeting time).

2. Course Description

Computational models come in different forms ranging from machine learning models that predict/classify patterns to agent-based models that investigate emergent phenomena from a bottom-up perspective. Regardless of their form, all computational models should go through the Verification and Validation (V&V) process, which checks the correctness of the model design and performance. The proliferation of high-level frameworks and tools make it possible to bypass or overlook such steps. This course aims to teach and improve V&V practices, which is considered as an essential methodological step in model development. Some of the topics include terminology and history of V&V, statistics and visualization for V&V, runtime verification, validation of statistical models, validation of data-driven models, and validation in the absence of data, among many others. Students will further their knowledge with weekly topic evaluations on Blackboard, synthesis assignment, and the final project.

3. Learning Outcomes

By the end of the course, students will

- have a fundamental knowledge of verification and validation of models,
- gain a methodological approach to questioning the quality of scientific models,
- be able to understand the ethical implications of model use in the real world,
- be exposed to different types of models and their verification and validation.

4. Format and Zoom Meeting Details

The course will be taught as synchronous online lectures supported by instructional material dissemination through Blackboard and Course Website.

Join Zoom Meeting Details (CSI 709/CSS 739 - Verification and Validation of Models)

Meeting link: https://gmu.zoom.us/j/96890344330?pwd=YndqSXpiMG1jaEs3M3dZSm1kdzI4UT09

Meeting ID: 968 9034 4330
Passcode: GMU2020
One tap mobile
+12678310333,,96890344330#,,,,,,0#,,4964945# US (Philadelphia)

+13017158592,,96890344330#,,,,,,0#,,4964945# US (Germantown)

Dial by your location
+1 267 831 0333 US (Philadelphia)
+1 301 715 8592 US (Germantown)
Meeting ID: 968 9034 4330
Passcode: 4964945

Find your local number: https://gmu.zoom.us/u/a6Y6045HH

Join by SIP
96890344330@zoomcrc.com

Join by H.323
162.255.37.11 (US West)
162.255.36.11 (US East)
115.114.131.7 (India Mumbai)
115.114.115.7 (India Hyderabad)
213.19.144.110 (EMEA)
103.122.166.55 (Australia)
64.211.144.160 (Brazil)
69.174.57.160 (Canada)
207.226.132.110 (Japan)
Meeting ID: 968 9034 4330
Passcode: 4964945

5. Textbooks and Other Instructional Material

We have no required textbooks for the class. The following is a list of books that you may find helpful:

- The MITRE Systems Engineering Guide.
  - https://www.mitre.org/sites/default/files/publications/se-guide-book-interactive.pdf
- Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains by John A. Sokolowski and Catherine M. Banks. Publisher: Wiley.
- Concepts of Model Verification and Validation. Thacker, B.H.; Doebling, S.W.; Hemez, F.M.; Anderson, M.C.; Pepin, J.E.; Rodriguez, E.A.
  - https://inis.iaea.org/collection/NCLCollectionStore/_Public/36/030/36030870.pdf

Each week, we will cover a new topic with a set of suggested reading material and slides. These materials will be listed both on the Blackboard and Course Website.

6. Technology Requirements

Activities and assignments in this course will regularly use the Blackboard learning system, available at https://mymason.gmu.edu. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher. You can check your speed settings using speed check software such as fast.com)

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7. Course Outline (tentative)

In this course, we will cover the following topics, which are subject to change at the discretion of the instructor, and changes will be announced during our lectures or via announcement emails.

