Swem Research Librarian Schedule Optimization

Cassandra Chang & Leyli Garryyeva

Department of Mathematics, The College of William and Mary, P.O. Box 8795, Williamsburg, VA 23187

Executive Summary

The research librarians at the Swem Library currently have a working schedule during which they can allocate hours towards teaching class sessions, holding research appointments with students, and other library duties. The goal of this simulation project is to model the research librarian utilization and optimize the number of classes and research appointments made without overworking the librarians. The current base model showed that the overall librarian utility was not evenly distributed across the research librarians. The model was modified changing the assumptions on the librarian subject matter flexibility. Two modified models showed differing results on improvements to the objectives of the problem. Restricting the librarian subject matter flexibility improved the number of classes and students served while the librarian utilization became extremely unbalanced. Making the librarians universal improved the overall librarian utilization while the number of classes and students served has decreased.

1 Introduction

The Earl Gregg Swem Library (Swem) is central to the College of William & Mary in many ways. Physically, it is a center point of the campus. Swem is also an educational center, where students and faculty of all disciplines can come to enhance their research. Students can make appointments with research librarians for projects and papers, while any professor may schedule a class session with the librarian to instruct their entire class on how to utilize all the resources offered by the library. For example, a physics student may set up an appointment to get help on the literature review for a research project, and an art history professor may elect to spend a class period in the library to ensure that all the students in their course know how to properly find research materials for their studies at William & Mary.

To meet the patron demand, Swem employs ten research librarians, each with different subject focus areas. These librarians choose their available hours within their 8 am to 6 pm work day, during which the appointments can be scheduled. The appointments can be booked online. The librarians host the classroom sessions in one of the four classroom spaces – Kyle, Cox, Ford, and Dulin Learning Center – available within the library. The librarians served over 200 students and held 500 class sessions in 2018-2019 academic year. The goal of this simulation project is to optimize the librarian schedule so that as many students and classes can be instructed with minimal time conflict.

2 Data Collection

The data collected included the date, time, duration, instructing librarian, course number of the class taught, and the classroom utilized for each class session and research appointment. The class subjects were split into six categories: art, education, English, languages and linguistics, natural sciences, and social sciences. The librarians were also split into sets depending on their specialty subjects so that, for example, a student who is in the social sciences can choose between multiple librarians who can all assist with social science related research and writing

style. One librarian can be in multiple subject sets depending on their subject matter flexibility. The subject sets are presented in Table 1. All of the research librarians have led class sessions for the art and social science categories, whereas education and English tend to be more specialized. This may be due to the higher proportion of art and social science courses making appointments.

The overall time range of data collection was from September 2018 to November 2019. Data was collected on Monday through Friday every hour from 8 AM to 5 PM. Based on the academic calendar, students are on break for majority of the months of January, May, June, July, and August. Therefore, the data for these months were omitted from further analysis and the data set included ten months of data with around 200 workdays and 1800 hours.

The distribution of the number of appointments per hour varies across the week. Figure 1 demonstrates the total research appointments made across our data collection period. Also, due to the fact that there were no research appointments scheduled at 8 AM across the entire data collection period, this hour was omitted from the plot to better understand the distribution of research appointments during the rest of the day.

It appears that all five days have one common feature – there is a dip in the number of appointments around midday. It appears that students prefer to schedule their appointments mid-morning or in the afternoon, avoiding early morning times, midday lunch times, and evening times.

However, there is a confounding factor in the research appointment data. Figure 3 shows that some of the research librarians had scheduled more research appointments than they had available hours. Essentially, they had taken more appointments than they had specified on their availability calendar. This makes it difficult for the model to be extremely precise as this difference between the stated availability and the actual appointment hours reduces the scheduling accuracy. We also see that there are occasionally quite few research appointments or available hours for a librarian in a month. This suggests that the librarians' weekly schedules are not always consistent and, thus, makes it difficult to model the system properly. Ideally, we would want the availability hours to match with the number of student appointments booked.

Figure 2 shows the distribution of all the class appointments made for the same time period, with the addition of 8 AM appointments which are prevalent in this case. Mondays and Wednesdays have similar appointment distributions, as do Tuesdays and Thursdays. This is likely due to the general class schedule, where classes are often held at the same time either on Mondays and Wednesdays, or Tuesdays and Thursdays. Fridays are, generally, less popular than the other weekdays with the appointment times being more prevalent within 10 AM to 2 PM time block.

Further analysis of the class appointments revealed that the highest types of courses to utilize the librarians for their classes tended to be social science. These classes made up the largest proportion of our data. The social sciences tend to have more literature review-based papers and projects than the other subjects, which is a potential cause for this proportion. In addition, this was a broader subject than the others, so naturally the numbers would appear to be higher.

The data for the librarian time allocation on other duties were unavailable forcing rough estimations of the general number of the librarians that could have other duties appear throughout the day.

3 Model Description

In general, the simulation model has three types of entities entering the system: students, classes, and other librarian duties. Upon entering the system these entities seize the librarian and classroom resources (if needed) for a sched-

Table 1: The librarians that hold classes in each subject category

Subject	**Librarian Members**
Art	All Librarians
Education	Paul, Liz
English	Paul, Liz, Kristy, Natasha, Mary, Jessica
Languages	Morgan, Paul, Liz, Kristy, Candice, Alex, Natasha, Mary, Jessica
Natural Sciences	Morgan, Paul, Liz, Kristy, Candice, Natasha, Mary, Jessica
Social Sciences	All Librarians

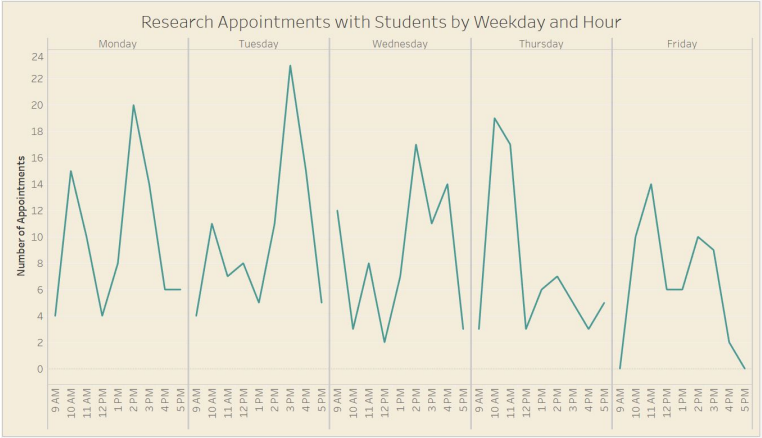

Figure 1: Total research appointments by weekday and hours between 9 AM to 5 PM

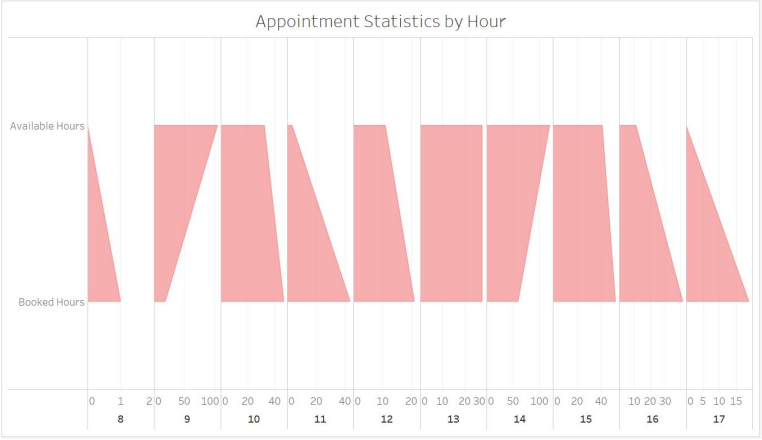

Figure 2: Available hours compared to booked hours by hour of the day

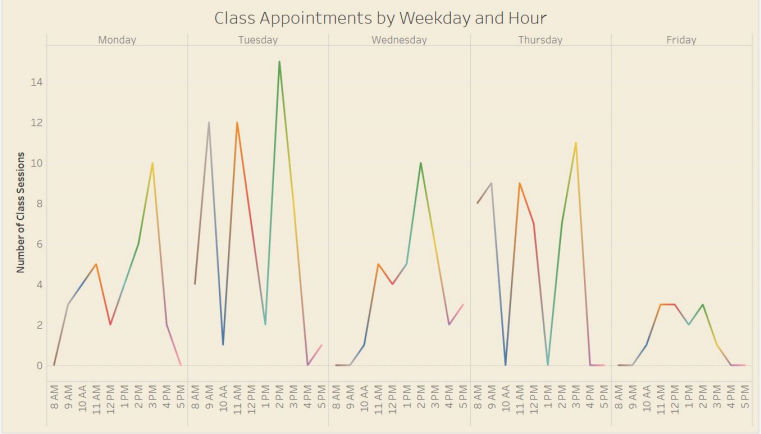

Figure 3: Total class appointments by weekday and hours between 8 AM to 5 PM

uled period of time, and then release the resources and exit the system. The system diagram for the model is shown in Figure 4. The model runs under the assumption that students and classes of a particular subject matter will only use librarians who specialize in that subject matter, or who have previously taught courses in those subjects. We also assume in this case that each of the research librarians have the same schedule every week.

