Using Simulation to Assist Recruitment in Seasonally Dependant Contact Centers

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UNITED KINGDOM · CHINA · MALAYSIA

My Research Interests: It's all about ooABM

- Technical Aspects
  - From archetypes to multi-agent systems
  - Engineering agent-based social simulations
    - Using UML to define agents and their interactions

- Applications
  - My Mission: Applying ooABM to as many fields as possible
    - Business studies (Risk Assessment; CBA; MCDA)
    - Economics (Game Theory; Agent Based Computational Economics)
    - Social Sciences (Political Science; Social Simulation)
    - Engineering (Manufacturing; Urban Modelling; Energy; Transportation)
    - Computer Science (Robotics; Game Development)

Introduction

- The weather is unpredictable and can have a large impact on the profitability of seasonal businesses, particularly if staffing requirements are highly temperature-dependent

- An example for such a business is a company that provides boiler maintenance and repair services
  - In particular their Call Centre (CC) staffing level requirements depend very much on the severity of the winter
  - The likelihood of boilers breaking down during winter is correlated to the severity of the winter

Introduction

- Challenge
  - If recruitment starts too early then staff will have increased idle time
  - If recruitment starts too late and the work increases faster than staff can cope, there will be lots of complaints and lost customers

- Aim
  - To develop a novel simulation tool that helps managers to make better informed decisions about their CC recruitment needs (of permanent an temporary staff)
    - Timing for hiring new staff
    - Deciding about the optimal length of temporary contracts

Background

- Mostly CC modelling focusses on staffing level optimisation
  - We did not find tools that focus specifically on recruitment timing strategies

- Three common OR approaches to predict staffing levels
  - Spreadsheet models (for short term predictions)
    - Using historic data to predict staffing levels
  - Complex mathematical approaches (quite abstract)
    - Constraint programming (sometimes combined with linear programming)
  - Simulation (allows studying the dynamics of the system over time)
    - Usually DES but nowadays more frequently also hybrid DES/ABS models

Tool Development

- Conceptualisation (after Robinson 2004)
  - Problem
    - A boiler maintenance and repair company receive calls from customers throughout the year to book appointments. Service calls stay reasonably constant throughout the year, however breakdown calls increase during colder months. Staffing levels need to be increased in order to meet service level targets, however level is determined by financial constraints.
  - Objectives
    - Consistently meet these KPIs from June to May
      - Average time in system of customers < 6 min.
      - Abandonment rate < 5%
      - Calls answered within 20 sec. > 90%
      - Calls per advisor per hour: 6-8

Tool Development

- Conceptualisation
  - Constraints:
    - At least 3 member of CC staff must be on shift
    - CCs receive calls 24/7
  - Experimental factors
    - FTE available at model initialization
    - Target FTE
    - Winter severity level
    - Customer base number
    - Abandonment rate distribution
    - Contract length of new staff

Tool Development

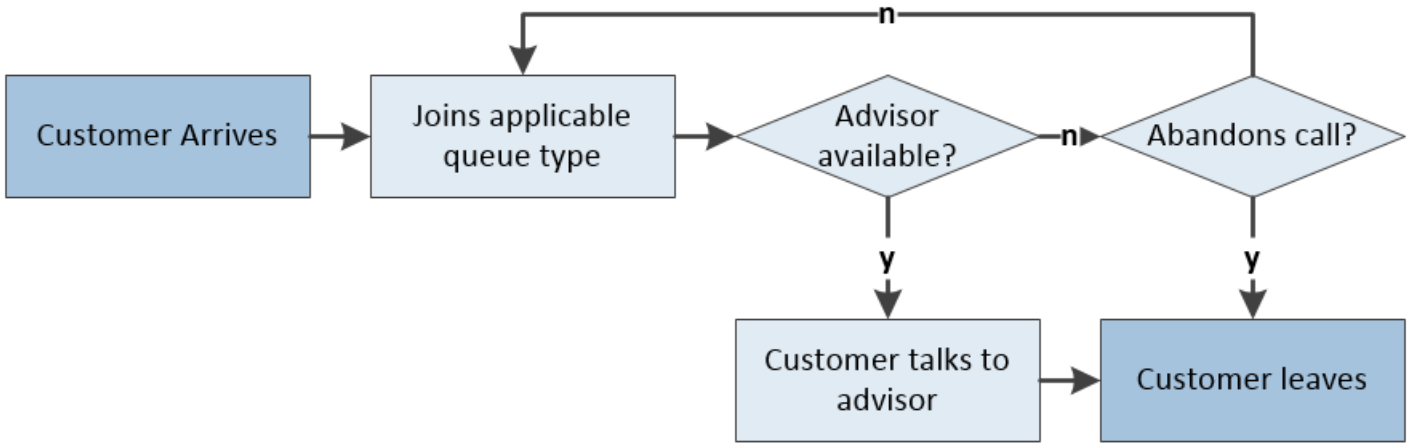
- Conceptualisation
  - Responses
    - Number of calls answered
    - Number of calls abandoned
    - Number of calls answered after queuing for less than 20 seconds
    - Number of advisors available on a day
    - Length of time the call is in the call process system
  - Assumptions
    - Weather and recruitment are not affected by location (in the UK)
    - One member of staff interacts with one customer at a time
    - Customers who have abandoned calls do not call again

Tool Development

- Conceptualisation
  - Simplifications
    - Customers calling in multiple times is included as part of arrival rate
    - Services and breakdowns calls are included; sales calls are excluded
    - Staff members leave according to distribution, there is no difference between staff members who resign or are dismissed
    - Customer base is static
    - Recruitment process focus on training time
    - We consider unlimited queues - no dropped calls

