

WATERLOO **ENGINEERING**



Programming
Competitor Information Package

~

Spring 2023
Waterloo Engineering Competition
July 15, 2023



WATERLOO
ENGINEERING SOCIETY

SCHEDULE

The schedule of the Spring 2023 *Programming* competition is as follows:

Time	Activity	Location
8:30-9:00 am	Sign-In	E-7 Second Floor Event Space
9:00-9:15 am	Opening	E-7 Second Floor Event Space
9:20-9:50 am	Competition Introduction	HQ (E-7 5343)
10:00-1:00 pm	Competition Time	Assigned Breakout Room
1:00-1:30 pm	Lunch	Ideas clinic
1:30-4:30 pm	Competition Time	Assigned Breakout Room
4:45-6:30 pm	Team Presentations	HQ (E-7 5343)
6:30-7:00 pm	Judge Discussion and David Wang Concert	E-7 Second Floor Event Space
7:00-7:30 pm	Announce Winners	E-7 Second Floor Event Space

*Times are approximate. Exact event timing may change on the day of the competition, which will be communicated to competitors

GENERAL RULES & GUIDELINES

1. Competitors will be presented with a 15-minute question period following the welcome and briefing. Please try to ask your questions during this time period so that they have full WEC staff attention.
2. The competition is six (6) hours in duration.
3. Visitors are not allowed. Violation of this rule will result in immediate disqualification.
4. Relevant resources can be found on [this](#) github repository.
5. All submitted materials must be clearly uploaded onto a private repository on GitHub. Each team must add [AyJayH](#) and [Victor-Kalenda](#) as a collaborator to their repository for testing purposes. Submission deadline is at the end of the six (6) hours allocated for the competition. If a team is three (3) or more minutes late in submitting any deliverables, the team will be disqualified.
6. If teams are unsure about rules or require further clarification, please ask one of the organizers. Volunteers may be able to assist, but in the event of discrepancies between volunteers and organizers, the organizers' opinion will be followed.
7. Time remaining in the competition will be announced to competitors at the 2 hour, 1 hour, 30 minute and 10 minute marks.
8. Teams are not allowed to make any changes to the project submission after the design stage is over. Dishonesty will not be tolerated and will result in disqualification.
9. Plagiarism and cheating will not be tolerated.
10. Any attempt to hack the system or acting in bad faith will result in disqualification. The expected inputs will be clearly outlined and they must be adhered to.

TECHNICAL GUIDELINES

1. Competitors can use any programming language they want, the programming language must be able to read and write JSON files.
2. Bring anything you need to develop and demo your software: laptop, charger, USB, tablet, phone, etc. WEC Staff are not responsible for supplying any hardware.

SCENARIO

You are the manager for a company that needs to schedule truck routes through Ontario. Your headquarters are in Mississauga, and your company has 3 Warehouses which contain the packages you are delivering to your clients. There will be 10 unique drop off locations where packages can be sent to. You have no limit on how many trucks you send out, however, each truck will cost you. The cost of a truck is dependent on the information outlined in “Details”. By the end of the week, all deliveries must be fulfilled or else you will fail. Late deliveries will only earn a penalty.

The “Details” section outlines all the important constraints for implementing your solution.

SOLUTION STAGES

1. Trucks start at HQ, packages start at warehouses, and they must be delivered by the end of the week
2. Trucks start at HQ, packages start at warehouses, and packages must arrive within the desired hours
3. Trucks start at HQ, packages start at warehouses, and packages must be delivered by their deadlines
4. Trucks start at HQ, packages start at warehouses, and deadlines must be met - overtime considerations must be accounted for
5. Trucks start at HQ, packages start at warehouses, deadlines are met, overtime is accounted for, and traffic between 07:00-09:00 and 16:00-18:00 is considered

Difficulty Level	Deadlines	Working hours	Traffic Simulation	Delivery hours
1	n/a	n/a	n/a	n/a
2	n/a	n/a	n/a	06:00 - 20:00
3	Deadlines	n/a	n/a	06:00 - 20:00
4	Deadlines	Overtime	n/a	06:00 - 20:00
5	Deadlines	Overtime	Traffic	06:00 - 20:00

*You shouldn't try to optimize until you've found a workable solution for the last stage

GEOGRAPHY DETAILS

[Map](#)

Cities:

1. Tilbury
2. Mississauga
3. Cornwall
4. London
5. Windsor
6. Niagara Falls
7. Barrie
8. Kingston
9. Huntsville
10. North Bay

Warehouses:

1. Goderich
2. Toronto
3. Picton

Headquarters:

Mississauga

OBJECTIVE

Your job is to implement a program that can produce a truck schedule for a randomized delivery agenda that minimizes expenses whilst still complying with the rules and regulations. Keep in mind that an optimal low-cost solution may not be ideal for worker satisfaction or company reputation (overtime and late deliveries) so it will cost you points in your solution.