A more detailed view of the model is shown in the block diagram, which is split into two sections. The first section, where the entities are created, is shown in Figure 3. Class entities, student entities, and duty entities are created and assigned a subject and appointment duration. They are routed to different weekdays and times to account for the variation in the demand for appointments throughout the day and the week. The second section, where the entities enter the stations and fully make and attend their appointments, is shown in Figure 6 . Here, the entities are assigned to a specific librarian and leave if the librarian assigned to them are not available. They are then counted and tallied into various categories and then disposed of from the system.

The simulation length is 50 hours with five replications, which imitates one week of the librarians' schedules. The statistics data is collected on the individual librarian utilization, number of student and class appointments made, and appointments lost by patron type.

3.1 Entities and Attributes

Student entities, class entities, and librarian duty entities are created separately. Ten students and classes are generated at each hour, one per librarian. However, there is only a certain probability (dependent on the weekday and hour) that each entity will continue to make an appointment. Applying these probabilities, the entities either remain in the system and attempt to get a librarian or sent out of the system. The remaining entities are then assigned their attributes. Each entity has five attributes, listed in Table 2. These attributes describe the type of patron making the appointment (i.e., an entire class or just one student), the duration of the appointment, the weekday the appointment is held, time and duration of the appointment, the subject matter of the patron's interested, and a set index that allows students in a subject category with multiple librarians to select one randomly, so that there is no preference for a particular librarian over the others in the same field.

The librarian duties are created every hour with a batch size drawn from a discrete trace-driven distribution. These are then sent to each subject station to keep a librarian from

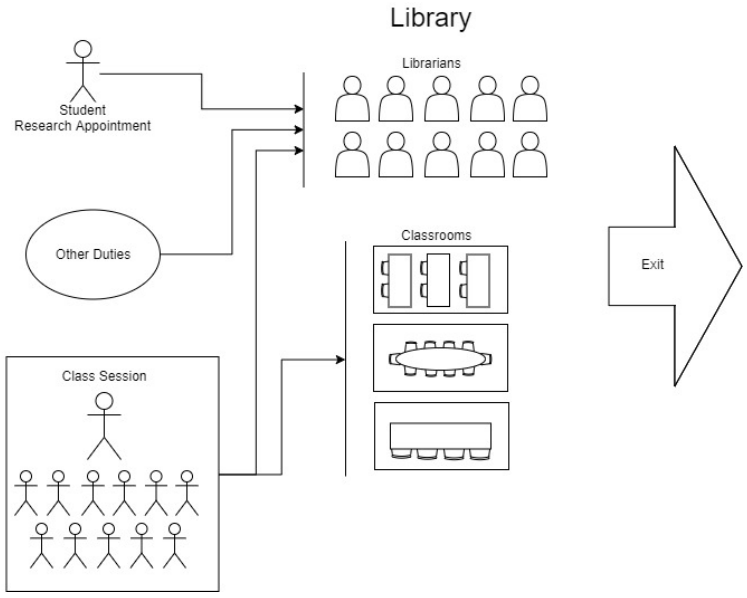

Figure 4: The system diagram for Swem Library. Students and duties only involve the use of a librarian, while classes require both a librarian and a classroom

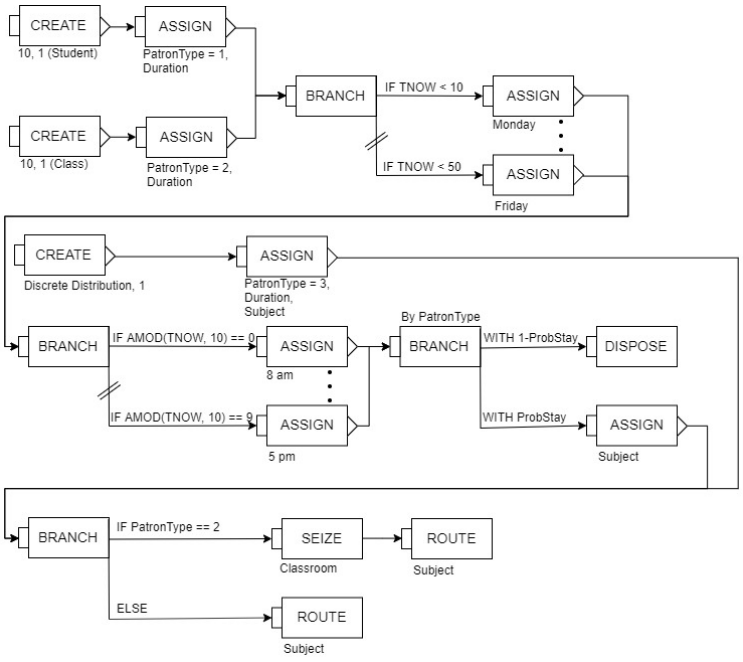

Figure 5: The block diagram for the first section of the model. The vertical ellipses and hashes in the `BRANCH` blocks represent sections where the same branches would be repeated several times for the various weekdays or hours

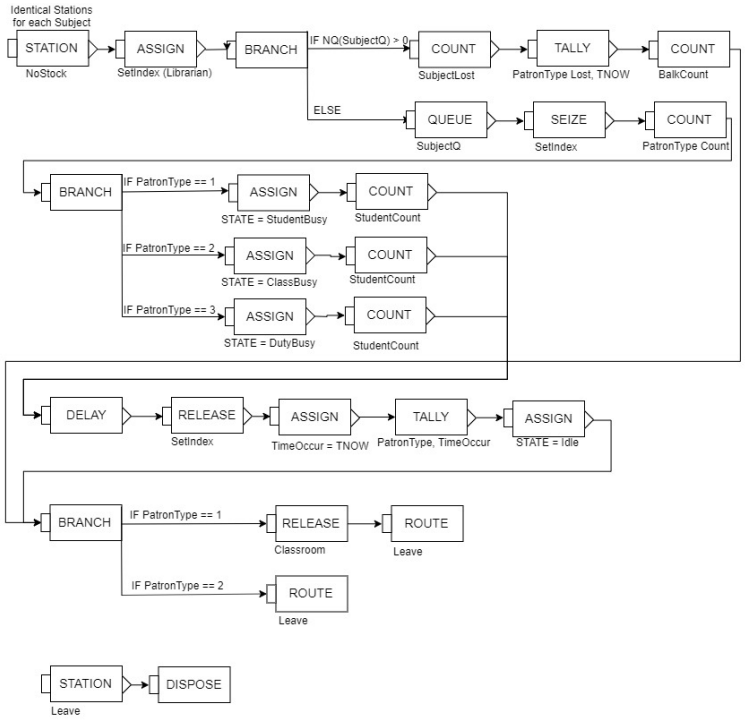

Figure 6: The general block diagram for the second section of the model. One general station type is shown as the stations are the same for each subject. The only variations in the stations lie in the number of librarians available in that subject and the probability that each librarian takes the appointment

being used for an appointment when they are busy. This mimics the librarians having scheduled other meetings or duties outside of teaching classes and students. The duration of each duty varies between half an hour and two hours.

3.2 Model Variables

The variables for the model are the probabilities of the students making an appointment with Poisson distribution and class appointments with random discrete probabilities attached to them. These probabilities vary by weekday and hour; therefore, the variables are distinguished by hour and are a one-dimensional array of probabilities, one for each day of the week. This information is shown in Table 3 and Table 4. Since these probabilities also change with the months, due to rushes at the beginning of the semester to familiarize students with the library and at the end of the semester when final projects are due, the model can also be adjusted for seasonal demand by altering these variables for each month and running the simulation for a particular month.

