2016 HiMCM
Problem A: Swim, Bike, and Run

A **triathlon** is a multiple-stage athletic endurance competition of three continuous and sequential events, usually long distance swimming, cycling, and running. Triathletes' overall course completion time includes their time for each event plus their time for transitions between the three events.

Race organizers provide each participant a transition area where he/she can pre-position a bike, running shoes, performance gear and other equipment needed to transition from swimming to cycling and from cycling to running. An athlete's time in the transition area (denoted as **T1** for swimming to cycling and **T2** for cycling to running) counts toward the total race time. The race begins with the swimming event and participants start the race in a sequence of waves of groups of swimmers at intervals of some number of minutes apart.

Your team is working with your town's Mayor to organize a triathlon to support your local youth organization. You are expecting about 2000 runners and plan to have a traditional open Olympic triathlon, which consists of a 1500m swim, a 40K bike ride and a 10K run. You hope to attract some professional triathletes (best in the nation and world) and some premier triathletes (not quite professionals, but among the fastest amateurs in previous triathlons). As this is an open triathlon, there is no qualification time required for participation, and so, the vast majority of your participants will be open registrants. You have done some research and have found that most races have a variety of divisions based on gender and age, as well as on professional, premier, or open status. Having a variety of divisions also helps to attract participants, as you will provide awards to the top finishers in each division.

The Super Tread Race Company has agreed to sponsor your event. If this year's race goes well, Super Tread will commit to supporting the race again next year. The CEO of Super Tread wants to ensure the race is a world-class event that will attract professional racers and serious amateur athletes each year to further promote the company's brand and sales. As such, the CEO wants you to minimize congestion on the course. In other words, participants should be able to proceed without hindrance during each phase of the triathlon. For example, a crowd of slower swimmers should not slow down faster swimmers.

The Mayor of your town wants the triathlon to be an enjoyable event for the many amateur participants, but also wants to minimize the length of time the local roads in the town are closed for the cycling and running portions of the triathlon. While you expect the time between the start of the first group of swimmers and the completion of the last runners to take a number of hours, you cannot keep the local roads closed for more than 5.5 hours.

You have a data set of results from a recent triathlon to assist you in preparing to organize your race (see HiMCM_TriDataSet.xlsx). These data include participants' gender, age, status (professional, premier or open), race event times, transition times, and total times.

Part I. Explore and discuss minimizing course congestion and minimizing road closure time. In order to minimize both course congestion and road closure time; use your data set to determine:

1. the divisions you will use in your race, and
2. a schedule of wave start times.

Part II. Explore any advantages you may achieve in terms of congestion and road closure time if you adjust the race distances of the swimming, biking, and/or running events of your triathlon.

Part III. Write a two-page letter to the Mayor of your city summarizing your analysis. Include your race day event schedule as the second page of your letter. This cover letter will be the first two pages of your report.

Your submission should consist of:

- One-page Summary Sheet,
- Two-page letter to the Mayor,
- Your solution of no more than 30 pages for a maximum of 33 pages.
- Note the appendix and references do not count toward the 33 page limit.

PROBLEM NOTES:

1. HiMCM_TriDataSet.xlsx is based on an Olympic distance triathlon consisting of a 1500m swim, 40K bike ride, and a 10K run.

2. Key for Data Set Column Headings

	A	B	C	D	E	F	G	H	I	J
1	BIB NO.	AGE	GENDER	CATEGORY	SWIM	T1	BIKE	T2	RUN	FINALTM
2	1	33	M	M PRO	00:12:22	00:02:57	01:00:12	00:00:47	00:34:27	01:50:45
3	2	32	M	M PRO	00:12:02	00:03:11	00:57:06	00:00:49	00:35:24	01:48:32
4	3	31	M	M PRO	00:12:40	00:03:16	01:01:16	00:00:44	00:34:27	01:52:23
5	4	28	M	M PRO	00:14:11	00:03:00	01:05:24	00:00:55	00:32:51	01:56:21
6	5	27	M	M PRO	00:12:13	00:03:03	01:02:46	00:00:52	00:34:58	01:53:52
7	7	26	M	M PRO	00:13:09	00:03:34	01:03:23	00:01:00	00:36:26	01:57:32

