Available Machines in Laundry Room (Monte Carlo Simulation)

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IS597PR Fall 2021

Background & Purpose

Background:

- Most of the apartments managed by the university still only have a communal laundry room in Champaign;
- It should be noted that Orchard Downs is a community that primarily provided for graduate students and their families.

  The room types contain 2B2B and 1B1B. About 40% of 2B2B tenants are families (more than 3 people), 20% are one person, and 40% are two people. For 1B1B, 50% are two people living, and 50% are living alone.

Purpose: Calculate the average waiting period for students to save their time

01 Design Assumptions

- The laundry room is only available to tenants in the Orchard Downs community. And the laundry room can be used 24 hours.

- People usually start washing clothes from 8 am to 10 pm, and they are more likely to start washing clothes at 6:00 PM-9:00 PM. And people prefer to do laundry on weekends.

- Every time washing clothes, they need to use both washing machines and dryers.

- If the washing frequency is ***once a week***:
  - Each family (more than 3 people) and a unit with 2 people must use 3 washing machines and 2 dryers each time.
  - A tenant living alone uses 2 washing machines and 1 dryer at a time.
- If the washing frequency is ***twice a week or more***:
  - Each family (more than 3 people) and a unit with 2 people use 2 washing machines and 1 dryer each time.
  - A tenant living alone uses 1 washing machine and 1 dryer at a time.

02 Variables

The number of dryers and washing machines

Number of residents planning to do laundry this week

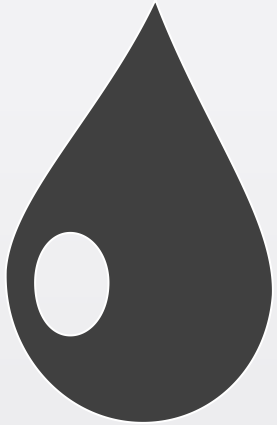
The interval between the user putting clothes from the washing machine to the dryer

Each run time of the washing machine and dryer

The washing frequency of each unit

03 Hypotheses

No more than **80%** of the time in a week, people go to the laundry to complete the washing and drying work within **2 hours**



If **20%** of residents reduce their washing frequency per week, the average queue time will be reduced

04 Workflow

Input

[num_WashMachine, num_Dryer, num_resident, time_interval, washTime, dryTime, frequency]

num_assign:

- (Based on background)
- Probability 3(working days):7(weekends)

- count the number of different units;

- numpy.random.binomial

Randomly output the number of laundry people on weekdays and weekends;

- numpy.random.randint

Randomly assign laundry date;

total_num_of_eachday:

- Frequency

- calculate the number of different units to be washed every day

Update_method:

[the result of "total_num_of_eachday"]

- From 8 am to 10 pm – total 14*60 mins

- random.choices

Randomly assign laundry date;

- Assumption

Specify the number of machines that the unit needs to use (**frequency**)

washing process

(Suppose a user needs to use ***n*** washing machines. The user uses the current available machines instead of using the current washing machine ***n*** times.)

After washing all clothes, the user will proceed to the drying step

- **random.choices**

Randomly set interval time;

