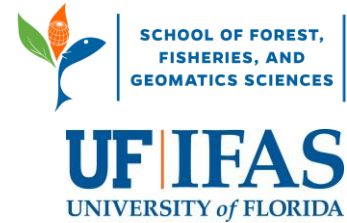# Lidar Remote Sensing For Forestry Applications

FOR6934   **Spring 2024**

Dr. Carlos Alberto Silva, Instructor
Newins Ziegler Room 342
c.silva@ufl.edu (352)-294-6885
Silva Lab: https://carlos-alberto-silva.github.io/silvalab/home.html

Office Hours: Monday 1:40 – 2:40 pm or email for appointment (Instructor C. Silva)

Lecture Schedule: Monday: Period 5-6 (11:45 am – 1:40 pm)
Lecture Location: McCarty Hall B - 1676 MCCARTY Dr Gainesville, FL 32611
Bldg #: 0496 – Class Room 3108
Lab Schedule: Tuesday: Period 6-8 (12:50 pm – 3:50 pm)
Lab Location: While the exact location may vary, in general we will be meeting at the
CALS Computer Lab (3086 McCarty Hall B – MCCB 3086) and at the Austin Cary Forest.
Class website: https://elearning.ufl.edu/

Course Description

Lidar remote sensing is a state-of-the-art technology that is becoming widely used in many applications. This new class will teach you everything you need to know about lidar technology, research, and applications in forestry. Learn how to visualize, process lidar point cloud data, build terrain and canopy height models and establish statistical models. We will use open-source software including R-statistical language and FUSION/LDV. This class is a face-to-face course and includes a chance to develop your own lidar project with the many datasets available. Projects can include: data visualization, aboveground biomass and fuel load estimations, and more. Students are encouraged to choose a project that is close to their own interests.

Course Essential Questions

- What is lidar and how this technology can be applied in forestry?
- What are the lidar platforms and systems?
- What are the state-of-the-art open-source tools for lidar data processing?

Course Objectives

Upon completing the course, students will be able to:

- Understand how lidar technology works and how it can be used in forestry applications
- Be able to process raw (las/laz) lidar data to digital terrain and canopy height models.
- Be able to extract various lidar metrics for estimating vegetation structure.
- Be able to build statistical models for estimating and mapping vegetation attributes.
- Analyze and evaluate your own lidar dataset using some of the methods described above. properly measure physical attributes of individual trees and forest stands (e.g. timber volume);

Cornerstone Tasks
- *Laboratory Assignments:* Written reports will describe lab activities and synthesis of collected field data plus reinforce R skills.
- *Quizzes:* Online assessments of student knowledge through the course website (https://elearning.ufl.edu/)
- *Lecture notes:* One-page of lecture notes
- *Final Project:* Student team will collaboratively plan, develop, and present a lidar application project as the final project.

Teaching Methods
- *Lectures:* Narrated PowerPoint lectures will focus on presenting new information as well as that summarized from the assigned readings. Guest speakers will be invited to give talks during the second half period of the lecture.
- *Assigned Readings:* Each week various articles and videos will be posted on-line prior to lecture. It is to your advantage to read these articles as they will often reinforce information given in lecture, aid in field study, or contain information appearing on exams.
- *Labs:* Lab periods may happen in the classroom, on campus, or at a nearby location. Lab exercises are designed to provide students with hands-on experience with lidar processing methods, to reinforce lecture material, and to hear from experts during guest lecture periods. Typically, a written lab report will be prepared based on the subject matter and specialized instructions.
- *Quizzes:* Quizzes will be given covering lecture material, assigned readings/videos, and lab subjects.
- *Group Study:* Students will often work in assigned groups (teams) to complete lab data collection, processing, analysis, and certain reports. Students are encouraged to form small *ad hoc* study groups outside of class to reinforce concepts and to informally quiz each other on the course material presented.
- *Individual Study:* Each student will be expected to attend class and labs in person; detailed note-taking is encouraged. In addition, students should complete assigned readings, produce required lab reports, and spend individual time reviewing materials in advance of quizzes.

