

# Orf 467

## Term Exam

Wednesday, December 06, 2017

### Instructions

1. This exam is **Closed Book/Everything (except Brain & Cheat Sheet)** to be taken under a **strict** definition of the honor code. You have 80 minutes to complete the exam, starting at 1:30pm, ending promptly at 2:50pm. The exam is printed below.
  2. By **Closed Book/Everything** I mean that you are allowed to use your brain, a single 8.5"x11" sheet of paper, a pencil, and an eraser. **Nothing else!**  

If you bring a phone, electronic device, computer, iPod, iPad, iXxx, notebook, book, calculator or anything else, all of those items **MUST** be place in a bag or back pack (not your pockets) and remain there during the entire exam. If you do not have a bag or back pack in which to place these devices, you **MUST** place them on the desk in front of the room before you start the exam and retrieve them after you have completed the exam. You may not take a call, respond to a tweet, or check Facebook at any time during the exam. Non-compliance will be considered as a violation of the honor code. Do **NOT** sign the pledge if you are non-compliant.
  3. There are 4 questions having many parts. This is a long exam and will take some time, especially #4! Be concise and please answer **MY** questions; don't add some of your own! (That makes the exam even longer!!). Be **concise & blunt**. Fewer words are better than flowing sentences.
  4. Please use pencil and write neatly. I can't grade what I can't read.
  5. You are permitted a 2-sided 8.5x11 inch "cheat sheet". It **MUST** have your name on it. Its preparation is subject to the University's honor code. (Basically, you wrote and prepared it; it is not a copy of someone else's. It does **NOT** need citations. You can create it electronically using "cut & paste"). It **MUST** be turned in with your exam. If you choose to take the exam without using a cheat sheet you **MUST** write in big letters on the front page of the exam: "I Am **NOT** using a Cheat Sheet." This must be written **BEFORE** you start the exam. If your exam booklet does not contain your cheat sheet or does not have the "NOT using" declaration written on the front, I will **NOT** grade your exam.
  6. You need **NOT** transcribe an answer from your cheat sheet. Simply circle the answer and mark it with the question number. Indicate on your exam booklet "see cheat sheet". If I find it and can read it, I will grade it; else, zero!
  7. I will only grade exams that have a signed pledge.
  8. Good Luck!
- .....

**Transportation Systems Analysis***Fall 2017/18*1. (30 pts.) **Generalities**

- a. (2 pts.) What fundamental value does transportation deliver to society?
- b. (2 pts.) Given a linear network of N nodes and A arcs. What is produced by Dykstra's algorithm (and other shortest path algorithms) that makes the determination of the optimal path from any node to the source node so easy to determine?
- c. (2 pts.) Under what circumstances is it necessary to use a "Nested Logit" approach to compute Mode Splits?
- d. (2 pts) Kornhauser really likes visual representations of information/data. He especially likes flow maps. He especially likes the energy flow maps prepared by Lawrence Livermore Labs. Briefly describe two aspects on the nation's production and consumption of energy that are clearly presented in these flow maps. (1 pt for each)
- e. (3 pts.) What is the **most** fundamental technological characteristic that differentiates autonomousTaxi (aTaxi) systems from conventional modes of public transportation like buses, (1 pt.), paratransit (1 pt.). and commuter rail (1 pt)? (Hint: It is something different for each one.)
- f. (2 pts.) Why do we pixelate the USA person-trip data (1pt)? What is the pixelation formula (if it isn't on your cheat sheet, describe its main characteristics.)? (1 pt)
- g. (3 pts) In our Nationwide aTaxi ride-sharing analysis (HW6), our initial estimation of the ride-sharing potential is for a specific operational plan for our fleet of aTaxis that will deliver a specific Level-of-Service (LoS). What is the baseline LoS? (2pts.). Why did we choose (I imposed) this LoS? (1 pts)
- h. (2pts) What does Chenyi Chen (or Artur Filipowicz) use to generate the training sets for their "DeepDriving" real-time perception systems? (1 pt) Why is this an elegant source of training data? (1 pt)
- i. (8 pts) One of the main benefits of ridesharing is the reduced number of vehicles needed to serve the same personTrip demand. A before/after flow map could readily display where the rideshare potential of aTaxi service could be most beneficial at reducing congestion. Carefully outline the computational processes that you would execute using which of our various data sets to show the impact of shared-ride aTaxi service in reducing congestion in your home county. Be careful to describe (for example, list the data elements) the input data set (2pts), what transformations using what other data sets would you apply to the input data to transform it into data that you can use to make the display (2pts). Carefully describe the output data set that you will use to make the flow map (2pts) and make a very rough sketch of what you would expect the final flow map might look like (2 pts)
- j. (4 pts) In doing the analysis the quality of the input data is really important because, as we all know: garbage in means garbage out, but it is at times non-trivial to determine the difference between garbage and gospel. One pragmatic way is to have some expectation as to what various summarizations of the data should 'look like'. Please make a rough sketch of what you would expect/expected **two** summarizations, your input personTrip data would look like for you to have confidence that the input data is likely gospel rather than garbage. Be sure to label the axes of each chart and provide a title/legend of each chart. (It doesn't have to be pretty, but it needs some precise labeling). (2 pts for each).