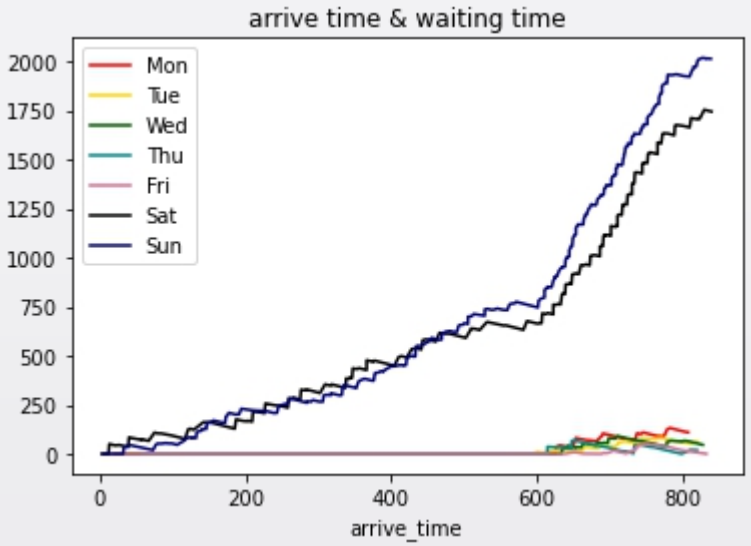
drying process

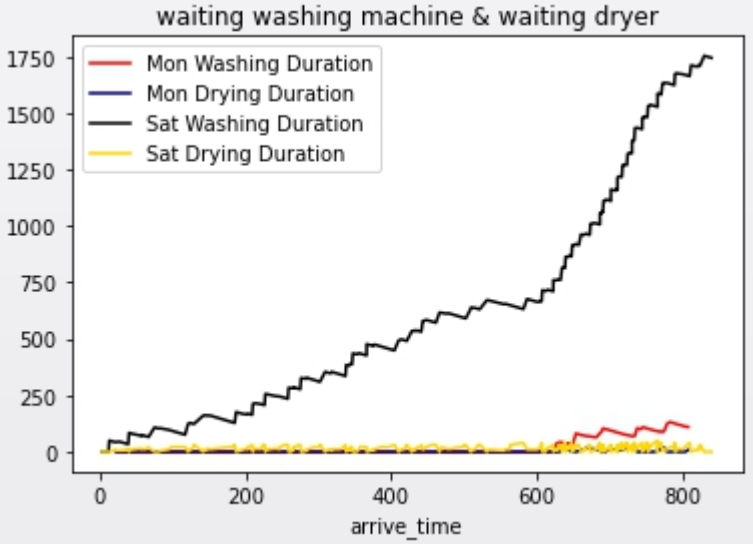
(Similar to the above, the user uses the current available machines instead of using the current washing machine ***n*** times.)

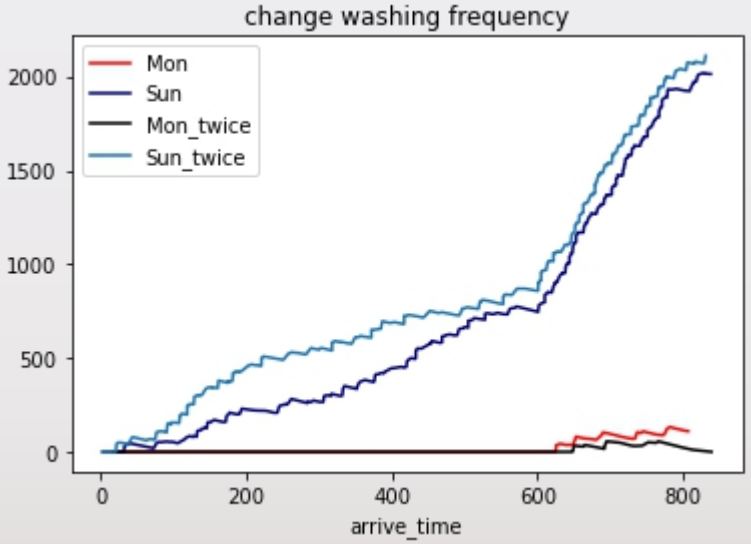
05 Output Dataframe

	arrive_time	unit	ned_washing_machine	ned_dryer	Total_Wait_washing_duration	Got_washing_machine_time	finish_washing_minute	Got_dryer_time	finish_dry_minute	Total_Wait_dryer_duration
0	16	solitude	3	2	0	16	76	85	155	0
1	28	solitude	3	2	0	28	88	97	167	0
2	65	solitude	3	2	0	65	125	134	204	0
3	130	couple	2	1	0	130	190	199	269	0
4	154	solitude	3	2	0	154	214	223	293	0

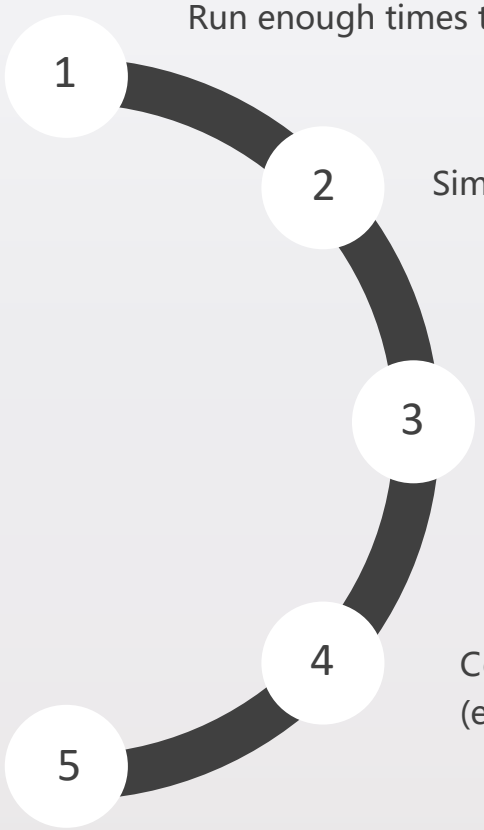
06 Visualization







07 Future Improvement



1. Run enough times to get credible data
2. Simplify the code to optimize time complexity
3. Add input variable -- the time to wait for the user to take out the clothes each time the washing machine or dryer finishes its work
4. Consider other factors to refine the model
   (e.g. holiday, fall break, weather)
5. Propose recommendations based on the results
   (e.g. the ratio of dryers to washing machines,
   need to upgrade the machine to shorten the waiting time?)

Thank you

Github: https://github.com/DYZhang117/2021Fall_finals