Suggested textbook
- Maltamo M, Næsset E and Vauhkonen J (ed) 2014. *Forestry Applications of Airborne LaserScanning: Concepts and Case Studies* (Dordrecht: Springer Science & Business Media) p464. Online available free through: https://link.springer.com/book/10.1007/978-94-017-8663-8

Grading

Quizzes (10 @ 10 pts each):	100 pts
Lecture Notes (10 @ 5 pts each):	50 pts
Lab Assignments (10 @ 20 pts each):	200 pts
Final Project (written 200 pts + presentation 150 pts)	350 pts
Total:	700 pts

Quizzes: Timed quizzes will be given at intervals during the semester. Quizzes will be "open book". Quizzes will be completed on Canvas. You will be given 2 attempts to complete the quiz and your best attempt will be kept.

Lecture Notes: One-page lecture notes due at 11:45 am on Monday the next week at the beginning of class. Late homework will be assessed a penalty of 50% before grading.

Group Project: Students will collaboratively plan, develop, and present a lidar project based on lidar data already collected and available in the course.

Lab Assignments: Laboratory assignments will consist of: 1) a few questions related to the actual laboratory activities, 2) submission of data recorded in the lab as a file and analysis. Assignments will be completed by your team but submitted individually.

Final grading follows University standards and is based on the following scale (https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx):

Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Course Score	638 - 700	580 - <638	522 - <580	464 - <522	406 - <464	348 - <406	290 - <348	232 - <290	174- <232	116 - <174	58- <116	0-<58
Grade Points	4	3.67	3.33	3	2.67	2.33	2	1.67	1.33	1	0.67	0

General Course Prerequisites

This course is designed for SFFGS graduate students.

General Course Requirements, Attendance, and Make-Up Work

For a rewarding and safe experience in this class it is necessary that you be self-motivated, independent, and that you always observe safety and proper planning. Be prepared for class means also having completed assigned readings.

Due to the nature of most labs in that data are collected for further workup or an experience is shared that requires analysis or comment, **attendance in lab is mandatory and lab reports may only be turned in if you attend the labs.** However, if there is a special circumstance covered by the UF attendance policy (https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/), please contact the instructor ahead of time.

It is your responsibility to keep track of assignment due dates and times as listed in Canvas. Some assignments may be due on paper at the beginning of a lecture period. Online assignment due times will be 11:59pm or just before midnight. Assignments open and close based on the clock governing the Canvas server so submitting assignments at the last minute may prove troublesome for you – don't wait! A grace period, usually 12 hours, **may** be added to each assignment due date during which late work will be accepted (but deemed late). Any late assignment scores will be reduced by 50% of the original point value and then be graded according to the rubric. No assignments will be accepted after the assignment closes so do not email them to an instructor.

Generally, no make-up assignments will be offered other than for exceptional situations covered by the UF attendance policy (https://catalog.ufl.edu/UGRD/academic-

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regulations/attendance-policies/), serious illness or injury (reported to the instructor and followed by a physician's note within five days of the first absence), or extreme weather resulting in the closure of campus. Extra credit assignments are rarely, if ever, provided.

Things you will need for this class:
1) A computer with R (https://www.r-project.org/), RStudio (https://www.rstudio.com/) and office software for written reports and internet access to the class eLearning site in Canvas. An alternative is accessing UF APPS http://apps.ufl.edu and using office software available there. Mac users are encouraged to use the version of Excel and other Microsoft Office software in UF APPS to ensure file compatibility.
2) Some way to take class and field notes (clipboard or hard binder for field notes).
3) For field labs, sunscreen, long sleeves, and a hat will help prevent sunburn.
4) A water bottle for field labs.
5) Some field activities may expose you to challenging environments that could include stinging insects, dense and thorny brush, heat, and wet terrain. Appropriate field gear, including heavy pants and boots, IS MANDATORY for this class in order to participate in field labs. **Individuals not properly dressed will not be allowed to participate. (University Insurance covers only properly outfitted individuals).** You may get muddy, wet, and sweaty depending on the lab site. Field labs happen rain or shine (nearby lightning or hail might send us scurrying to the vans).

If you are allergic to insect bites, or if you have other medical conditions for which emergency treatment may be required, **it is your responsibility to inform the instructor before the course starts, about:** (1) your specific condition, (2) where you keep your medicine, and (3) how to administer emergency treatment should the situation arise.