Week # (Date)	Topic	Assignment due
Week #1 (08/24)	• Course Introduction • Models in Science	**Introduction on BB**
Week #2 (08/31)	• Verification and Validation Fundamentals	Discussion of Week #1
Week #3 (09/07)	LABOR DAY - No lecture	
Week #4 (09/14)	• Statistics and Visualization Techniques for Verification and Validation	Discussion of Week #2
Week #5 (09/21)	• **Lightweight, Feedback-Driven Runtime Verification** **Guest Lecture by Dr. Christopher Lynch**	Discussion of Week #4
Week #6 (09/28)	• Commonly Used Computational Techniques to Support Simulation Model Validation	Discussion of Week #5
Week #7 (10/05)	• Verification and Validation of Agent-Based Models	Discussion of Week #6
Week #8 (10/12)	• Validating Machine Learning Models - Basics, Common Pitfalls and Challenges (Will do the lecture on Tuesday)	**Mid-semester survey** Discussion of Week #7
Week #9 (10/19)	• **Safer Reinforcement Learning with Planner-based Demonstrations** **Guest Lecture by Dr. Bilal Kartal**	Discussion of Week #8
Week #10 (10/26)	• **Verification and Validation of Cognitive Models** **Guest Lecture by Dr. William Kennedy**	Discussion of Week #9
Week #11 (11/02)	• Validation of Statistical Models	Discussion of Week #10
Week #12 (11/09)	• **Validation of Network Models** **Guest Lecture by Dr. Amir Ghasemian**	Discussion of Week #11
Week #13 (11/16)	• Synthesis assignment and final project Q&A • **Fuzzy Cognitive Maps and Verification & Validation** **Guest lecture by Dr. Philippe Giabbanelli**	Discussion of Week #12 **Declare final project option and list selected papers on BB.**
Week #14 (11/23)	• Asynchronous video assignment	Discussion of Week #13 **Synthesis assignment**
Week #15 (11/30)	• Spatial Models and Validation • Verification and Validation as a Service	**Final project report**
Week #16 (12/07)	• Final project presentations and Q&A	**Final project presentation videos**
Week #17 (12/14)	No class - grading in progress	

8. Grades

Each weekly discussion assignment is worth two points. Technically, you can get (12x2) 24 points out of 20. The synthesis assignment is worth 30 points, and the final project is worth 50 points.
At the end of the term, the score will be given based on the sum of weekly discussions, synthesis assignments, and final project scores.

Weekly discussion	**20 pts (can get up to 24 pts: 2 pts x 12)**
Synthesis assignment	**30 pts**
Final project	**50 pts (25 pts report + 25 pts video + Q&A)**

Final grades at the end of the course will be assigned based on the following table, independent of the relative standing in the class.

Final Mark	Corresponding Grade
>=97	A+
93.0 – 96.99..	A
90.0 – 92.99..	A-
87.0 – 89.99..	B+
83.0 – 86.99..	B
80.0 – 82.99..	B-
77.0 – 79.99..	C+
73.0 – 76.99..	C
70.0 – 72.99..	C-
60.0 – 69.99..	D
<60.0	F

9. Exams

There are no exams in this class.

10. General guidelines for assignment/project preparation and submission

- **Weekly Discussion Assignments (20 pts + 4 pts BONUS)**
  - The discussion assignment aims to facilitate online engagement and learn about different perspectives for the same content.
  - The text of the weekly discussion assignment should be at least 300 words long and should cover ***Suggested Readings*** (1pts) and ***Lecture*** (1pts). Lectures will be recorded so that students can watch them again.
  - If an assignment has less than 300 words, the total point will be reduced accordingly. For instance, if your assignment has 225 words and covers both suggested readings and the lecture, your score will be calculated as 2*225/300=1.5.
  - The weekly discussion assignments will be submitted individually under the Discussion Board on Blackboard and visible to all students and instructors. Each week, there will be a

designated place where you will submit your assignment by creating a new thread. Assignments can be updated until the next lecture's start time.