3.3 Stations Utilized

The model is divided into various stations for each subject. The stations are listed in Table 5. Each of the subject stations follow the same pattern: an entity arrives, is assigned a set index if there are multiple librarians in the subject, and then checks to see if the librarian is busy at that moment. If the librarian is idle, then the entity may enter the queue for the librarian, seize the librarian, add to the counter for each subject appointment made, delay for the appoint-

Table 2: Description of attributes associated with each entity

Attribute	Description	Values
`PatronType`	The type of entity entering the system. These values determine priority in the queue.	0: Student 1: Class 2: Other duty
`Duration`	The appointment duration for each patron type, in hours.	Students: 0.5, 1. Classes: 1, 1.5, 2. Other duties: 1, 1.5, 2.
`TimeOccur`	Time of the appointment occurrence	TNOW - Duration
`Weekday`	The day of the week that the appointment is held.	1: Monday 2: Tuesday 3: Wednesday 4: Thursday 5: Friday
`Subject`	The subject category of interest for each patron. Here, a dummy `Subject` is created for the additional duties of the librarians.	1: Art 2: Education 3: English 4: Languages/Linguistics 5: Natural Sciences 6: Social Sciences 7: Duties
`SetIndex`	An attribute to pick a librarian in each subject. If the subject is only associated with one librarian, pass the librarian resource number. Otherwise, randomly select a librarian in the set.	Librarian resource number.

Table 3: Poisson distribution means of the number of research appointments at each hour of the weekdays

	Monday	Tuesday	Wednesday	Thursday	Friday
9 AM	0.4	0.4	1.0	0.3	0.0
10 AM	1.3	0.8	0.3	1.3	1.0
11 AM	0.8	0.1	0.1	1.0	0.5
12 PM	0.4	0.6	0.2	0.3	0.3
1 PM	0.8	0.5	0.7	0.6	0.6
2 PM	0.6	0.6	1.0	0.4	0.7
3 PM	0.7	1.5	1.0	0.5	0.4
4 PM	0.6	1.0	1.1	0.3	0.2
5 PM	0.6	0.5	0.3	0.5	0.0

Table 4: Probabilities that a class session occurs at a certain hour per weekday

	Monday	Tuesday	Wednesday	Thursday	Friday
8 AM	0.06	0.081	0.025	0.101	0.013
9 AM	0.09	0.149	0.050	0.181	0.053
10 AM	0.05	0.020	0.678	0.022	0.107
11 AM	0.154	0.182	0.110	0.174	0.093
12 PM	0.026	0.169	0.042	0.152	0.08
1 PM	0.077	0.027	0.068	0.029	0.24
2 PM	0.222	0.169	0.186	0.130	0.147
3 PM	0.205	0.149	0.169	0.152	0.267
4 PM	0.077	0.013	0.059	0.022	0
5 PM	0.034	0.041	0.22	0.036	0

ment time, and release the librarian. Entities are not allowed to remain in a queue for a librarian, as there is often not a queue for appointments. Once an appointment is booked, that librarian is marked as busy and unavailable for other entities. The final station consists of only a disposal process, where the entities leave the system.

3.4 Model Alterations

The base model described above was assumed to be the current way of scheduling the research librarians. Further alterations were implemented to determine if certain changes in the system could optimize librarian utility and the number of appointments and class sessions taken.

3.4.1 Redistribution of Task Priorities

One of the first modifications under consideration is altering the priority of the tasks. In the base model, other librarian duties have the highest priority, followed by class sessions. Student research appointments had the lowest priority. The priorities were altered as following:

1. Low Value First (LVF) – students had first priority, classes next, and duties last;
2. First-In-First-Out (FIFO) – the first appointment or duty that reaches a librarian is given first priority.

Although entities are not allowed to queue for a librarian resource in the traditional sense, we use this priority to determine which entity gets higher priority if multiple entities arrive at the same librarian at the exact same time. This should be likely as all of the entities are created on the hour and would arrive at the same time given that they were not disposed of.

3.4.2 Redistribution of Librarians Across Subject Areas

Another change that may affect the librarian utilization is the subject matter expertise of each librarian altered as follows:

1. Restricted Set (Set) – reserving more librarians within the subject areas, i.e. restricting which librarians can help with certain subjects;
2. Universal Set (Universal) – shifting around which librarians can assist with certain subjects. In this case, any librarian has an equally likely chance of helping a student regardless of the subject topic.

4 Study Results

The results for the base model and each of the alterations are presented below. The focus of the analysis will be centered around individual librarian utilization as well as the number of

Table 5: Stations used in the model. The subject stations all follow the same workflow.

Station	Workflow
Art	1. Assign research librarian
Edu	2a. With a certain probability, leave without appointment
Eng	2b. With a certain probability, check if librarian is busy.
Lang	If not busy, seize librarian.
Sci	3. Mark tallies and counter based on `PatronType`
SocSci	4. Delay for appointment time
	5. Release resources
Leave	6. Dispose of entity

appointments made and potential appointments lost.

4.1 Base Model

The graphs of the base model output are given below. Figures 7 and 8 present the data on the number of class and student research appointments held by the librarians. These figures illustrate that social sciences, art, English, and education subjects had similar demand for both class and student sessions. Natural sciences and languages subjects slightly vary among the two types of patrons with languages having higher demand in a class setting while natural science appointments are more common among individual students.

When it comes to the librarian utilization, Candice and Liz have highest utilization rates at 0.6, while Mary and Jessica have the lowest utilization of around 0.2. The goal for the modification of the model would be to balance these discrepancies in the librarian utilization. This data is presented in the Figure 4.2 for comparison with the model alterations mentioned earlier.

Furthermore, Figure 9 shows the number of lost appointments by subject and patron type. Firstly, the number of the lost class sessions exceeds the number of the student appointments. Among the lost class sessions, social sciences, art, languages and natural sciences have the overall highest number of lost appointments, which matches the earlier observation that these subjects were also among those with the highest number of class appointments made. Among the lost student appointments, languages have the highest number, followed by social sciences and art.

These statistics will serve as a reference point to any potential improvements that can be made in terms of balancing the librarian utilization and decreasing the number of the lost potential appointments for both class and student session types.

4.2 Comparison of the Base Model to the Modification Models Outputs

Changes in the task priorities have proved to be inefficient in improving the system. Figure 10 shows that the librarian utilization remained the same for the LVF and FIFO model modifications. Further analysis of the outputs (see Appendix 6.3.3 for the output data) showed that the base model outputs for the number of tasks done and lost also remained the same. Taking into consideration this lack of impact on the improvement of the system, the LVF and FIFO were excluded from the further analysis.

On the other hand, the utilization was affected by the set and universal model alterations. When looking at the set modification model, we can see the following:

1. Alex, Jessica, and Natasha had significant reductions in their utilization;

2. Katherine, Morgan, and Mary slightly increased their utilization; and

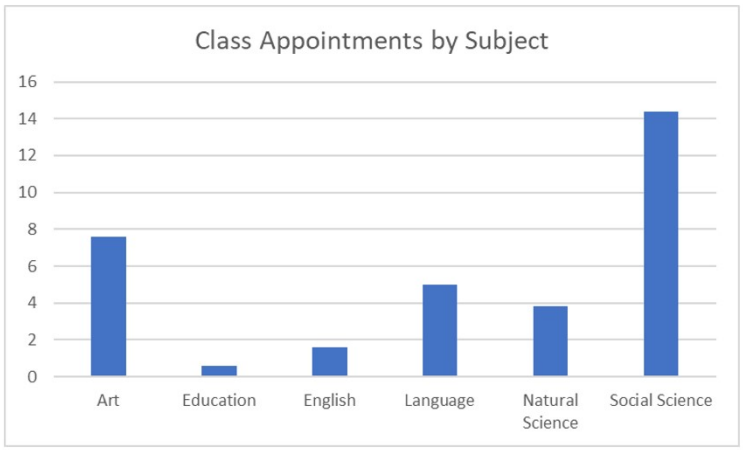

Figure 7: The total number of classes scheduled by subject

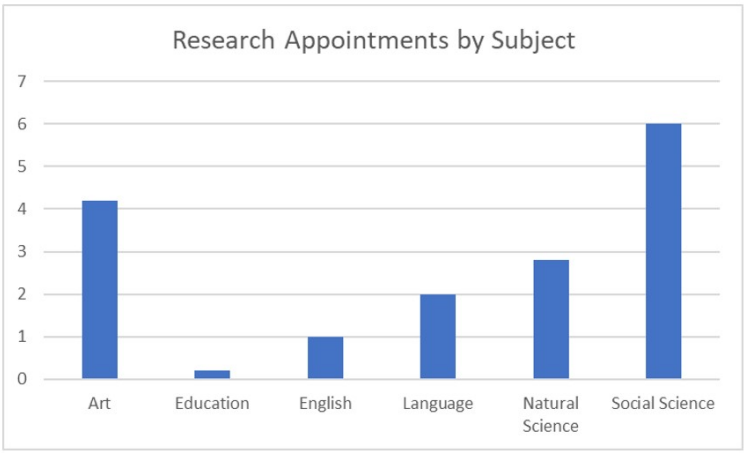

Figure 8: The total number of research appointments scheduled by subject

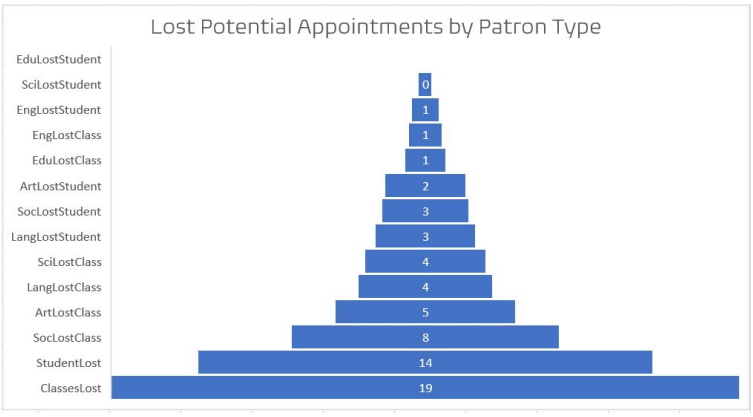

Figure 9: Number of lost potential appointments by patron type and subject

3. utilization of Candice, Liz, Paul, and Kristy remained close to the base model outputs.

We conclude that the set model does not improve the librarian utilization measures as it fails to balance the utilization of all the librarians overall.

Next, the universal modification model shows the following results:

1. Candice's utilization decreases, making the universal model the only model that was able to alter this utilization output;

2. Liz and Paul have a non-significant utilization reduction, but since these do not exceed 0.70 utilization mark, they do not pose concerns about the imbalanced utilization;

3. Katherine and Morgan have slightly higher utilization, which also fall below the 0.70 mark; and

4. Alex, Jessica, Natasha, Kristy, and Mary have higher utilization, which proves to balance the overall librarian utilization.

Therefore, the universal set model appears to perform best at balancing the librarian utilization.

Figure 11 demonstrates the total number of jobs done and lost by duty type for the base, set, and universal models. When compared to the base model, the number of classes served remains the same for the set model while this number decreases by 10% for the universal model. The number of students served decreased for both modified models with the universal model having the lowest observed value. The number of duty counts taken on by the librarians decrease, but not significantly, for the set model and increased by 24% for the universal model. When looking at the lost counts by job type, we see that while the overall librarian utilization has increased for the universal model, this improvement happened at the cost of serving less classes and students and distributing other duties more evenly.

Figure 12 extends the information illustrated in Figure 11 by breaking down the lost potential appointments by subject, patron type, and model. The number of class sessions lost in social sciences, art, and languages are universally high. Yet, the number of lost social science classes is 10% higher for the universal model and 12% lower for the set model. The number of lost classes in English and art see a notable increase in the set model. When it comes to lost student appointments, the number of social science, language, and natural science appointments lost in the universal model exceeded the base model performance. Hence, with no significant losses in the class and student appointment losses, except with a decrease in the number of social science classes served, the set model appears to outperform other models.

4.3 Future Directions and Extensions

The base model and the alterations showed rather interesting results. However, there are some major assumptions made regarding the system operations and data distributions. There is a huge gap in the data regarding the additional duty distribution of the librarians which might be a crucial factor in improving the performance of both models. Additional information on the actual demand for appointments at a certain hour would also be beneficial for the model. Increasing the level of detail of data collection as well as better modeling the intricacies of the system would lead to a more accurate model and may change model output results.

Potential additions to the model include expanding the model to account for varying demands for different appointments across the academic year, including statistics for classroom usage, and fitting the model with more specific tasks and time partitions for each librarian.

The demand for class appointments tends to peak around the start of each semester, when students are new to topics or to college in gen-

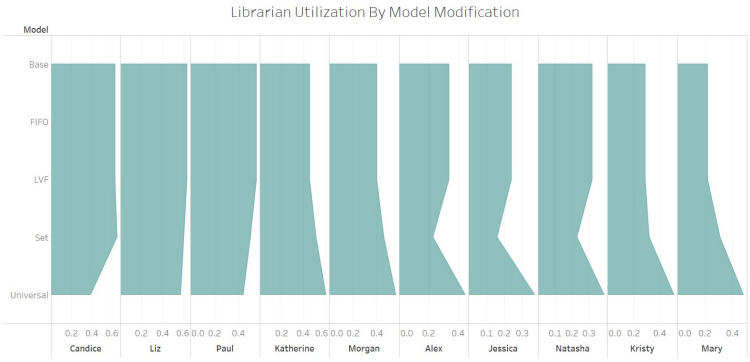

Figure 10: Librarian Utilization by Model Modification

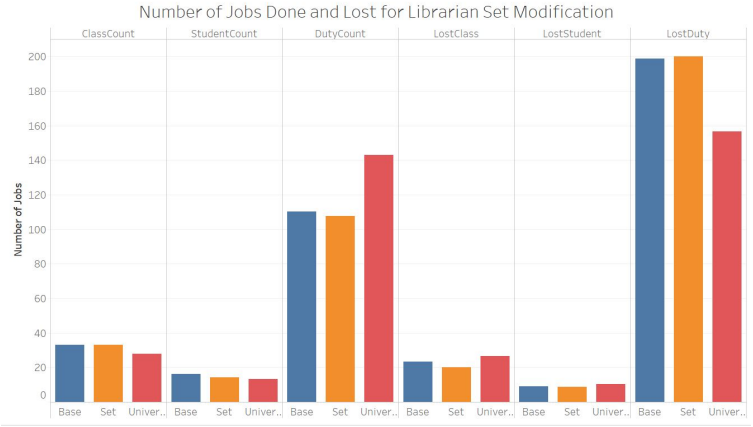

Figure 11: The Total Number of Jobs Done and Lost for Librarian Set Modifications

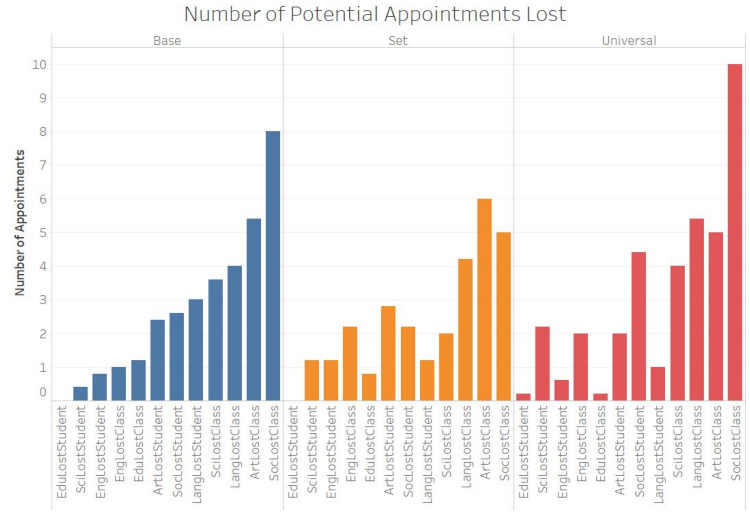

Figure 12: Number of Potential Appointments Lost by Subject and Model Modification

eral. Intuitively, this makes sense as a professor is likely to devote an entire class at the beginning of the semester towards research and preparing students for future projects and papers. A similar effect may happen with the student research appointments and other duties. The model currently simulates five weeks of librarian scheduling, approximately one month. By altering the variables at certain points in the year, we can potentially include this seasonal pattern in our simulation in addition to the noise from other sources.