The following is important information concerning certain hazards of working outside in Florida:

- Chiggers: http://edis.ifas.ufl.edu/pdffiles/IG/IG08500.pdf or http://pherec.org/EntGuides/EntGuide6.pdf
- Ticks & Lyme Disease: http://edis.ifas.ufl.edu/pdffiles/MG/MG20400.pdf or http://fmel.ifas.ufl.edu/buzz/clticks.shtml
- Heat: http://solutionsforyourlife.ufl.edu/hot_topics/agriculture/heat_stress.html
- Dehydration: http://fineinstitute.com/patient-education/?id=11913&lang=English&db=hlt&ebscoType=static&widgetTitle=Spinal+Links

Class and Discussion Decorum

All course participants are expected to interact with dignity and professionalism in the classroom, in the field, or in an on-line discussion. Be professional. You are preparing for a career and should be learning to interact with your fellow classmates as you would in your future professional life. Written communication should follow standard rules for grammar and spelling and be clear, concise and intelligent.

Be respectful and open to opinions and ideas that differ from yours. The exchange of diverse thoughts, ideas and opinions are an important part of the scholarly environment. When responding to statements or posts made by others, address the ideas, not the person. Disagreement with the ideas of others is perfectly acceptable; *how* one disagrees should not be hurtful or offensive. Insulting remarks and name-calling are never appropriate.

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Respect the formal learning environment. This includes arriving and leaving on time, shutting off cell phones and other electronic devices while in class, being open to the opinions and ideas of others, and working effectively and professionally in the field. Irresponsible and careless acts in the field will result in exclusion from future field activities.

Academic Honesty

In 1995 the UF student body enacted a new honor code and voluntarily committed itself to the highest standards of honesty and integrity. When students enroll at the university, they commit themselves to the standard drafted and enacted by students. The quality of a University of Florida education is dependent upon community acceptance and enforcement of the honor code.

The Honor Code: **We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.**

On all work submitted for credit by students at the university, the following pledge is either required or implied: **"On my honor, I have neither given nor received unauthorized aid in doing this assignment."**

It is assumed all work will be completed independently unless the assignment is defined as a group project, in writing by the instructor. This policy will be vigorously upheld at all times in this course.

Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code.

Software Use

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Campus Helping Resources

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

University Counseling & Wellness Center
3190 Radio Road, (352) 392-1575, www.counseling.ufl.edu/cwc/
Counseling Services
Groups and Workshops
Outreach and Consultation
Self-Help Library
Training Programs
Community Provider Database

Office of Victim Services
1515 Museum Road, (352) 392-5648, https://police.ufl.edu/about/divisions/office-of-victim-services/

Career Resource Center
First Floor JWRU, (352) 392-1601, www.crc.ufl.edu/

Students with Disabilities
0001 Reid Hall, (352) 392-8565, www.dso.ufl.edu/drc/

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. **If you have registered with the Disability Resource Center and require academic accommodations, it is your responsibility to privately inform the instructor of your needs as soon as possible before the first class session.**

UF attendance policy
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/
Please contact the instructor ahead of time or as soon after an absence to be considered excused.

The UF Religious Holidays Policy is available at:
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/#religiousholidaystext
At the University of Florida, students and faculty work together to allow students the opportunity to observe the holy days of their faith. A student should inform the faculty member of the religious observances of their faith that will conflict with class attendance, with tests or examinations, or with other class activities **prior to the class or occurrence of that test or activity**.

Additional Information

- Map of lecture and lab location

Lecture: McCarty Hall B - 1676 MCCARTY Dr Gainesville, FL 32611
Bldg #: 0496 – Class Room 3108