- **Synthesis Assignment (30 pt)**
  - This assignment aims to (1) help students reconcile various topics covered in the lecture, (2) exercise writing skills, and (3) articulate a methodological plan to model development in future studies.
  - Students should choose five or more peer-reviewed papers regarding the topics covered in the class and write a synthesis paper. Below you can see two guides explaining synthesis paper writing.
    - http://jan.ucc.nau.edu/dso6/synthesis.htm
    - https://www.bgsu.edu/content/dam/BGSU/learning-commons/documents/writing/synthesis/asked-to-synthesize.pdf
  - Your paper should have at least 2,000 words (~4 pages single spaced) and conclude with your reflections on V&V concerning future studies.
  - The synthesis assignment should be prepared and submitted individually via Blackboard.
- **Final Project (50 pts)**
  - The final project aims to use all learned knowledge in action.
  - There are three options that students can choose to complete the final project.
    - Option 1 - Critique: students select two (unassigned) peer-reviewed papers that report a model (of any type). The selected papers must have a decent model description, model runs, and results. The student (s) is expected to critique the verification and validation approach of the selected papers.
    - Option 2 - Application: students select two open-source models (of any type) that have an associated peer-reviewed paper and should conduct at least one V&V test per model.
    - Option 3 - Mixed: select one paper as in Option 1 and select one application as in Option 2.
  - Students can form a group of two or participate individually.
  - The selected papers (applications) should be communicated with the instructor by the due date, according to the course outline table above.
  - Two deliverables should be submitted to Blackboard, based on the due dates noted in the course outline table.
    - Deliverable 1 (25 pts): written report
    - Deliverable 2 (25 pts): video capture (up to 10 minutes) and Q&A performance (up to 5 minutes). The video should be uploaded to Youtube etc. unlisted and the instructor should be given a link to the presentation.
- Assignments should be submitted **through the Blackboard course website**. Every assignment should allow you to submit the work multiple times up until the deadline. The last version of the assignment will be graded.

Please note: Assignments should be submitted only through the Assignment submission section of the Blackboard system - DO NOT email assignments directly to the instructor.

11. Late submission

The weekly assignments and the synthesis assignment submitted **after the due date will be penalized with 10% reduction, as long as the submission date is within 72 hours of the due date**. For the final project, **students are expected to strictly abide by the deadline** because there will be a live

presentation video play and Q/A sessions in the last week of the lecture. Exceptions to this policy may be made given serious circumstances at the discretion of the Instructor. Please contact the instructor as soon as possible in such cases.

Please note: Deferral of a work is a privilege and not a right; there is no guarantee that a deferral will be granted. Please make sure you notify the instructor as soon as you know a deferral is required.

12. Attendance

Attendance is not part of the overall grade but highly recommended.

13. Blackboard and Course website

The course has a Blackboard website. The Blackboard website will provide you with a portal through which you may obtain lecture notes, retrieve assignment data, review links to additional materials, and receive special announcements. You are required to visit the course website regularly and follow all announcements. Please notify ITS (and, if necessary, the instructor) if you encounter any problems accessing the Blackboard website.

Additionally, the course has a publicly facing website hosted on GitHub. This public website will only include course material/schedule and aims to disseminate our course to a larger group of academic. This website is read-only for students and no student information or submission will be made through this public website.

14. Electronic communication, office hours and support

All course-related submission of assignments should be made through the course Blackboard website. Please **DO NOT** email your assignment submissions to the instructor unless the Blackboard website is down for an extended period.

Students are encouraged to contact the instructor for questions regarding the course content. The ideal time to contact the instructor for such inquiries is the office hours which is provided under General Information. The instructor will notify the students via GMU email if there are any temporary or permanent changes in office hours. Students should contact the instructor via email to make an appointment because of the new virtual office hours mandated by the university.

15. Students with disabilities

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in the Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474

16. Expectations from students

- *Academic Integrity:* Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture. [See http://academicintegrity.gmu.edu].
- *Honor code:* Students must adhere to the guidelines of the George Mason University Honor Code. [See https://oai.gmu.edu/mason-honor-code/].

- *MasonLive/Email (GMU Email):* Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and the program will be sent to students solely through their Mason email account.
- *University Policies:* Students must follow the university policies (See http://universitypolicy.gmu.edu) including the Responsible Use of Computing [See https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).

17. Frequently asked questions

- *Have another question?*
  Ask the instructor via email. If your question applies to all students, it will be shared here as well.

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported by the instructor.

Notes: (1) Recording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan. (2) The format and template of this syllabus is prepared based on the syllabus of Dr. Andreas Zufle's GGS 787 - Scientific Data Mining for Geo-informatics 2018 course. A partial content of this syllabus is adopted from the syllabus of Dr. Jason Kinser's CDS 230 - Modeling and Simulation 1 - Summer 2017 course.