Another point of interest in the simulation is the classroom usage. Professors can request which classroom they would like to use for their class sessions, as each classroom has slightly different amenities and features. Rather than simply treating each classroom as the same type of resource, various probabilities for the use of each classroom could be included as they may be influential in how the class sessions are scheduled.

Finally, increasing the level of detail and amount of specificity in describing the other librarian duties may also enhance the model. We first assumed that the other duties are of first priority to the librarians, which shows that they would have already saved that block of time for meetings or other tasks. However, there may be some situations where a class or appointment must happen and the librarians must rearrange their schedules to accommodate these emergency-like appointments. This is also evident in the data, as some librarians had more appointments scheduled than they had originally put as available in their schedule. Incorporating the probability that a student forgets to come to their research appointment or that other library events require last minute help will also add stochasticity and likely improve how the well the model resembles the actual system.

5 Conclusions

After performing the analysis of the data and running multiple models to compare the outputs under varying assumptions we present the following conclusions. All of the librarians have below 70% utilization after altering the model under universality assumption of the librarians' subject matter expertise. This model modification also seems to be the most efficient in balancing the librarian utilization. However, when considering the number of classes and students served versus those lost, this model actually appears to perform poorly. On the other hand, the restricted set model under-performs in terms of balancing the overall librarian utilization while improving the system in terms of the number of classes and students served. Hence, depending on the type of tasks the library considers to be higher priority, the universal model can be considered a better performing model in terms of increased performance of other duties and a more even distribution of the librarian utilization. However, if the priority is to serve as many students and classes as possible, then the set model would be a better fit. The optimal model is dependent on the needs and intentions of the librarians.

6 Appendix

6.1 Data

Table 6: The subject categories in which the librarians were placed for the Restricted Model Modification

Subject	**Librarian Members**
Art	Morgan
Education	Paul
English	Liz
Languages	Paul, Liz
Natural Sciences	Kristy, Katherine
Social Sciences	Candice, Alex, Mary, Jessica, Natasha

6.2 Results

Table 7: Librarian Utilization outputs by model

Model	Alex	Candice	Jessica	Katherine	Kristy	Liz	Mary	Morgan	Natasha	Paul
Base	0.34	0.63	0.24	0.46	0.29	0.63	0.22	0.40	0.32	0.55
Set	0.23	0.65	0.16	0.52	0.32	0.60	0.31	0.46	0.23	0.50
Universal	0.45	0.39	0.37	0.61	0.51	0.57	0.48	0.56	0.39	0.44
LVF	0.34	0.63	0.24	0.46	0.29	0.63	0.22	0.40	0.32	0.55
FIFO	0.34	0.63	0.24	0.46	0.29	0.63	0.22	0.40	0.32	0.55

Table 8: Number of jobs done by model and duty type

Model	Class Count	Duty Count	Student Count	**Total**
Base	33	110	16	**159**
Set	33	108	14	**155**
Universal	30	136	12	**178**
LVF	33	110	16	**159**
FIFO	33	110	16	**159**

Table 9: Number of the class session held by model and subject

Model	Art	Education	English	Language	Natural Science	Social Science	**Total**
Base	8	1	2	5	4	14	**33**
Set	5	1	3	3	6	16	**33**
Universal	7	1	2	4	4	12	**30**
LVF	8	1	2	5	4	14	**33**
FIFO	8	1	2	5	4	14	**33**

Table 10: Number of student appointments held by model and subject

Model	Art	Education	English	Language	Natural Science	Social Science	**Total**
Base	4	0	1	2	3	6	**16**
Set	4	0	1	1	3	6	**14**
Universal	3	0	1	2	1	4	**12**
LVF	4	0	1	0	3	6	**14**
FIFO	4	0	1	2	3	6	**16**

Table 11: Number of lost jobs by subject and patron type

Counters	Base	LVF	FIFO	Restricted Set	Universal Set
ArtLostStudent	2	2	2	3	2
ArtLostClass	5	5	5	6	5
ArtLostDuty	11	11	11	13	12
EduLostStudent	0	0	0	0	0
EduLostClass	1	1	1	1	0
EduLostDuty	20	20	20	14	12
EngLostStudent	1	1	1	1	1
EngLostClass	1	1	1	2	2
EngLostDuty	20	20	20	18	11
LangLostStudent	3	3	3	1	1
LangLostClass	4	4	4	4	5
LangLostDuty	36	36	36	33	23
SciLostStudent	0	0	0	1	2
SciLostClass	4	4	4	2	4
SciLostDuty	21	21	21	23	19
SocLostStudent	3	3	3	2	4
SocLostClass	8	8	8	5	10
SocLostDuty	90	90	90	100	79
StudentLost	**9**	**9**	**9**	**9**	**10**
ClassLost	**23**	**23**	**23**	**20**	**27**
DutyLost	**199**	**199**	**199**	**200**	**157**

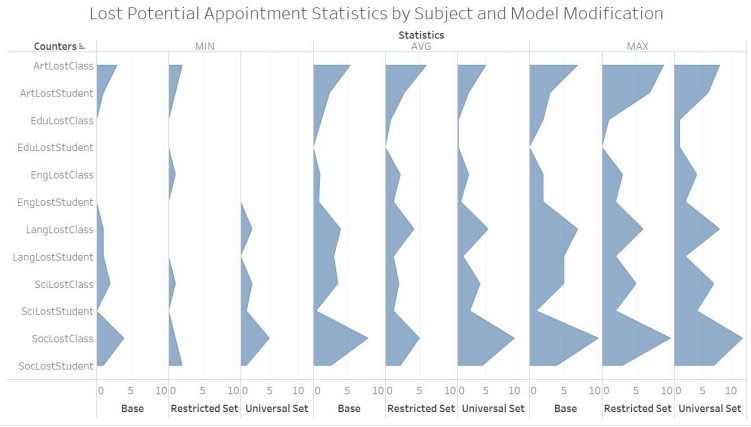

Figure 13: Lost Potential Appointment Statistics by Subject and Model Modification

