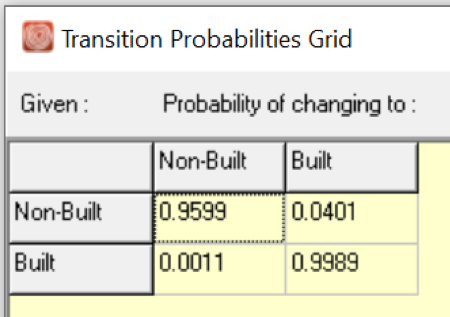
**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

*Select the single best answer for each multiple-choice question by highlighting your answer in yellow. Essay responses must use well-written, grammatically-correct, full sentences that are organized into paragraphs. Include citations when appropriate. Your essay responses must demonstrate what you have learned in this course. For the essays, a grade of C requires mostly correct answers; a grade of B requires answers that give correct details and refer to the literature; a grade of A requires answers that give correct details, refer to the literature, and go in-depth in a creative & elegant manner. You are allowed to use the book, your notes, the internet, but not classmates or other people. Your work must be entirely your own. Use Moodle to access the exam and to submit the exam as a Word document with your Clark University userid in the filename.*

**Part A: Multiple Choice** *30 points = 30 answers @ 1 points each*

1. A machine-learning algorithm, such as a Multi-Layer Perceptron, is an example of what?
   1. Inductive model
   2. Deductive model
   3. Process model
   4. All of the above
2. Who are agents of land change?
   1. Transportation Planners who advise on infrastructure development
   2. Conservationists
   3. Farmers
   4. All of the above
3. Which word describes a projection into the future based on a continuation of historic trends?
   1. Extrapolation
   2. Interpolation
   3. Prediction
   4. Scenario
4. What is the procedure called when you compare the simulated change to the reference change?
   1. Calibration
   2. Interpolation
   3. Simulation
   4. Validation
5. What is a way to attain 95% percent correct when the reference maps during the validation interval show gain of built in 5% of the extent?
   1. Simulate that nothing changes
   2. Simulate that 5% gain of built allocated randomly
   3. Simulate that all non-built becomes built
   4. Simulate using a model that does not allow you to input the quantity
6. What is it called when you gather data first and then develop a model based on that data?
   1. Predictive analysis
   2. Inductive approach
   3. Validation
   4. Deductive approach
7. If the correct quantity of change is used to simulate change, then which must be true:
   1. Correct Rejections = Hits
   2. Hits = Misses
   3. Hits > False Alarms
   4. Misses = False Alarms
8. What is the mathematical expression that GEOMOD uses for suitability of Built in Soil A?
   1. Size of Built in Soil A / Total Area of Extent
   2. Size of Built in Soil A / Total Area of Soil A
   3. Total Area of Soil A / Size of Built in Soil A
   4. Total Area of Soil A \* Size of Built in Soil A
9. Which of these is an example of a pattern of change, not a process of change?
   1. A new factory opens because the city gives the factory a tax break
   2. Contractors prefer to build new houses in school districts with higher test scores
   3. Maps show that half of the forest loses from the initial to subsequent time points
   4. A historic law limited who is allowed to purchase a house based on race and religion
10. What does it mean when a segment of a TOC curve has a slope greater than the diagonal uniform line?
    1. The increase in Hits divided by the increase in simulated change for the pixels that contribute to the segment is greater than one.
    2. The increase in Hits divided by the increase in simulated change for the pixels that contribute to the segment is greater than the ratio of the sum of Hits and Misses to the size of the extent.
    3. The segment is below the diagonal line
    4. The pixels that contribute to the segment experience change less intensively than the spatial extent experiences change.
11. What is a feature in a TOC curve that shows that the transition potential map accurately indicates where change does *not* occur?
    1. The AUC is less than 0.5
    2. The AUC is greater than 0.5
    3. The curve is steeper than the diagonal line in the lower-left corner
    4. The curve is flatter than the diagonal line in the upper right corner
12. What is the most important information given by a transition potential map?
    1. The absolute values of transition potentials
    2. The contrast of the colors
    3. The ranking of the pixels according to their transition potential values
    4. The quantity of change
13. Which land change model requires input maps of land cover at more than one time point?
    1. GEOMOD
    2. Land Change Modeler
    3. Both
    4. Neither
14. If the matrix below dictates the simulated change from 1985 to 1999, then 0.0401 means what?
    1. The proportion of Non-Built pixels that transition from Non-Built to Built
    2. The proportion of Built pixels that transition from Built to Non-Built
    3. The proportion of built pixels that transition from Built to Non-Built
    4. The average of the transition potential values for the transition from Non-Built to Built
    5. The average of the transition potential values for the transition from Built to Non-Built
15. Suppose you are running LCM to simulate transitions among three categories: Forest, Other, and Built. LCM does not simulate any gain of Forest for your run. If a pixel is simulated as transitioning from Other to Built, but that pixel transitioned from Other to Forest according to the reference maps, then how would this pixel be classified in a three-way crosstab map of validation according to our class’s assignment concerning this concept?