BIB NO.	Registration Number of Participant
AGE	Age in years on race day
GENDER	M – male F – female
CATEGORY	Registration Category
	M Pro – male professional F Pro – female professional
	M Premier – male premier F Premier – female premier
	M Open – male open race F Open – female open race
	CLY – open Clydesdale – men over 220 lbs.
	ATH – open Athena – women over 165 lbs.
SWIM	Swim Time (hh:mm:ss)
T1	Transition time from swim to bike (hh:mm:ss)
BIKE	Bike Time (hh:mm:ss)
T2	Transition time from bike to run (hh:mm:ss)
RUN	Run Time (hh:mm:ss)
FINALTM	Total time for all events and transitions (hh:mm:ss)

2016 HiMCM
Problem B: Shop and Ship

As online stores start to compete with traditional brick and mortar stores the goal is to combine the benefits of both types of businesses. Brick and mortar stores provide the benefit of seeing the actual items, picking up your purchase right away, and not having to pay for shipping. But, sometimes the store is not convenient to your location, or you do not have time to go shopping. Online stores offer the convenience of shopping from home and the added benefit, in many cases, of no additional sales or other taxes. And, with international shipping, many more items are available to shoppers all over the globe via the Internet. For the purposes of this HiMCM problem, we will use an example from the United States.

Your recreation equipment company currently not selling apparel/clothing has a small brick and mortar store, but conducts most of its business through online sales. Your company's headquarters and main warehouse is located in New Hampshire (NH), USA. Due to increased demand for your product, you are expanding and your team's task is to choose locations for the new warehouses. Your initial expansion goal is to service the 48 continental United States (not Alaska-AK or Hawaii-HI or Puerto Rico-PR) with one-day ground shipping with United Parcel Service (UPS).

Part I. Analyze the optimal placement of warehouses to meet the one-day ground shipping requirement. Determine and discuss your criteria as you address the following questions.

1. What is the minimum number of warehouses needed to service the continental United States with one-day ground shipping?
2. Where should the new warehouses be located?

As an example, **Figure 1** shows UPS ground shipping from NH.