6.3 Model Code

6.3.1 Base Model File

```
BEGIN;

Class    CREATE, 10, : 1;                                    ! Create 10 class entities per hour
         ASSIGN: PatronType = 2:
                 Duration = DISC(0.271, 1, 0.943, 1.5, 1, 2):    ! Assign duration to a class
                 NEXT(Day);                                  ! Send the entity to a weekday


Student  CREATE, 10, : 1;                                    ! Create 10 student entities per hour
         ASSIGN: PatronType = 1:
                 Duration = (0.01, 0.5, 1, 1):               ! Assign duration to a research appt
                 NEXT(Day);                                  ! Send the entity to a weekday


         ! Other duties aside from classes and appts that librarians may have come up
         ! 0- none of the librarians are assinged other duties, 10- all are busy with other duty
Duties   CREATE, DISC(0.01, 0, 0.03, 1, 0.06, 2, 0.1, 3, 0.2, 4, 0.35, 5,
                      0.55, 6, 0.8, 7, 0.9, 8, 0.95, 9, 1, 10), : 1;

         ASSIGN: PatronType = 3:                             ! These get highest priority
                 Subject = 7:                                ! Dummy subject to assign other duties
                 Duration = DISC(0.35, 1, 0.675, 1.5, 1, 2.0);
                 BRANCH, 1: WITH, 1/13, Art:                 ! Each duty gets assigned to a subject
                            WITH, 1/13, Edu:                 ! number of librarians per subject divided
                            WITH, 1/13, Eng:                 ! by the total number of librarians
                            WITH, 2/13, Lang:                ! total number of librarians = 10 + 3
                            WITH, 2/13, Sci:                 ! extra 3 is for multi subject librarians
                            WITH, 6/13, Soc;


Day      BRANCH, 1: IF, TNOW < 10, Monday:                  ! Assign weekdays in 10-hour increments
                    IF, TNOW < 20, Tuesday:                 ! First 10 hours are Monday, etc.
                    IF, TNOW < 30, Weds:                    ! Send to appropriate weekday block
```

```
                    IF, TNOW < 40, Thurs:
                    ELSE, Friday;

Monday   ASSIGN: Weekday = 1: NEXT(Time);                    ! Assign weekdays Monday (1) - Friday (5)
Tuesday  ASSIGN: Weekday = 2: NEXT(Time);
Weds     ASSIGN: Weekday = 3: NEXT(Time);
Thurs    ASSIGN: Weekday = 4: NEXT(Time);
Friday   ASSIGN: Weekday = 5: NEXT(Time);

Time     BRANCH, 1: IF, AMOD(TNOW, 10) == 0, 8am:            ! determine hour of day using modulus
                    IF, AMOD(TNOW, 10) == 1, 9am:            ! if mod of TNOW is 0 send to 8 am, etc.
                    IF, AMOD(TNOW, 10) == 2, 10am:
                    IF, AMOD(TNOW, 10) == 3, 11am:
                    IF, AMOD(TNOW, 10) == 4, 12pm:
                    IF, AMOD(TNOW, 10) == 5, 1pm:
                    IF, AMOD(TNOW, 10) == 6, 2pm:
                    IF, AMOD(TNOW, 10) == 7, 3pm:
                    IF, AMOD(TNOW, 10) == 8, 4pm:
                    ELSE, 5pm;


8am      BRANCH, 1: IF, PatronType == 1, 8amS:                ! send students 8am block
                    ELSE, 8amC;                               ! send class 8am block

9am      BRANCH, 1: IF, PatronType == 1, 9amS:
                    ELSE, 9amC;

10am     BRANCH, 1: IF, PatronType == 1, 10amS:
                    ELSE, 10amC;

11am     BRANCH, 1: IF, PatronType == 1, 11amS:
                    ELSE, 11amC;

12pm     BRANCH, 1: IF, PatronType == 1, 12pmS:
                    ELSE, 12pmC;

1pm      BRANCH, 1: IF, PatronType == 1, 1pmS:
                    ELSE, 1pmC;

2pm      BRANCH, 1: IF, PatronType == 1, 2pmS:
                    ELSE, 2pmC;

3pm      BRANCH, 1: IF, PatronType == 1, 3pmS:
                    ELSE, 3pmC;

4pm      BRANCH, 1: IF, PatronType == 1, 4pmS:
                    ELSE, 4pmC;

5pm      BRANCH, 1: IF, PatronType == 1,5pmS:
                    ELSE, 5pmC;

8amS     BRANCH, 1: WITH, 1-Balk8S(Weekday), Out:
                    WITH, Balk8S(Weekday), Att;

9amS     ASSIGN: ProbStay = POIS(Balk9S(Weekday))/10: NEXT(SysBr);   ! Assign prob of staying for each hour
10amS    ASSIGN: ProbStay = POIS(Balk10S(Weekday))/10: NEXT(SysBr);
```

```
11amS    ASSIGN: ProbStay = POIS(Balk11S(Weekday))/10: NEXT(SysBr);
12pmS    ASSIGN: ProbStay = POIS(Balk12S(Weekday))/10: NEXT(SysBr);
1pmS     ASSIGN: ProbStay = POIS(Balk1S(Weekday))/10: NEXT(SysBr);
2pmS     ASSIGN: ProbStay = POIS(Balk2S(Weekday))/10: NEXT(SysBr);
3pmS     ASSIGN: ProbStay = POIS(Balk3S(Weekday))/10: NEXT(SysBr);
4pmS     ASSIGN: ProbStay = POIS(Balk4S(Weekday))/10: NEXT(SysBr);
5pmS     ASSIGN: ProbStay = POIS(Balk5S(Weekday))/10: NEXT(SysBr);


8amC    ASSIGN: ProbStay = Balk8C(Weekday): NEXT(SysBr);
9amC    ASSIGN: ProbStay = Balk9C(Weekday): NEXT(SysBr);
10amC   ASSIGN: ProbStay = Balk10C(Weekday): NEXT(SysBr);
11amC   ASSIGN: ProbStay = Balk11C(Weekday): NEXT(SysBr);
12pmC   ASSIGN: ProbStay = Balk12C(Weekday): NEXT(SysBr);
1pmC    ASSIGN: ProbStay = Balk1C(Weekday): NEXT(SysBr);
2pmC    ASSIGN: ProbStay = Balk2C(Weekday): NEXT(SysBr);
3pmC    ASSIGN: ProbStay = Balk3C(Weekday): NEXT(SysBr);
4pmC    ASSIGN: ProbStay = Balk4C(Weekday): NEXT(SysBr);
5pmC    ASSIGN: ProbStay = Balk5C(Weekday): NEXT(SysBr);


SysBr   BRANCH, 1: WITH, 1 - ProbStay, Out:                    ! With prob of disposal by weekday, exit
                   WITH, ProbStay, Att;                        ! else send to get subject assignment


! Subject Divisions: 1 - Art; 2 - Edu; 3- Eng; 4- Lang; 5 - STEM; 6- SocialSci
Att      ASSIGN: Subject = DISC(0.240, 1, 0.255, 2, 0.334, 3, 0.462, 4, 0.62, 5, 1, 6);
         BRANCH, 1: IF, PatronType == 2, Room:
                    ELSE, GetLib;

Room     SEIZE: Classroom: NEXT(GetLib);                       ! seize classroom and get librarian

GetLib   ROUTE: 0, Subject;                                    ! delay 0 hours, send to subject stations

! Art subject station
Art      STATION, Art;
         BRANCH, 1: IF, PatronType == 1, ArtS:
                  IF, PatronType == 2, ArtC:
                  ELSE, ArtD;

ArtS    ASSIGN: SetIndex = 1: NEXT(ArtB);                      ! Get Morgan (1st resource) as a librarian

! Prob of getting a different librarian for the class
ArtC    ASSIGN: SetIndex = DISC(0.081, 1, 0.189, 2, 0.324, 3, 0.568, 5,
                               0.649, 6, 0.676, 7, 0.784, 8, 0.811, 9, 1, 10):
                NEXT(ArtB);
ArtD    ASSIGN: SetIndex = 1: NEXT(ArtB);                      ! Get Morgan (1st resource) as a librarian

ArtB    BRANCH, 1: IF, NR(SetIndex) > 0, ArtL:                 ! if the librarians are busy dispose students
                   ELSE, Art2;                                 ! else get an appointment
Art2     QUEUE, ArtQ;                                          ! send to queue
         SEIZE: SetIndex;                                     ! Seize the assigned librarian
         COUNT: PatronType, 1;                                 ! count
         BRANCH, 1: IF, PatronType == 1, A1:
                    IF, PatronType == 2, A2:
                    ELSE, A3;
```

```
ArtL     COUNT: ArtLost, 1;
         TALLY: PatronType + 6, TNOW:
                NEXT(Balk);                                  ! count entities that didn't get an appointment

Edu      STATION, Education;
         ASSIGN: SetIndex = DISC(0.5, 2, 1, 3);              ! Get Paul or Liz (2nd & 3rd resources)
         BRANCH, 1: IF, NR(SetIndex) > 0, EduL:              ! if the librarians are busy dispose students
                    ELSE, Edu2;                              ! else get the appointment

Edu2     QUEUE, EduQ;
         SEIZE: SetIndex;
         COUNT: PatronType+3, 1;
         BRANCH, 1: IF, PatronType == 1, A1:
                    IF, PatronType == 2, A2:
                    ELSE, A3;

EduL     COUNT: EduLost, 1;
         TALLY: PatronType + 9, TNOW:  NEXT(Balk);

Eng      STATION, English;
         BRANCH, 1: IF, PatronType == 1, EngS:
                   IF, PatronType == 2, EngC:
                   ELSE, EngD;

! Assign probabilities of getting a librarian in the subject
EngS    ASSIGN: SetIndex = DISC(0.2, 2, 0.45, 3, 0.55, 5, 0.7, 8,  0.9, 9, 1, 10): NEXT(EngB);
EngC    ASSIGN: SetIndex = DISC(0.048, 1, 0.143, 2, 0.286, 3, 0.476, 5, 0.667, 8, 0.762, 9, 1, 10):
                NEXT(EngB);
EngD    ASSIGN: SetIndex = 3: NEXT(EngB);

EngB    BRANCH, 1: IF, NR(SetIndex) > 0, EngL:
                    ELSE, Eng2;

Eng2     QUEUE, Engl1Q;
         SEIZE: SetIndex;
         COUNT: PatronType+6, 1;
         BRANCH, 1: IF, PatronType == 1, A1:
                    IF, PatronType == 2, A2:
                    ELSE, A3;

EngL     COUNT: EngLost, 1;
         TALLY: PatronType + 12, TNOW: NEXT(Balk);


Lang     STATION, Language;
         BRANCH, 1: IF, PatronType == 1, LangS:
                    IF, PatronType == 2, LangC:
                    ELSE, LangD;

LangS    ASSIGN: SetIndex = DISC(0.7, 2, 1, 3): NEXT(LangB);
LangC    ASSIGN: SetIndex = DISC(0.063, 1, 0.219, 2, 0.406, 3, 0.5, 5, 0.688, 6,
                                 0.750, 7, 0.813, 8, 0.906, 9, 1, 10): NEXT(LangB);
LangD    ASSIGN: SetIndex = DISC(0.5, 2, 1, 3): NEXT(LangB);

LangB    BRANCH, 1: IF, NR(SetIndex) > 0, LangL:
```

```
                  ELSE, Lang2;
Lang2    QUEUE, LangQ;
         SEIZE: SetIndex;
         COUNT: PatronType+9, 1;
         BRANCH, 1: IF, PatronType == 1, A1:
                  IF, PatronType == 2, A2:
                  ELSE, A3;

LangL    COUNT: LangLost, 1;
         TALLY: PatronType + 15, TNOW: NEXT(Balk);

Sci      STATION, Science;
         BRANCH, 1: IF, PatronType == 1, SciS:
                IF, PatronType == 2, SciC:
                ELSE, SciD;

SciS     ASSIGN: SetIndex = DISC(0.2, 4, 1, 5): NEXT(SciB);
SciC     ASSIGN: SetIndex = DISC(0.091, 1, 0.182, 2, 0.318, 3, 0.455, 5, 0.5, 6, 0.727, 8, 0.864, 9, 1, 10):
                 NEXT(SciB);
SciD     ASSIGN: SetIndex = DISC(0.8, 4, 1, 5): NEXT(SciB);

SciB         BRANCH, 1: IF, NR(SetIndex) > 0, SciL:
                        ELSE, Sci2;

Sci2     QUEUE, SciQ;
         SEIZE: SetIndex;
         COUNT: PatronType+12, 1;
         BRANCH, 1: IF, PatronType == 1, A1:
                  IF, PatronType == 2, A2:
                  ELSE, A3;

SciL     COUNT: SciLost, 1;
         TALLY: PatronType + 18, TNOW: NEXT(Balk);


Soc      STATION, SocialSci;
         BRANCH,1:  IF, PatronType == 2, SocC:
                IF, PatronType == 1, SocS:
                  ELSE, SocD;


SocS     ASSIGN: SetIndex = DISC(0.2, 3, 0.2, 6, 0.3, 7, 0.6, 8, 0.7, 9, 1, 10): NEXT(SocB);
SocC     ASSIGN: SetIndex = DISC(0.051, 1, 0.256, 2, 0.321, 3, 0.333, 4, 0.5, 5,
                                 0.526, 6, 0.641, 7, 0.833, 8, 0.923, 9, 1, 10): NEXT(SocB);
SocD     ASSIGN: SetIndex = DISC(0.05, 3, 0.75, 6, 0.85, 7, 0.9, 8, 0.95, 9, 1, 10): NEXT(SocB);

SocB     BRANCH, 1: IF, NR(SetIndex) > 0, SocL:
                  ELSE, Soc2;

Soc2     QUEUE, SocQ;
         SEIZE: SetIndex;
         COUNT: PatronType+15, 1;
         BRANCH, 1: IF, PatronType == 1, A1:
                  IF, PatronType == 2, A2:
                  ELSE, A3;
```

```
SocL     COUNT: SocLost, 1;
         TALLY: PatronType + 3, TNOW: NEXT(Balk);

! Code to animate the busy states of the librarians
A1       ASSIGN: STATE(SetIndex) = StudentBusy;
         COUNT:  StudentCount: NEXT(Hold);
A2       ASSIGN: STATE(SetIndex) = ClassBusy;
         COUNT:  ClassCount: NEXT(Hold);
A3       ASSIGN: STATE(SetIndex) = DutyBusy;
         COUNT:  DutyCount: NEXT(Hold);


Hold     DELAY: Duration;                                    ! Delay for the duration assigned
         RELEASE: SetIndex;
         ASSIGN: TimeOccur = TNOW - Duration;
         TALLY: PatronType, TimeOccur;                       ! Tally time an event occurs by job type
         ASSIGN: STATE(SetIndex) = Idle: NEXT(AppOver);      ! release the librarian, send to AppOver block

AppOver  BRANCH, 1: IF, PatronType == 2, Over:               ! If class send to Over block, else to dispose
         ELSE, Leave;


Balk     COUNT: BalkCount,1;
         BRANCH, 1: IF, PatronType == 2, Over:
                    ELSE, Leave;

Over     RELEASE: Classroom: NEXT(Exiting);                  ! Release the classroom and send to leave

Exiting  ROUTE: 0, Leave;
Leave    STATION, Leave;
Out      DISPOSE;                                            ! Entities exit the system
```