Lab: CALS Computer Lab (3082 McCarty Hall B)
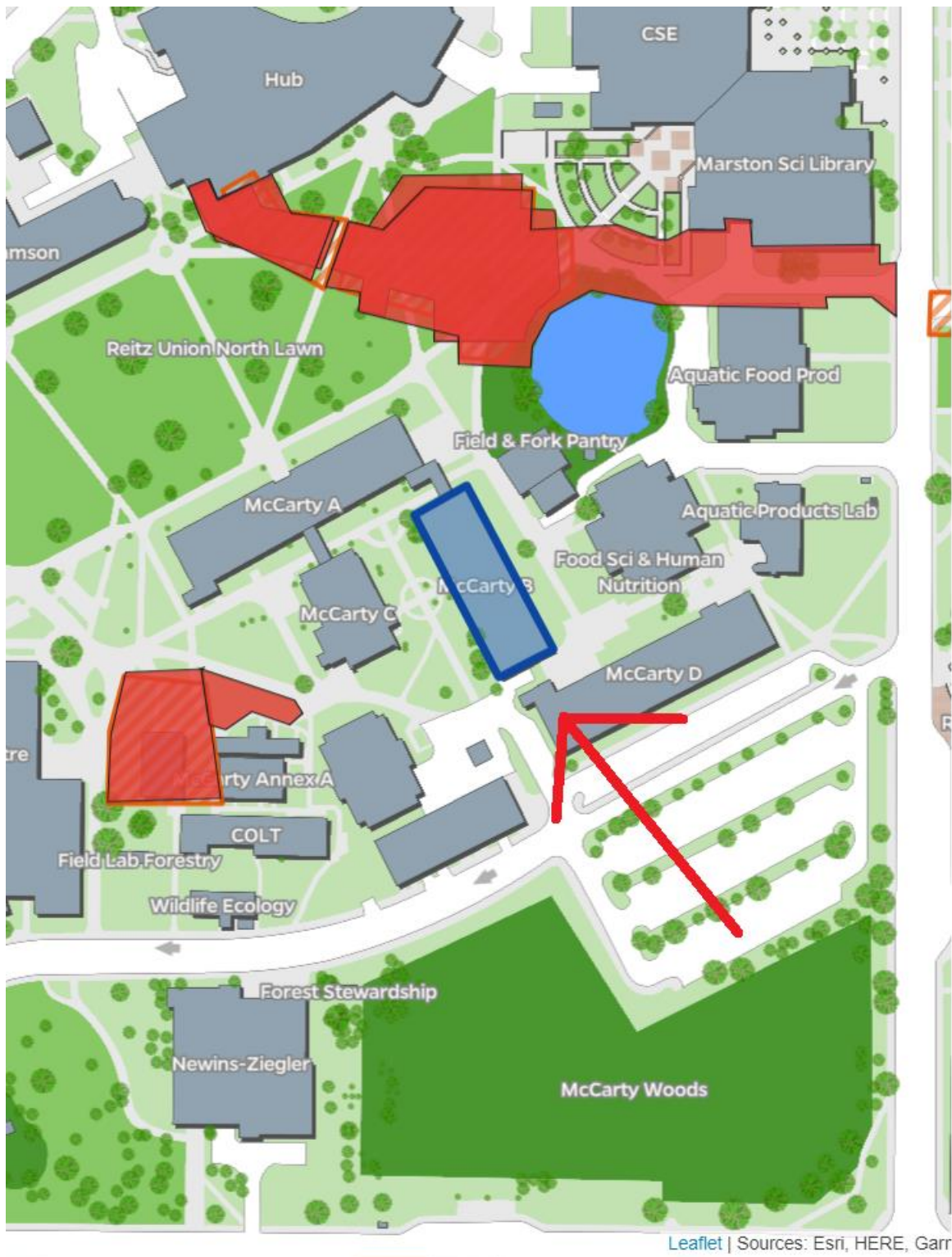
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FOR6934: Lidar Remote Sensing For Forestry Applications: 2024 Spring Class Schedule

(Sequence and topics subject to change)