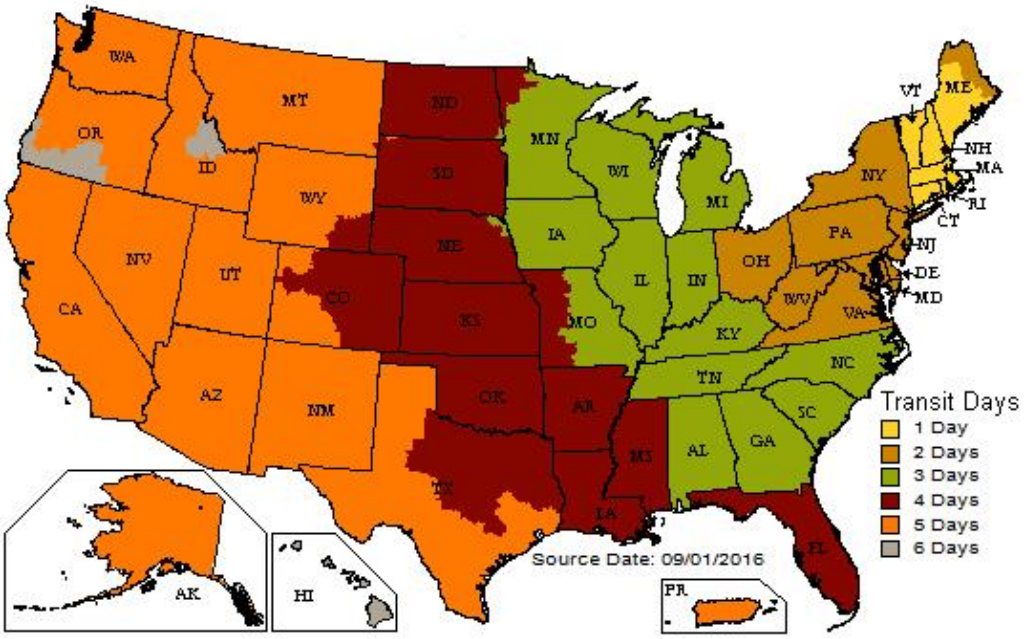

Figure 1: Ground Transit Times When Shipping From NH (https://www.ups.com/maps/)

Part II. The state of NH has no sales tax, meaning that if you physically buy a product in New Hampshire, you do not have to pay sales tax. Current US federal law requires that companies must collect required sales tax where they have physical locations. Although tax laws in different cities, states, and countries can be complicated, for the purposes of our HiMCM problem, we will assume the following:

*Any online order delivered to a location within a state where a warehouse is located will have that state's tax added to the order cost.

*Any online order delivered to a location outside a state where a warehouse is located will NOT be taxed.

* Problem Note 1 provides state tax information. For example, DE, MT, NH, and OR do not have state sales tax.

1. Describe and discuss how the warehouse locations you selected in Part I will affect your customer's tax liability.
2. Analyze and discuss any possible changes to the number of warehouses or locations of those warehouses in order to minimize the tax liability to the most customers possible.

Part III. Your company has decided to add clothing and apparel to your line of products. Several states do not tax clothing or have minimal taxes on clothing as shown in Problem Note 1.

1. Analyze the impact of the warehouse locations from **Parts I** and **II** based on the addition of clothing and apparel to your inventory.
2. Discuss any possible changes to the number of warehouses or locations of those warehouses based on increasing your clothing sales.

Part IV. Determine your final recommendation and justification of the number of warehouses and location of the warehouses. Write a one-page letter to your Company's president summarizing your final recommendation and justification. This letter will be the cover letter to your HiMCM contest report.

Your submission should consist of:

- One-page Summary Sheet,
- One-page letter to the your Company's president,
- Your solution of no more than 30 pages for a maximum of 32 pages.
- Note the appendix and references do not count toward the 32 page limit.

PROBLEM NOTES:

1. Sales Tax

State Sales Tax Rates for 48 Continental US States

AL 4%		**AZ** 5.6%	**AR (2)** 6.5%
CA 7.5%	**CO** 2.9%	**CT** 6.35%	**DE (1)** No Sales Tax
DC 5.75%	**FL** 6%	**GA** 4%	
ID 6%	**IL (2)** 6.25%	**IN** 7%	**IA** 6%
KS 6.5%	**KY** 6%	**LA** 4%	**ME** 5.5%
MD 6%	**MA(1)** 6.25%	**MI** 6%	**MN (1)** 6.88%
MS(2) 7%	**MO** 4.23%	**MT (1)** No Sales Tax	**NE** 5.5%
NV 6.85%	**NH (1)** No Sales Tax	**NJ (1)** 7%	**NM** 5.13%
NY (1) 4%	**NC** 4.75%	**ND** 5%	**OH** 5.75%
OK 4.5%	**OR (1)** No Sales Tax	**PA (1)** 6%	
RI (1) 7%	**SC** 6%	**SD** 4%	**TN (2)** 7%
TX 6.25%	**UT (2)** 5.95%	**VT (1)** 6%	**VA** 5.3%
WA 6.5%	**WV** 6%	**WI** 5%	**WY** 4%

(1) None or limited tax on clothing and shoes.
(2) Some tax on groceries.

2. Resources

http://www.ups.com/maps?loc=en_US&srch_pos=1&srch_phr=maps
http://www.tax-rates.org/taxtables/sales-tax-by-state
http://www.whereig.com/usa/zipcodes/