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2. (25 pts.) **Transportation Policy and Plans**

- a. (2 pts.) According to Kornhauser, what transportation project would be most beneficial to the town of Princeton, why?
- b. (3 pts.) According to Kornhauser, what is the fundamental reason why the Automated Highway Systems (AHS) contemplated from the 1939 World's Fair through the 1997 "San Diego I-5" AHS demonstration have not and are not likely to become a reality?
- c. (2 pts.) According to Kornhauser, what is the fundamental reason why Personal Rapid Transit (PRT), contemplated from the "1968 Alden StaRRcar" through today's Morgantown/Masdar/Heathrow systems, have not attained wide-spread implementation?
- d. (3pts) Public oversight (safety, traffic laws, rules of the road, etc.) of transportation is fragmented by the basic technological characteristics of each mode of transport. There is one for air travel (FAA), one for railroads (FRA), one for trucks (FMCSA), one for cars and light trucks (NHTSA), ... Kornhauser believes that Driverless cars and light trucks should be classified as a **new** mode and public oversight should be entrusted to a **new** Administration, say NDVSA (National Driverless Vehicle Safety Administration) and taken away from NHTSA.

Do you agree or disagree (choose one!, 0 pts.) AND write a very brief argument as to why your choice (NHTSA or NDVSA) to do the public oversight of Driverless cars/light trucks is better than the other. (3 pts)

- e. (15 pts) NHTSA and SAE each now use 5 'Levels' to categorize different kinds/classes of automated cars. Kornhauser prefers to use only 3 classes/types which he argues clearly differentiate these technologies.
  - i. (3pts) What are the three distinct classes/types? (1 pt each)
  - ii. (3 pts.) What is the salient technological/operational features of each class/type? (1 pt each)
  - iii. (3pts) What is the most important value/utility that each class/type of automation delivers to the **Purchaser** of a vehicle having this class/type of automation (1 pt each)
  - iv. (3pts) Briefly describe the typical **Purchaser** that will most appreciate the most important value/utility for each of the 3 Kornhauser classes. (1pt each)
  - v. (3pts) What is the most positive value/utility **and** the most negative value (highest cost/dis-utility) that each class/type of automation will deliver to **Society** if this class/type of automation is a market success? (0.5pts each)

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3. (20 pts.) **Transportation Planning Models**

- a. (10pts) The “classical 4-step” transportation planning model.
  - i. (5 pts.) Name the steps and list the typical data elements that are INPUT to each step?
  - ii. (5 pts.) List the typical data elements that are OUTPUT by each step.
- b. (10pts) You’ve decided that the MyCity Homework should be upgraded to address the disaggregate rather than aggregate travel behavior of the city so you have decided to build an activity-based individual trip synthesizer that will generate each of the million or so daily trips taken by the residents of MyCity. Your objective is to have the spatial “granularity” of each trip be precise enough to be able to measure walk accessibility to either a PRT station or an aTaxi stand. Also, the temporal “granularity” of each trip needs be precise enough to assess the propensity of the opportunity for ride-sharing and its changes with the length of the delay in departing a vehicle to wait for potential ride sharers (“DD”).

Briefly describe the process that you will use to generate this individual trip file for your MyCity. Be sure to give examples (rough sketches are OK, label the axes and give a title) of the distributions that you will use and the potential source for these distributions (or the source data from which you might generate the distributions) (10 pts)

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4. (25 pts.) **Mode Split and Empty Vehicle Management of our Nation-wide aTaxi System(s).**

- a. (25 pts.) Management of Empty aTaxis & Fleet size (assuming homogeneous aTaxi fleet (one seating capacity)).

Assume that your state legislature has granted you the authority/charter to operate a fleet of aTaxis for your county. To plan for that operation you have available to you the synthesized person trip file(s) for your county (the ones that you've been dealing with in HW 6). You will make the assumption that the salient aspects of this person trip demand data set repeats itself every day. To that end you want to be prepared to serve that demand, so you want to know how many aTaxis to buy and the extent to which you will need to reposition empty aTaxis from where the last person exits to where the next 1<sup>st</sup> customer enters.

- a. (6 pts.) If we make a 'heroic' assumption that trips are the same every day and we wish to reposition aTaxis en-mass **just once** during the day. Starting with the aTaxi-vehicleTrip data, describe/outline/write pseudocode (pick one) how you will compute the **initial desired inventory (D(x,y))** of aTaxis that you will want at each pixel (x,y) at the start each day. (4 pts). Make a rough conceptual sketch of what you expect to see if you made a 2-D bubble chart of **D(x,y)** where the radius of the bubbles are proportional to D and located at x,y. Be sure to include a conceptual representation of your county boundary on your sketch. (2 pts)
- b. (6 pts.) Starting with the aTaxi Vehicle trip data, describe/outline/write pseudocode (pick one) that will generate the End-of-the-Day (EoD) supply of empty aTaxis available for redistribution, **(S(x,y))**. (4 pts). Make a rough conceptual sketch of what you expect to see if you made a 2-D bubble chart of **S(x,y)** where the radius of the bubbles are proportional to S and located at x,y. Be sure to include a conceptual representation of your county boundary on your sketch. (2 pts)
- c. (5 pts.) Formulate the optimization problem that you will solve to determine how many aTaxis to send from where to where "instantaneously" at the time that you do the once-daily repositioning? (3 pts) At about what time will you do this repositioning (1 pt) and why do it at about that time? (1 pt)
- d. (4 pts.) In class I described a process by which you can obtain an estimate of the **absolute minimum** number of aTaxis of a given seating capacity that would be needed for you to serve all the trips originating in your county. Briefly describe (or draw a sketch of) that process? (5 pts)
- e. (4 pts.) You have noticed that there is a large difference between the fleet size suggested by 4.b above as compared to 4.d. Consequently you will want to possibly modify what you do wrt the "overnight repositioning" and/or implement an empty repositioning strategy throughout the day and/or negotiate with your neighboring counties some joint operational plan and/or...that will help you serve essentially all of your customers with a fleet size that is closer to that of 4.d (or maybe even less). Please briefly describe that strategy and briefly describe why it might substantially reduce the number of aTaxis that you need to buy to serve all of your customers. ? (4 pts)