# Comp 4202/5204
# Computational Aspects of Geographic Information Systems

Through recent advances in technology such as navigation systems, mobile devices, changing user demands and new software such as Mapquest and Google Earth, the field of GIS is becoming increasingly important and also very interesting from a CS perspective. Many aspects of our daily lives are effected, the commercial impact/potential of GIS is tremendous, and novel algorithmic and applied problems need to be solved. This course lays the foundations to understand, use and further this technology.

## Learning Modality

The content for this course will be delivered online. The plan is to do it as ZOOM Live Stream from a set-up I created at my home that includes a whiteboard. Students can tune into at the scheduled time (see the lecture schedule below). Lectures will be recorded but attendance during class times is highly recommended.

## Prerequisite: A 3rd year course in Data Structures and Algorithms or the equivalent.

## Course Objectives

This is a recently revamped course on this topic. You will learn about Geographic Information, its principles, techniques used and analysis of geographic/spatial data. You will be able to understand what is inside a GIS, and several of the underlying algorithms. Having taking this course, you will be able to answer e.g., how do they visualize disease spread, how Google determines the best route algorithmically. This course provides you with insights into how a Geographic Information System works, how geographic or spatial data differ from other data, what the techniques are to store, access and manipulate algorithmically such data. You will also be able to explore some aspect of GIS yourself through a project of your choosing (with my help). Depending on the class size, we might focus on modern digital cities: challenging and solutions.

# Lecture Schedule

| Days | Time | Location |
|------|------|----------|
| Mondays | 11:35 -12:55 | Online Lecture |
| Wednesdays | 11:35 -12:55 | Online Lecture |

I anticipate to make the lectures available via Brightspace for subsequent viewing. Online the code will be send through Brightspace. If a U of Ottawa student cannot get access please email me. sack@scs.carleton.ca.

# My office Hours Schedule

| Days | Time | Location |
|------|------|----------|
| Mondays | 10:00 -11:00 | Online using the same Zoom code |

First office hour January 15th.

# Important Dates

| Date | Due |
|------|-----|
| January 6 | First class |
| January 29 | Project and Class presentation proposal |
| Feb 24 - .. | Class presentations  exact dates tbd |
| After each talk | Presentation file due |
| April 1 | Project write-up due (latest hand-in April 4) |
| April 7 | (Brief) project demos (mandatory) |
| April ?? | centrally scheduled |

# Grading Scheme  for 5204

| | |
|---|---|
| I. 2 Assignments (each 10%) | 20% |
| II. Class participation and presentation incl. write-up | 25% |
| III.   Project including write-up | 30% |
| IV.  One tutorial | 5% |
| V. Final exam | 20% |

# Grading Scheme  for 4202

| | |
|---|---|
| I. 2 Assignments (each 15%) | 30% |
| II. Class participation          expected | |
| III. Choose exactly 2 out of these a, b, or c:<br>           a) Class presentation incl. write-up 20% | 40% |
|            b) Project/Survey including write-up) 20% | |
|            c) Tutorials 20% | |
| IV. Final exam | 30% |

# Textbooks

There is no textbook as such. A good intro into the field is provided in: Geographic Information Science and Systems by Longley et al. Fourth edition, Wiley.

Assignments will be posted as they become available. Please note the following rules and requirements about assignments:

- Late assignments will not be accepted.
- Assignments emailed to me will not be accepted.
- I will not respond to emails sent shortly before or after assignment deadlines asking for exceptions to the preceding two rules.

- You can type your solutions, or write them by hand and scan them (for example, using a scan app on your phone or using a real scanner).
- Solutions written-up in LaTeX are preferred, but not strictly required. In case you want to learn LaTeX, here is a tutorial. Learning LaTeX is a useful exercise, since many programs (including Microsoft Word) now use LaTeX for typesetting formulas.
- Each assignment must be submitted as one single PDF file through BrightSpace Use your student ID as part of the filename.

# Project

This is may be the nicest part of the course. Students are almost always finding some project that they like. Projects can be implementation-oriented or theory- based. In almost all cases, I would recommend an implementation-oriented projects. **The class presentation and the topic of the project need to be distinct to allow for maximal learning. Graduate students are expected (see weighting) to produce a stronger project.**

# • Implementation Projects

For implementation projects you would typically implement different data structures or algorithms. Then, their performance is established through rigorous experimental testing. The write-up contains a description of the data structures algorithms implemented and tested, the tests carried out and the results of the experiments. Should the results show interesting behaviours, they must be explored and discussed. Projects are e.g., finding "best" bicycle routes inside Ottawa, improving the OC Transpo system ... The implementation project **is not** just showing how to use a GIS and its functions.

You will demonstrate your projects to me and your class mates in a special demonstration class (see schedule). This is part of the evaluation.