CRITICAL CONSTRAINTS

Truckers can drive no more than 14 hours on any given day, and no more than 70 hours within the week. Groups that fail to meet this law will be awarded no points for their solution.

You are also responsible for providing a solution which delivers all packages to their specified locations by the end of the week. Groups that fail to do so will be awarded no points for their solution.

DETAILS

Provided Information

- Distances between cities and the delivery schedule/requirements

Truck Related Information

- A trucker cannot legally drive for longer than 14 hours on any given day. (Critical for Success)
- Trucks can carry five (5) packages at a time.
- Loading/unloading the truck doesn't take any time once it's reached the destination
- The week starts on Monday morning at 00:00 and ends on Sunday night at 11:59 (inclusive).
- Each Trucker costs 20 \$/hr plus a base weekly cost of \$300. If a trucker exceeds 60 hours of work in a week (and no more than 70), they must be paid 30 \$/hr in overtime.
- The cost of gas is 68 cents per kilometer for all your trucks.
- Assume all trucks travel at a constant speed of 100 km/hr.
- There is no limit to how many truckers you can send out or when you can send them out.
- Truckers can stop at any point to rest (This includes the sides of highways)

Other Information

- All packages are the same, meaning that packages are not assigned to a delivery destination.
- Each late delivery will incur a \$200 late fee per day overdue.
- All packages should arrive between 06:00 and 20:00 on the day of their deadline, not earlier.
- Between 07:00-9:00 and 16:00-18:00, all trucks will travel 30% slower due to traffic.

RESOURCES

Please clone this [repository](#) for the relevant files.

You will be provided with 2 jsons: an input and a distance file. The distance file will contain all the relevant distances between the cities and warehouses to be used in your calculations. The input file will contain a randomized delivery schedule. There will also be 2 python scripts for randomizing the input.json to test different cases: the first file will correspond to stages 1 and 2 of the competition, before the introduction of deadlines. The next script will format the json to contain information about the days that packages need to be delivered. There will also be an output.json where you will upload your truck schedule, as dictated in the OUTPUT section.

File tree

```
WEC_P_S23/  
|__ stage1-2.py  
|__ stage3-5.py  
|__ json/  
|__ distance.json  
|__ input.json  
|__ output.json
```

Here is a brief preview of what the files should look like. If your files don't look like this, please consult one of the organizers

input.json (stage1-2) - you will need to run stage1-2.py to see this, and the numbers may be different

```
{  
  "Brampton": 21,  
  "Kitchener": 10,  
  "Kingston": 5,  
  "North_Bay": 6,  
  "Tilbury": 10,  
  "Johnstown": 16,  
  "Mississauga": 0,  
  "Cornwall": 10,  
  "Niagara_Falls": 6,  
  "Barrie": 16  
}
```

input.json (stage3-5) - you will need to run stage3-5.py to see this, and the numbers may be different

```
{
  "Brampton": {
    "Total": 12,
    "Monday": 1,
    "Tuesday": 2,
    "Wednesday": 2,
    "Thursday": 1,
    "Friday": 2,
    "Saturday": 2,
    "Sunday": 2
  },
  "Kitchener": {
    "Total": 20,
    "Monday": 4,
    ...
  }
}
```

distance.json

```
{
  "Tilbury": {
    "Tilbury": "n/a",
    "Mississauga": 293,
    "Cornwall": 753,
    "London": 136,
    "Windsor": 56,
    "Niagara_Falls": 324,
    "Barrie": 375,
    "Kingston": 579,
    "Huntsville": 499,
    "North_Bay": 623,
    "Goderich": 208,
    "Toronto": 313,
    "Picton": 513
  },
  "Mississauga": {
    "Tilbury": 293,
    "Mississauga": "n/a",
    ...
  }
}
```