    1. Miss
    2. Wrong hit
    3. Wrong hit and unpredicted
    4. False alarm
16. When using Logistic Regression to run the transition sub-model in LCM, what does it mean if sampling is not applied?
    1. The algorithm will use all the pixels when running the sub-model
    2. Each user will get a different output for their transition potential map
    3. Each user will get the same output for their transition potential map
    4. Both a and c
17. What do the transition potential values determine when simulating from non-built to built?
    1. The probability of each pixel transitioning from non-built to built
    2. The likelihood of each pixel transitioning from non-built to built
    3. The sequence of pixels for which the model simulates the transition from non-built to built based on the ranking of the transition potential values
    4. The quantity of simulated change from non-built to built
18. How does the inclusion of a planning incentive to LCM affect the quantity of simulated change?
    1. The planning incentive increases the simulated quantity of change
    2. The planning incentive decreases the simulated quantity of change
    3. The planning incentive could increase or decrease the simulated quantity
    4. The planning incentive does not affect the quantity
19. A Markov Matrix based on the reference change during 1971-1985 is used as the Markov matrix for simulating during 1985-1999. How many pixels will change for a simulation of 1985-1999?
    1. Less than the number of pixels of change during 1971-1985
    2. Equal to the number of pixels of change during 1971-1985
    3. Greater than the number of pixels of change during 1971-1985
    4. Not enough information is given to determine the number of pixels of simulated change
20. How would you describe patterns when the patterns during the calibration interval are different than the patterns during the validation interval?
    1. Stationary
    2. Non-stationary
    3. Stochastic
    4. Random
21. How can you guarantee an increase in the Figure of Merit of your simulation?
    1. By using the quantity of simulated change that corresponds to the point under the upper left corner of the TOC parallelogram
    2. By simulating change everyplace
    3. By adding more driver variables to your simulation
    4. None of the above
22. If a user forgets to use a mask to eliminate pixels that are already built at the beginning of a simulation of the gain of built, then what will be the effect on the AUC of the TOC?
    1. The AUC will smaller than if a proper mask had been used
    2. The AUC will larger than if a proper mask had been used
    3. The AUC will not be affected
    4. Not enough information is given to determine what will happen to the AUC
23. Which of these is the most informative method of evaluating a transition potential map?
    1. The area under the TOC curve
    2. The shape of the TOC curve
    3. The Figure of Merit of a run that has the correct quantity
    4. Percent correct of a run that has the correct quantity
24. How does the use of a dynamic variable and recalculation stages in LCM affect the simulation?
    1. Increases the total quantity of change
    2. Allows the simulation to ignore the Markov Matrix
    3. Allows pixels to transition more than once during the simulation’s temporal extent
    4. Increases the Figure of Merit
25. If a TOC Curve has an AUC of 1, then what quantity of simulated change will produce the highest Figure of Merit?
    1. At a quantity of simulated change that is less than the quantity of reference change
    2. At a quantity of simulated change that is equal to the quantity of reference change
    3. At a quantity of simulated change that is greater than the quantity of reference change
    4. Not enough information is given to determine this
26. If you increase the quantity of simulated change from one simulation to the next, then what happens to the Figure of Merit from one simulation to the next?
    1. The FOM will increase
    2. The FOM will not change
    3. The FOM will decrease
    4. Not enough information to tell
27. Which of the following is consistent with Pontius’ recommendations for the next version of VCS?
    1. The required Figure of Merit should derive from the true deforestation quantity during the calibration interval
    2. The required Figure of Merit should be greater than the percentage of deforestation during the calibration interval
    3. The required Figure of Merit should be greater than the percentage of deforestation during the validation interval
    4. The VCS requirements should use scatter plots to reveal the influence of simulated deforestation on biomass disturbance
28. The VCS specifies that the Figure of Merit must be \_\_\_ the percent deforestation during the calibration interval. How should you fill in the blank?
    1. Determined independently from
    2. Greater than or equal to
    3. Less than
    4. Less than or equal to
29. According to Pontius et al. (2018), what qualifies a model as successful in advancing science?
    1. If the scientist can learn from the model
    2. If the model has minimal error
    3. If the model uses the most sophisticated machine learning algorithm available
    4. If the model produces the highest FOM compared to other models in the same study
30. What were you doing when you created a three map crosstab to evaluate the performance of a simulation?
    1. Sensitivity analysis
    2. Pattern calibration
    3. Pattern validation
    4. Structural validation