	Week	Topics	Readings	Assignment/Due Date/Value
1	Jan 8	Course Introduction		
2	Jan 15	**HOLIDAY (Martin Luther King Jr. Day)**		
3	Jan 22	Applications of lidar in forestry & **Quiz 1** & **Lecture Notes 1**	Ch 1 & Research Articles	
4	Jan 29	Principles of lidar remote sensing, platforms and systems & **Quiz 2** & **Lecture Notes 2**	Ch 3	Quiz 1 / 10 pts and Lecture Notes 1/ 5 pts
5	Feb 5	Open-source tools for lidar data processing & **Quiz 3** & **Lecture Notes 3**	Research Articles	Quiz 2 / 10 pts and Lecture Notes 2/ 5 pts
6	Feb 12	**HOLIDAY (Presidents' Day)**	9	Feb 19
7	Feb 19	Lidar-derived digital terrain, digital surface and canopy models & **Quiz 4** & **Lecture Notes 4**	Research Articles	Quiz 3/ 10 pts and Lecture Notes 3/ 5 pts
8	Feb 26	Lidar-derived plot and grid canopy metrics & **Quiz 5** & **Lecture Notes 5**	Ch20	Quiz 4/ 10 pts and Lecture Notes 4/ 5 pts
9	Mar 4	Lidar data collection demo and final project selection & **Quiz 6** & **Lecture Notes 6**	Research Articles	Quiz 5 / 10 pts and Lecture Notes 5/ 5 pts
10	Mar 11	**SPRING BREAK**		
11	Mar 18	Forest canopy gap detection & **Quiz 7** & **Lecture Notes 7**	Ch 21	Quiz 6/ 10 pts and Lecture Notes 6/ 5 pts
12	Mar 25	Area-based approach for estimating and mapping forest attributes using lidar data & **Quiz 8** & **Lecture Notes 8** Guest speaker: TBD	Ch 8-16	Quiz 7/ 10 pts and Lecture Notes 7/ 5 pts
13	Apr 1	Individual tree detection (ITD) & **Quiz 9** & **Lecture Notes 9** Guest speaker: TBD	Ch 5-6	Quiz 8/ 10 pts and Lecture Notes 8/ 5 pts
14	Apr 8	NASA's Global Ecosystem Dynamics Investigation Lidar & **Quiz 10** & **Lecture Notes 10** Guest speaker: TBD	Research Articles	Quiz 9/ 10 pts and Lecture Notes 9/ 5 pts
15	Apr 15	Final Project	Research Articles	Quiz 10/ 10 pts and Lecture Notes 10/ 5 pts
16	Apr 22	Final Project		
		All assignments & topics are subject to change		

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(Sequence and topics subject to change)

	Week	Topics	Assignment/Due Date/Value	Location
1	Jan 9	Lab 1 Orientation		
2	Jan 16	Lab 2 Applications of lidar in forestry (literature review) & **Lab Assign. 1**		Computer Lab
3	Jan 23	Lab 3 Lidar data visualization using CloudCompare and FugroViewer & **Lab Assign. 2**	Lab 1 Assig. - 20 pts	Computer Lab
4	Jan 30	Lab 4 Introduction to R and FUSION/LDV & **Lab Assign. 3**	Lab 2 Assig. –20 pts	Computer Lab
5	Feb 6	Lab 5 Digital terrain, surface and canopy modeling models & **Lab Assign. 4**	Lab 3 Assig. - 20 pts	Computer Lab
6	Feb 13	Lab 6 Lidar-derived plot and grid canopy metrics & **Lab Assign. 5**	Lab 4 Assig. - 20 pts	Computer Lab
7	Feb 20	Lab 7 TLS data processing and tree-level metrics computation & **Lab Assign. 6**	Lab 5 Assig. - 20 pts	Computer Lab
8	Feb 27	Lab 8 Forest canopy gap detection & **Lab Assign. 7**	Lab 6 Assig. - 20 pts	Computer Lab
9	Mar 5	Lab 9 ABA for forest attribute modeling and mapping & **Lab Assign. 8**	Lab 7 Assig. - 20 pts	Computer Lab
10	Mar 12	**SPRING BREAK**		
11	Mar 19	Lab 10 Individual tree detection (ITD) and Treetop App & **Lab Assign. 9**	Lab 8 Assig. - 20 pts	Computer Lab
12	Mar 26	Lab 11 Final Project & **Lab Assign. 10**	Lab 9 Assig. – 20 pts	Computer Lab
13	April 2	Lab 12 Final Project	Lab 10 Assig. Final Project – preliminary report - 20 pts	Computer Lab
14	Apr 9	Lab 13 Final Project		Computer Lab
15	Apr 16	Lab 13 Final Project		Computer Lab
15	Apr 23	Final Project Presentation	Final Project report and presentation 350 pts	Computer Lab
All assignments & topics are subject to change				