OUTPUT: The output for your code should be a json file that follows the provided structure

```
{
  "Total_cost":
  "Truck_1":{
    "Total_cost":
    "Monday":{
      "Total_time_driving":
      "Total_distance":
      "Total_cost":
      "Delivery_1":{
        "Start_time":
        "End_time":
        "Start_destination":
        "End_destination":
        "Distance":
        "Delivery_type":
        "Start_quantity":
        "End_quantity"
      }
      "Delivery_2":{
        "Start_time":
        "End_time":
        "Start_destination":
        "End_destination":
        "Distance":
        "Delivery_type":
        "Start_quantity":
        "End_quantity"
      }
    }
  }
  "Tuesday":{
    "Total_time_driving":
    "Total_distance":
    "Total_cost":
    "Delivery_1":{
      "Start_time":
      "End_time":
      "Start_destination":
      "End_destination":
      "Distance":
      "Delivery_type":
      "Start_quantity":
      "End_quantity"
    }
  }
}
```

Further information on the output.json:

1. The full schedule from Monday to Sunday must be given for each truck used, even if the truck is inactive on a particular day - the output for an inactive day wouldn't have any deliveries but would include the Total_time_driving, Total_distance and Total_cost (which would all be 0)
2. Delivery_type is either "pickup" or "drop_off"
3. Give the time in "hh:mm" format - round to the nearest minute
4. DO NOT include units - distance is in kilometers, cost is in dollars to 2 decimal points

SUBMISSION DETAILS

At the start of the competition you must share a private github repository with us ([AyJayH](#) and [Victor-Kalenda](#)). We will check the repository at the end of the 6 hours and will use whatever is present 3 minutes after the end of the competition.

In your repository, you must include the original file structure from the provided github [repository](#), along with your script(s) in the top level (WEC_P_S23/). They can be written in whatever language you prefer, but you must use the jsons as an input to your code. DO NOT edit the stage1-2.py and stage3-5.py code since we will use it to test your solution.

DEMONSTRATION

After your code is uploaded to github and we've made a copy, you must present your code and explain the reasoning behind your decisions. Include considerations regarding cost reduction, hours worked or any additional features you've implemented. Then, we will provide you with 3 random data sets (produced using the same script you've been provided with). You must show that your calculations are correct and that the critical constraints are met.

PROCEDURAL RULES

The following rules must be followed during the design and implementation stages of the competition. Any teams in violation of the rules may be disqualified at the discretion of the WEC staff.

1. Teams have six (6) hours to complete the design and development of the script.
2. Teams are not allowed to leave the competition premises unless they have submitted their prototypes to the competition staff.

EVALUATION

The team with the highest score will win and move on to compete at the Ontario Engineering Competition.

Category	Maximum Score
Solution	45 points
Calculation Correctness	25 points
Low Cost	10 points
Respected delivery timing (06:00 - 20:00)	10 points
Number of late deliveries	-5 points per delivery
Hours of overtime worked	-1 point per hour
Code Legibility/Quality	45 points
Algorithmic Quality	35 points
Meaningful documentation / comments	10 points
Other	10 Points
Traffic Simulation	5
Bonus: meaningful features / data analysis	5
Total	100 points

Additional Comments Regarding Marking Scheme

In case of a tie in total marks, the teams will be ranked based on their points scored in “solution”.

Completed marking sheets will not be disclosed to competitors; however, if teams wish to know their strengths and weaknesses for improvement in future competitions, judges and WEC staff will be available after the competition for questions.

SPONSORS



Sanford Fleming Foundation

The Sanford Fleming Foundation (SFF) proudly co-organizes and sponsors the Waterloo Engineering Competition, held in both the Spring and Fall terms. In partnership with the University of Waterloo's professional engineering community, SFF offers:

- Scholarships to promote student participation in exchange programs
- Awards recognizing academic excellence, leadership, and co-operative education proficiency
 - Travel grants for individuals and teams attending conferences and competitions

Through these initiatives, the SFF supports aspiring engineers, fostering growth and success.

Contributions to **WEC**: Food and Prize Money for attendees and WEC members

<https://uwaterloo.ca/sanford-fleming-foundation/>



Dr. David Wang

David Wang is the lead singer and lyricist for Critical Mass, a Canadian rock band that has been in existence since 1997. The band are two-time recipients of the Canadian Gospel Music Association Award for Best Rock Album (2000, 2005) and played for Pope John Paul II at World Youth Day 2002 in Toronto in front of a live and televised audience of a million people. In late 2021, the band released their most recent album, "Serenity", and will be touring in support of the album in early 2023.

Contributions to **WEC**: Concert

