Computer Vision, CS-431, Semester 2251, FALL of 2025 **Thomas B. Kinsman**

You are provided with images of a walk in the woods.

Sometimes hikers cannot see yellow. There are lots of leaves. In Autumn, many of the leaves turn yellow. The hikers need to be able to see the yellow circles that are nailed to the sides of the trees. They follow these markers to know how to find their way in and out of the trail. Otherwise, they can get lost.

Your goal is to develop a computer vision application, from first principles, without the use of Generative AI or a neural network, to be a be able to identify the yellow circles on the trail.

You will then put a bright orange circle around that trail marker, that is twice the diameter of the marker. This should be displayed in the final resulting image.

Wait…, that might not work. Not all of the images have trail markers in them. You will have to decide a Degree of Confidence (DOC) about if there is really a trail marker in the image or not. What's worse, sometimes there are two trail markers on the same tree. What will you do then?

You can work in pairs, or alone. Be sure to clearly identify who did what and where.

Project Breakdown:
The first thing to do is to form teams of one or two people. Then, you need to think about how to identify the yellow circles in the forest. How will you be able to tell the markers from the leaves. Remember, the lighting changes all over the forest. In some images the markers are in shade, in some images they are in full sun, and in other images they are in a mottled mixture of sun and shade.

Wait… there are more problems. Some images are over-exposed, and some are underexposed. Can you fix them all? Can you find a way to bring them all back into a uniform exposure so that the markers can be found?

Wait… there is another problem. The markers are not always the same size in the image. Sometimes Dr. Kinsman took the picture from right next to the marker, and at other times he took pictures of the markers up ahead. The size of the markers will change dramatically depending on how far away they are. How will you handle this issue?

Wait… there is another problem. Some of the images were taken with the cell camera rotated 90 degrees, or 180 degrees. Which way is up? Is there anything in the metadata that will help you figure out which way is up? Should this be done first or last?

Wait… there is another problem. How will you test your solution? You only have about 200 images, and most of them do not have yellow markers in them. How can you increase the size of your data set?

Think about all of these solutions and how you might want to solve them.

Before I give you my thoughts, I want you and your classmates to discuss possible solutions.

Some of my thoughts will be posted here … once you have done your own ideation.

Writeup – At the end of the Semester:
Use one inch margins, single spaced, 11 point font, TimeNewRoman font.

Submit a write-up that includes:

1. A full step-by-step, description of how you processed each image and solved the problem. Write this in English, to show understanding. Provide a high-level overview of how your solution works. (~1 page)

2. Then describe the details of how your program worked.
   What pre-processing did you do to the input images?
   How did you find the rocks in the image. (~1 to 2 pages)

   Note: whatever pre-processing you do to the images for training your classifier, you will need to do the same pre-processing for the input image, before you run your classifier on it.

   For example, I would expect that the first thing your program might want to do is background subtraction. How can you identify trees?

   Then I would expect some contrast enhancement, or perhaps color space rotation.

3. How did you grow the solution?
   Describe how you were able to get started and running, without having to have all of the code written before hand? How did you break down the problem to solve it? How did you *grow* the solution? What did you do first, then what did you do next? (~1 page)

4. Tell me about how you built a training set. How can you get a set of images so that you can automatically adjust your parameters to find the circles? In other words, you want to have some way of knowing where the final answer is. Then you can use changes in parameters until you find the solution. That will tell you the best set of parameters to use for your final classifier.

5. Describe the most challenging issues you faced, if any. (~1 page)
   Or, did your program run the first time through?

6. You will not be able to correctly identify all of the yellow markers. Some of just too weird to identify. What kinds of images did you try to identify first? What did you give up on?

7. Divide the input files into 20% testing files, and 80% training files.
   Report your classification accuracy on your own testing files.

8. Create a confusion matrix. This will tell how well your classifier worked overall.

		True Classification	
		Has Marker	Has No Marker
Classifier Guess:	Has Marker	# True Positives	# False Alarms
	Has No Marker	# False Negatives	# True Negatives

9. Write a conclusion (~1 page)
   What did you learn?
   Why should a company hire you?

Rubric for the Final Submission:

The program runs and processes the image:	20
The program code is well documented:	20
The program produces a reasonable output for input images:	30
The program prints the correct situation for the images. This prints out is the exact answer sought.	5
Your write-up is complete and shows strong evidence of learning.	25