**Part B: Short Answer** *10 points = 5 answers @ 2 points each*

1. Explain the difference between inductive and deductive.
2. Explain the difference between pattern and process.
3. Explain the difference between calibration and validation.
4. Explain the difference between stochastic and deterministic.
5. Explain the difference between prediction and scenario.

**Part C: Short Answer** *15 points*

The Verified Carbon Standard (VCS) uses the following criterion for a simulation model to qualify for a REDD project: “The minimum threshold for the best fit as measured by the Figure of Merit (FOM) shall be defined by the net observed change in the reference region for the calibration period of the model. Net observed change shall be calculated as the total area of change being modeled in the reference region during the calibration period as a percentage of the total area of the reference region. The FOM value shall be at least equivalent to this value.” What reasoning supports this criterion? Explain the virtues and weakness of such a criterion as opposed to other possible criteria such as FOM must be at least 85% or percent correct must be at least 85%.

Answer:

Their justification was based on Pontius et al. (2008) which says…. Although Pontius et al 2008 didn’t relate to that. One of the virtues of FOM is that some projects can qualify with FOM smaller than most cases in Pontinus et al 2008.

The criterion has fundamental errors, the first being that VCS adopted FOM that depends on loss in the reference region during calibration which is a kappa index which is completely different from FOM. Thus its does show the Forest loss during the simulation period.

Additionally most scientists only show a single values value of the FOM, but it would be helpful if the Hits, Misses, False alarms are shown.

**Part D: Short Answer** *15 points*

The Validation feature of TerrSet’s Land Change Modeler (LCM) produced the map below for our assignment 6. What recommendations do you have for the programmers at Clark Labs to improve LCM’s Validation feature? What would users be able to learn from your recommend output as opposed to the output that LCM’s Validation feature presently has?



**Part E: Long Essay** *30 points*

Pontius has seen journal articles that compare Geomod to TerrSet’s Land Change Modeler (LCM). The authors of such articles apply both models to a case study. The authors use the percent of pixels classified correctly to conclude that LCM is more accurate than Geomod at predicting land change. Therefore, the journal articles recommend the use of LCM instead of Geomod for the simulation of future change. What advice do you have for the authors concerning their approach in such journal articles? How would you write an article to advise users to decide whether to use Geomod or LCM?