

Arena Detailed Modeling

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ex Consider the call center model in the homework

PART I: What if there are 26 trunk phone lines available?

- We will use Seize and Release blocks. The reason we have them separately in the model is that there are other processes/logic between Seize and Release.

Seize and Release blocks have no difference in logic than the seize and release options in the process block except the fact that you may specify the queue in Seize block
(more on this later)

PART II: What if the ^{new} calls will be dropped if all 26 lines are busy? (We also need to record the attempted, dropped and completed calls count)

- Using build expression, we can check the current number of phone lines that are seized. A decide block will be useful.
- Record block with the option of count will be useful.

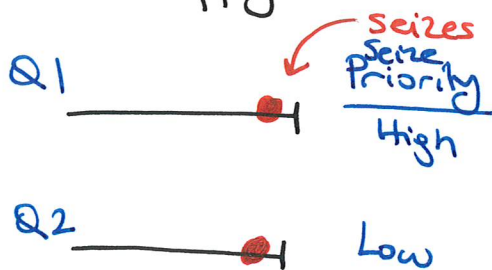
PART III: What if we would like to distinguish between different calls in the reports?

- We need to change the entity types once the call type is determined.

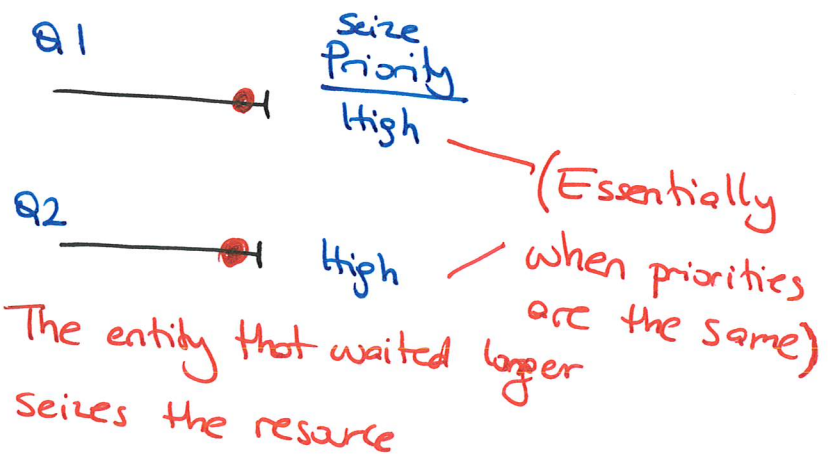
PART IV: What if the order status calls requiring to speak with a Sales Representative:

(a) Gets a lower priority than the Sales calls?

- In Arena if a resource is seized by two different seize (or process) blocks with separate queues the following rules apply:



The entity waiting in the higher priority queue seizes the resource



The entity that waited longer seizes the resource

(b) Waits in the same queue as Sales Calls with lower priority? This part is optional

- In Arena we can have shared queues.

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- When a queue is shared, entities may enter the queue from different seize blocks, and resume their flow in the logic of the model after ~~seizing~~^{seizing} the resource.
- We need a seize block for order status calls to seize a sales representative. (to be able to select the queue manually)
- Set the queue as shared.
- In order to reflect the priority we will utilize the "Lowest Attribute Value" option in the queue.
 - Hence we need an attribute whose value will determine the order of the queue
- We need to make the necessary assignments.

PART V : What if we would like to run this model for a workday (8AM-6PM) where calls received before 6PM are answered even if this happens after 6PM?

- (a) No calls after 6PM but the model should continue to run. (Assume that operating until 7PM will clear out all current calls)
- We need to stop the Create block to create new calls after 6PM.
 - We will utilize "Entities per Arrival" and "Max Calls" options in Create block.
 - Instead of having constant values of 1 and Infinite we will have variables Calls Per Arrival and Max Calls.
(Initial Value: 1) (Initial value: 999999)
 - We will build a "Cutoff Logic" that will change the values of these variables to Calls Per Arrival := 0 Max Calls := 1

(b) The system runs until the last call is answered.

(Disregard the assumption of operating until 7PM.)

- We need to know how many calls we currently have.
- We keep this information in a variable, called TotalWIP, that we increment when we accept a call and decrement as the customer hangs up.
- We need to adjust the "Run > Setup > Replication Parameters"

PART VI: What if we have varying arrival rates throughout the day?

- The arrivals will be a nonstationary Poisson Process.
(notice the connection with expo!)
- We will utilize the schedule module. The type "Arrival" will provide a schedule where values will be the arrival rate of the nonstationary Poisson process. (Schedules can only do nonstationary Poisson process)
- The unit of the arrival rate must be "rate/hour" even if the time periods for that rate is not hourly!
- See Kelton page 238 for the schedule of rates.
- * Do not forget to set this schedule in the create module
- Note that with this modification, we no longer require the arrival cut off logic to ~~stop~~ stop the create from creating calls after 6PM. The schedule takes care of this automatically!

PART VII: What if we can distinguish between the capabilities of each Tech Support Representative?