# • Theory Projects

Don't choose this if you are not research-oriented. You are encouraged to work on an open problem mentioned in class or stated in the literature. It may happen that you cannot solve the open problem proposed. In this case, you should describe the approaches attempted and the reasons why they did not work. Marking then focuses on the write-up, including the survey depth, and the strength of the approaches attempted.

# Class presentations

The class presentations give you a great opportunity to practice giving a talk. Here, the objective is for you to learn to speak talk in front of people. This will be useful if you are in academia or industry. Then, the stakes are higher and it is nice to practice in front of equals. I will give you feedback how to improve. Depending on the class size, we might get 15-20 minutes per talk (exact time t.b.d.). (Graduate students might request more time in advance.)

# Tutorial

ESRI has developed some tutorials to learn how to use its products. We are choosing a sample tutorial that you go through, make snapshots of how you did and then add likely some additional tasks (which we will specify). This has been added since students told me that they like a hand-on experience of GIS.

**Graduate Students**
You will be doing one tutorial to get a sense of what a real GIS is. **(mandatory)**

**Undergraduate Students**
You will be doing 4-5 tutorials to get a good sense about the capabilties of GIS (if you choose this option as one of your two).

# Exams

The final exam will likely be scheduled centrally and will be in-person. Some accommodation will be given for students who are abroad. They will then write on-line with software installed on their computer by Carleton to allow detailed

proctoring/monitoring. These students need to apply to me for the on-line exam and follow all instructions received from Carleton University on this. See https://carleton.ca/ses/distance-exams/.

## Undergraduate Academic Advisors

The Undergraduate Advisors for the School of Computer Science are available in Room 5302HP; or by email at scs.ug.advisor@cunet.carleton.ca. The undergraduate advisors can assist with information about prerequisites and preclusions, course substitutions/equivalencies, understanding your academic audit and the remaining requirements for graduation. The undergraduate advisors will also refer students to appropriate resources such as the Science Student Success Centre, Learning Support Services and Writing Tutorial Services.

## Graduate Academic Advisors

The Graduate Advisors for the School of Computer Science are available in Room 5302 HP; or by email at grad.scs@carleton.ca. The graduate advisors can assist with understanding your academic audit and the remaining courses required to meet graduation requirements.

## SCS Computer Laboratory

Students taking a COMP course can access the SCS computer labs. The lab schedule and location can be found at: https://carleton.ca/scs/tech-support/computer-laboratories/. All SCS computer lab and technical support information can be found at: https://carleton.ca/scs/tech-support/. Technical support staff may be contacted in-person or virtually, see this page for details: https://carleton.ca/scs/tech-support/contact-it-support/.

## University Policies

For information about Carleton's academic year, including registration and withdrawal dates, see Carleton's Academic Calendar.

**Pregnancy Obligation.** Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit Equity Services.

**Religious Obligation.** Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit https://carleton.ca/equity/focus/discrimination-harassment/religious-spiritual-observances/.
**Academic Accommodations for Students with Disabilities** If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for

Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre](#) website.

**Survivors of Sexual Violence.** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [carleton.ca/sexual-violence-support](#)

**Accommodation for Student Activities.** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see [the policy](#).

**Student Academic Integrity Policy.** Every student should be familiar with the Carleton University student academic integrity policy. A student found in violation of academic integrity standards may be awarded penalties which range from a reprimand to receiving a grade of *F* in the course or even being expelled from the program or University. Examples of punishable offences include: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found [here](#).

**Plagiarism.** As defined by Senate, "plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own". Such reported offences will be reviewed by the office of the Dean of Science.  Standard penalty guidelines can be found [here](#).

**Unauthorized Co-operation or Collaboration.** Senate policy states that "to ensure fairness and equity in assessment of term work, students shall not co-operate or collaborate in the completion of an academic assignment, in whole or in part, when the instructor has indicated that the assignment is to be completed on an individual basis". Please refer to the course outline statement or the instructor concerning this issue.


**Special Information**

It is important to remember that COVID is still present in Ottawa.  The situation can change at any time and the risks of new variants and outbreaks are very real.  There are a number of

actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

**Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important.  If you feel ill or exhibit COVID-19 symptoms do not come to class or campus.  If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately.  In all situations, you must follow Carleton's symptom reporting protocols.

**Masks:** Carleton has paused the COVID-19 Mask policy, but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained.  It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

**Vaccines:** While proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes.  Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in cuScreen as soon as possible.  Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time.  For the most recent information about Carleton's COVID-19 website and review the Frequently Asked Questions (FAQs).  Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Please note that for students who are taking this course from aboard, the test and examination in this course will use a remote proctoring service provided by Scheduling and Examination Services. You can find more information at https://carleton.ca/ses/e-proctoring. The minimum computing requirements for this service are listed on the SES website (https://carleton.ca/ses/online-exams/e-proctoring/e-proctoring-course-outline-template)."

The use of Generative AI including Chat GPT for any coursework is strictly forbidden.