6.3.2 Base Experiment File

```
BEGIN;
PROJECT, Librarian Simulation, Cassie and Leyli;

ATTRIBUTES: PatronType:                          ! 2- Duties; 1 - Class; 0 - Student descending by Priority
            Subject:                             ! 1 - Art; 2 - Edu; 3- Eng; 4- Lang;
                                                 ! 5 - STEM; 6- SocialSci, 7- Other Duties;
            Duration:                            ! Classes last 1, 1.5, 2 hours
                                                 ! Student appointments last 0.5, 1 hours
            Weekday:                             ! 1- Monday; 2-Tuesday; ...
            ProbStay:                            ! Probability of staying in the system and getting an appt
            SetIndex, 1:                         ! Randomly pick a librarian using random #
            TimeOccur;

VARIABLES: Balk8S(5), 0, 0, 0, 0, 0:             ! Prob of making a research appt by Weekday at 8 am
           Balk9S(5), 0.4, 0.4, 1, 0.3, 0.00001:      ! P(appointment) at 9 am
           Balk10S(5), 1.33, 0.778, 0.3, 1.25, 1:        ! same for each hour until 5 pm
           Balk11S(5), 0.778, 0.125, 0.125, 1, 0.5:
           Balk12S(5), 0.4, 0.556, 0.2, 0.3, 0.333:
           Balk1S(5),  0.8, 0.5, 0.7, 0.6, 0.6:
           Balk2S(5),  0.6, 0.625, 1, 0.444, 0.667:
```

```
          Balk3S(5),  0.714, 1.5, 1, 0.5, 0.375:
          Balk4S(5),  0.6, 1, 1.11, 0.3, 0.2:
          Balk5S(5),  0.6, 0.5, 0.3, 0.5, 0.00001:

! Prob of making a class appointment by Weekday at 8 am
          Balk8C(5),  0.06, 0.081, 0.025, 0.101, 0.013:
          Balk9C(5),  0.09, 0.149, 0.050, 0.181, 0.053:          ! P(appointment) at 9 am
          Balk10C(5), 0.05, 0.02, 0.678, 0.022, 0.107:           ! same for each hour until 5 pm
          Balk11C(5), 0.154, 0.182, 0.110, 0.174, 0.093:
          Balk12C(5), 0.026, 0.169, 0.042, 0.152, 0.08:
          Balk1C(5),  0.077, 0.027, 0.068, 0.029, 0.24:
          Balk2C(5),  0.222, 0.169, 0.186, 0.130, 0.147:
          Balk3C(5),  0.205, 0.149, 0.169, 0.152, 0.267:
          Balk4C(5),  0.077, 0.013, 0.059, 0.022, 0:
          Balk5C(5),  0.034, 0.041, 0.22, 0.036, 0;



          ! Declare 10 librarians as resources by names
          RESOURCES: 1, Morgan,,UsageState-:        ! Art; other library appt/s
                     2, Paul,,UsageState-:          ! Edu, Lang, ?Social
                     3, Liz,,UsageState-:           ! Social, English, Languages; Universal
                     4, Katherine,,UsageState-:     ! Science; ILL
                     5, Kristy,,UsageState-:        ! Science; ?Universal
                     6, Candice,,UsageState-:       ! Social
                     7, Alex,,UsageState-:          ! ?Psyc?
                     8, Natasha,,UsageState-:       ! Social
                     9, Mary,,UsageState-:          ! Social; ?Universal
                     10, Jessica,,UsageState-:      ! Social; ?Universal
                     Classroom, 4;                  ! Declare 4 classroom resources

QUEUES:   1, ArtQ, HVF(PatronType):                 ! High priotity entities go first
          2, EduQ, HVF(PatronType):                 ! Priority determined by PatronType
          3, EnglQ, HVF(PatronType):
          4, LangQ, HVF(PatronType):
          5, SciQ, HVF(PatronType):
          6, SocQ, HVF(PatronType);


DSTATS:   NQ(1), Art Queue:                         ! Check to make sure that there's no one in queues
          NQ(2), Education Queue:                   ! we can't have a queue for an appointment.
          NQ(3), English Queue:
          NQ(4), Language Queue:
          NQ(5), Science Queue:
          NQ(6), Social Sci Queue:
          NR(1), Morgan Util., "MorganHistory.dat":   ! Get stats for number of busy resources
          NR(2), Paul Util., "PaulHistory.dat":
          NR(3), Liz Util., "LizHistory.dat":
          NR(4), Katherine Util., "KatherineHistory.dat":
          NR(5), Kristy Util., "KristyHistory.dat":
          NR(6), Candice Util., "CandiceHistory.dat":
          NR(7), Alex Util., "AlexHistory.dat":
          NR(8), Natasha Util., "NatashaHistory.dat":
          NR(9), Mary Util., "MaryHistory.dat":
          NR(10), Jessica Util., "JessicaHistory.dat";
```

```
! Counts for the number of students, classes, duties assigned and lost by subject
COUNTERS: 1, ArtStudent:                          ! Number of "lost" appointments
          2, ArtClass:                            ! Number of appointments for each subject
          3, ArtDuty:

          4, EduStudent:
          5, EduClass:
          6, EduDuty:

          7, EngStudent:
          8, EngClass:
          9, EngDuty:

          10, LangStudent:
          11, LangClass:
          12, LangDuty:

          13, SciStudent:
          14, SciClass:
          15, SciDuty:

          16, SocStudent:
          17, SocClass:
          18, SocDuty:

! Number of unsuccessful appointments for each subject
          19, ArtLostStudent:
          20, ArtLostClass:
          21, ArtLostDuty:

          22, EduLostStudent:
          23, EduLostClass:
          24, EduLostDuty:

          25, EngLostStudent:
          EngLostClass:
          EngLostDuty:

          28, LangLostStudent:
          LangLostClass:
          LangLostDuty:

          31, SciLostStudent:
          SciLostClass:
          SciLostDuty:

          34, SocLostStudent:
          SocLostClass:
          SocLostDuty:

          StudentCount:
          ClassCount:
          DutyCount:
          BalkCount;

TALLIES:  1, StudentTimeIn, "StudentIn.dat":    ! Track the times at which appts were lost
```

```
          2, ClassTimeIn, "ClassIn.dat":
          3, DutyTimeIn, "DutyIn.dat":

          4, SocLostTimeStudent, "SocStudentLostTime.dat":
          SocLostTimeClass, "SocClassLostTime.dat":
          SocLostTimeDuty:


          7, ArtLostTimeStudent, "ArtStudentLostTime.dat":
          ArtLostTimeClass, "ArtClassClassLostTime.dat":
          ArtLostTimeDuty:

          10, EduLostTimeStudent, "EduStudentLostTime.dat":
          EduLostTimeClass, "EduClassLostTime.dat":
          EduLostTimeDuty:

          13, EngLostTimeStudent, "EngStudentLostTime.dat":
          EngLostTimeClass, "EngClassLostTime.dat":
          EngLostTimeDuty:

          16, LangLostTimeStudent, "LangStudentLostTime.dat":
          LangLostTimeClass, "LangClassLostTime.dat":
          LangLostTimeDuty:

          19, SciLostTimeStudent, "SciStudentLostTime.dat":
          SciLostTimeClass, "SciClassLostTime.dat":
          SciLostTimeDuty;

REPLICATE, 5, 0, 50,,,,,,,Hours;                  ! 5 weeks, 50 hours worth

STATIONS: 1, Art:                                  ! stations for each subject type
          2, Education:
          3, English:
          4, Language:
          5, Science:
          6, SocialSci:
          7, Leave;                                 ! station for sending entities off

! states of the librarians for the animation
STATESETS: UsageState, StudentBusy, ClassBusy, DutyBusy, Idle(Idle);

END;
```