- Among the 11 Tech Support reps, each one might accept calls for one or more products.

Charity P1	Sammy P1,2,3	Mya P3
Noah P1	Tierney P2	Ian P3
Molly P1,3	Aidan P2	Christie P3
Anna P1,2,3	Emma P2	

- We cannot add all ^{potential} reps for the process of product 1.

This means you need to seize all of these reps!

- Instead we will define Resource Sets.
- Go to Set module and create a set for each product type.
- We need to insert members to each list. While doing so, we put the reps with fewer product capabilities first (more on why we did this later)
- In the seize (or process) module we will no longer seize a single resource, but we will seize from a set.

- Set selection rules:

Cyclical: 1-2-3-1-2-3 ... (in a set with 3 members)

Random: (Random)

Preferred order: 1 has priority over 2 which has priority on 3 ...

Specific member: (The index of the member must be specified)

Largest Remaining Capacity: Member with the largest rem. cap.

Smallest Number Busy: Member with smallest number busy ^{makes sense with resources with multiple capacities.}

- We will select Preferred order.

- Save attribute will save the index of the member that is seized to an attribute specified here (may be useful in later stages of the model)

PART VIII: What if we have varying number of sales and tech support representatives throughout the day?

- See the work schedules of sales and tech support reps on Kelton p. 238.
- We will use Resource schedules as before.
- NOTE THAT: If a resource schedule goes down to zero before the end of the day you will need to explicitly state that the capacity is zero (Use Right Click > Edit via Dialog)
- Otherwise, since the schedules repeat the pattern from beginning, inactive resources go back to active. See, for instance, Charity. After time period 17, Charity should leave. But if we do not explicitly say that for periods 18-22 the capacity of Charity is zero, the schedule will start from the beginning and Charity will be back active.

PART IX: What if some of the technical calls (4% of the calls) require further investigation after the customer hangs up?

- The investigation takes Expo (60) minutes.
- The tech support representative that answered the original call calls the customer back and this call takes TRIA (2, 4, 9) min.
(This happens with a higher priority over the regular calls)
- These return calls also need one of the 26 trunk lines but they will have a higher priority.

PART X: What if we would like to obtain the number of rejected calls per each hour of operation?

- We need to have a counter per each hour of operation (10 hrs)
- Putting 10 counters (record blocks) will be OK but unnecessary.
- We will define a "Counter Set"

Go to set and define a set named "Rejected Calls" of type Counter.
 This set will have 10 members (in this case counters) that we define in statistics. The order of the members is important!
 Member 1 $\rightarrow$ 1st hour of operation ...

- We can reach these members of this ~~counter~~ set using record block.
- In the record block select "Record Into Set". You can select the Counter set and the Set (Member) Index.

Set Index should be written in terms of the current simulation time

$$\text{AINT}(\text{CTNOW}/60 + 1)$$

OR

$$\text{AINT}(\text{TNOW} + 1)$$

whether base time units are hours or minutes



Truncates the number and makes it an integer

PART XI: What if we plan to hire new sales employees who will work from 12PM (noon) to 4PM?

- We want to make this operation flexible (for further analysis)
- We define a new variable named New Sales.
- We modify the schedules (using edit view dialog)
the chart view will not work since we will have an expression now.

PART XII: What if we would like to learn the ^{total} amount of excess waiting time for sales calls?

- Customers waiting for more than 1 minute consider the wait time as excess.
- Arena keeps track of the waiting times of each entity automatically. The attribute ENTITY.WAITTIME can be utilized.

↑ Keeps only the queue times, not the delays.

- We will define a variable named Excess Wait Time and add the waiting times in excess of 1 minute (only the excess parts of the waiting times - if any)

This means the expression will be

$$\text{MAX}(\text{ENTITY.WAITTIME} - 1, 0)$$

OR

$$\text{MAX}(\text{ENTITY.WAITTIME} - (1/60), 0)$$

← Whether the base time units are minutes or hours.

PART XIII: Consider the following cost scheme:

- Sales reps: \$20/hour (New hires: \$17/hour)
- Tech support reps: \$18/hour
- Excess waiting cost: 81.8 cents/minute (\$49.08/hour)
- Cost of trunk lines: \$20/line day

What will be the cost of operating this system for one day?

- We need to have an item in the reports that contain this piece of information (Output statistic)

For the current employees:

- Sales: 45 hrs/day $\times$ \$20/hour = \$900/day
 - Tech support: 88 hrs/day $\times$ \$18/hour = \$1,584/day
- \$2,484/day

For the new hires:

Each new sales rep will work 4 hrs/day. So the expression will be New Sales $\times$ 4 hrs/day $\times$ \$17/hour

For excess waiting cost:

Excess Wait Time $\times$ \$49.08/hour

OR

Excess wait Time $\times$ $\left(\frac{81.8 \text{ cents/min}}{100} \right)$

Whether the base time units are in hours or minutes

For trunk lines

convert to \$'s.

\$20 $\times$ MR (Trunk Lines)

we could have written 26 instead. (just in case we add more lines later)