6.3.3 Base Output File

The following output is for one replication of the model run.

```
                              ARENA Simulation Results
                        Information Technology - License: 2957005765

                                   Summary for Replication 1 of 5

Project: Librarian Simulation                                  Run execution date :12/ 4/2019
Analyst: Cassie and Leyli                                      Model revision date:12/ 4/2019
```

Replication ended at time : 50.0 Hours
Base Time Units: Hours

TALLY VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Observations
StudentTimeIn	29.250	(Insuf)	9.0000	47.000	16
ClassTimeIn	23.378	(Insuf)	.00000	47.000	37
DutyTimeIn	24.096	(Insuf)	.00000	49.000	104
SocLostTimeStudent	20.500	(Insuf)	14.000	27.000	2
SocLostTimeClass	34.444	(Insuf)	22.000	47.000	9
SocLostTimeDuty	23.840	(Insuf)	.00000	50.000	94
ArtLostTimeStudent	2.0000	(Insuf)	2.0000	2.0000	2
ArtLostTimeClass	22.166	(Insuf)	7.0000	45.000	6
ArtLostTimeDuty	21.777	(Insuf)	4.0000	43.000	9
EduLostTimeStudent	--	--	--	--	0
EduLostTimeClass	31.000	(Insuf)	31.000	31.000	1
EduLostTimeDuty	22.259	(Insuf)	1.0000	45.000	27
EngLostTimeStudent	--	--	--	--	0
EngLostTimeClass	11.000	(Insuf)	11.000	11.000	1
EngLostTimeDuty	21.090	(Insuf)	2.0000	49.000	22
LangLostTimeStudent	24.800	(Insuf)	1.0000	47.000	5
LangLostTimeClass	19.857	(Insuf)	7.0000	40.000	7
LangLostTimeDuty	28.431	(Insuf)	.00000	50.000	44
SciLostTimeStudent	--	--	--	--	0
SciLostTimeClass	26.400	(Insuf)	3.0000	50.000	5
SciLostTimeDuty	26.764	(Insuf)	6.0000	50.000	17

DISCRETE-CHANGE VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Final Value
Art Queue	.00000	(Insuf)	.00000	.00000	.00000
Education Queue	.00000	(Insuf)	.00000	.00000	.00000
English Queue	.00000	(Insuf)	.00000	.00000	.00000
Language Queue	.00000	(Insuf)	.00000	.00000	.00000
Science Queue	.00000	(Insuf)	.00000	.00000	.00000
Social Sci Queue	.00000	(Insuf)	.00000	.00000	.00000
Morgan Util.	.30080	(Insuf)	.00000	1.0000	.00000
Paul Util.	.57040	(Insuf)	.00000	1.0000	1.0000
Liz Util.	.61040	(Insuf)	.00000	1.0000	.00000
Katherine Util.	.41020	(Insuf)	.00000	1.0000	.00000
Kristy Util.	.36020	(Insuf)	.00000	1.0000	.00000
Candice Util.	.70000	(Insuf)	.00000	1.0000	.00000
Alex Util.	.37040	(Insuf)	.00000	1.0000	.00000
Natasha Util.	.29020	(Insuf)	.00000	1.0000	.00000
Mary Util.	.24000	(Insuf)	.00000	1.0000	.00000
Jessica Util.	.34060	(Insuf)	.00000	1.0000	.00000

COUNTERS

Identifier	Count	Limit

ArtStudent	4	Infinite
ArtClass	11	Infinite
ArtDuty	9	Infinite
EduStudent	0	Infinite
EduClass	0	Infinite
EduDuty	6	Infinite
EngStudent	1	Infinite
EngClass	2	Infinite
EngDuty	11	Infinite
LangStudent	2	Infinite
LangClass	7	Infinite
LangDuty	12	Infinite
SciStudent	2	Infinite
SciClass	2	Infinite
SciDuty	22	Infinite
SocStudent	7	Infinite
SocClass	15	Infinite
SocDuty	45	Infinite
ArtLost	17	Infinite
EduLost	28	Infinite
EngLost	23	Infinite
LangLost	56	Infinite
SciLost	22	Infinite
SocLost	105	Infinite
StudentCount	16	Infinite
ClassCount	37	Infinite
DutyCount	105	Infinite
BalkCount	251	Infinite