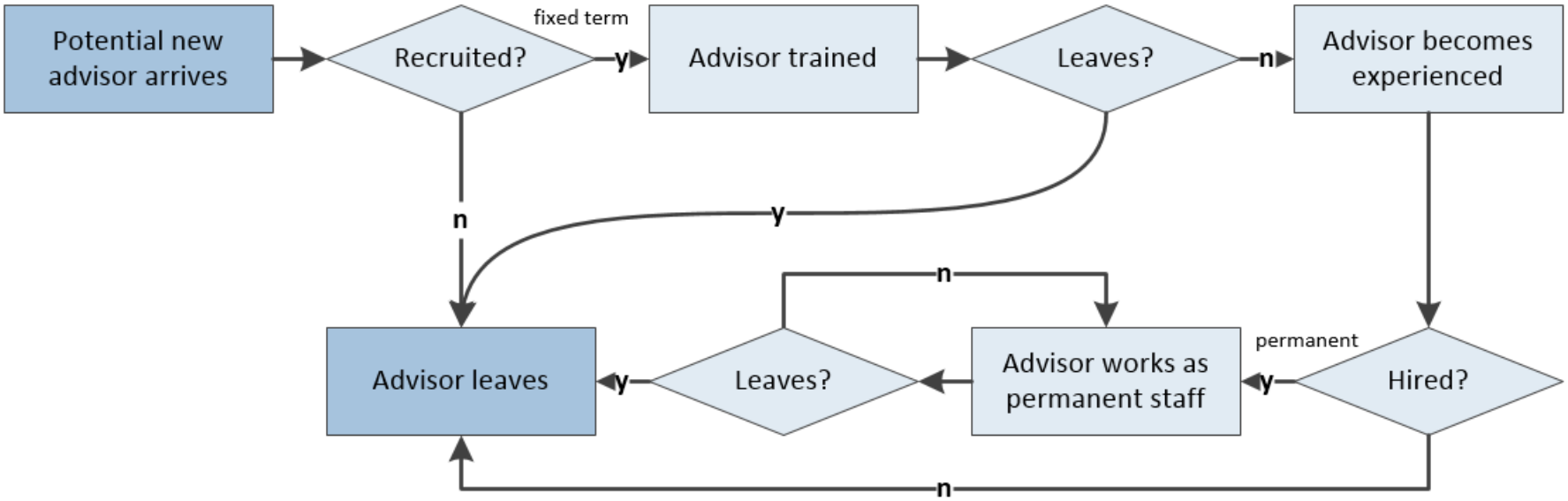
Tool Development

- Conceptual Model
  - Call Centre (CC): Call process



Tool Development

- Conceptual Model
  - Call Centre (CC): Recruitment Process



Tool Development

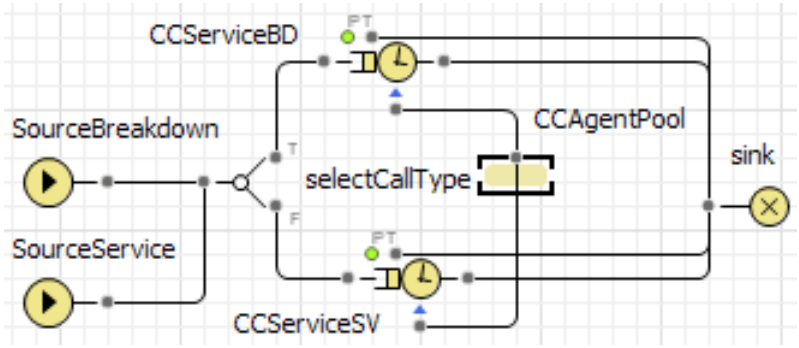
- Conceptual Model
  - Call Centre Advisor (CCA) and Calls (C)
    - Passive agents: Individual objects with a list of attributes to give them a personal identity but do not initiate any actions and do not have any specific goals

Call Centre Advisor Class
• Type (permanant or fixed term) • Level of training • Time till leave

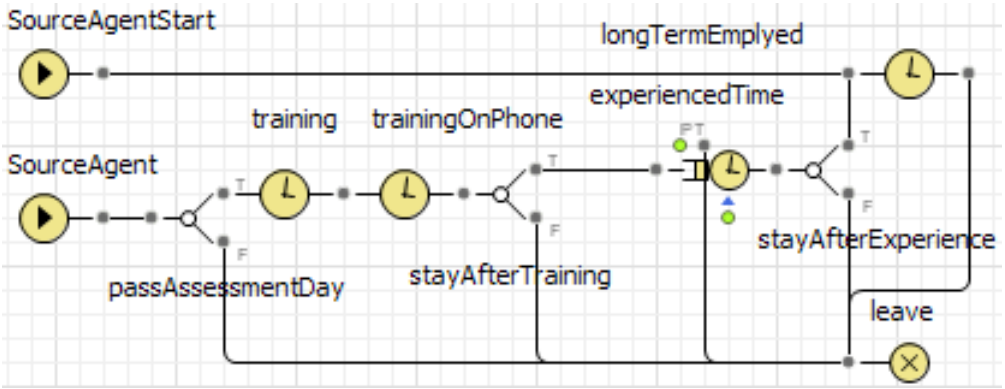
Call Class
• Type (Service or breakdown) • Time till abandon • Time enter queue • Time leave queue • Time enter system • Time leave system

Implementation

- Call Processes



- Recruitment process



Implementation

- Agents

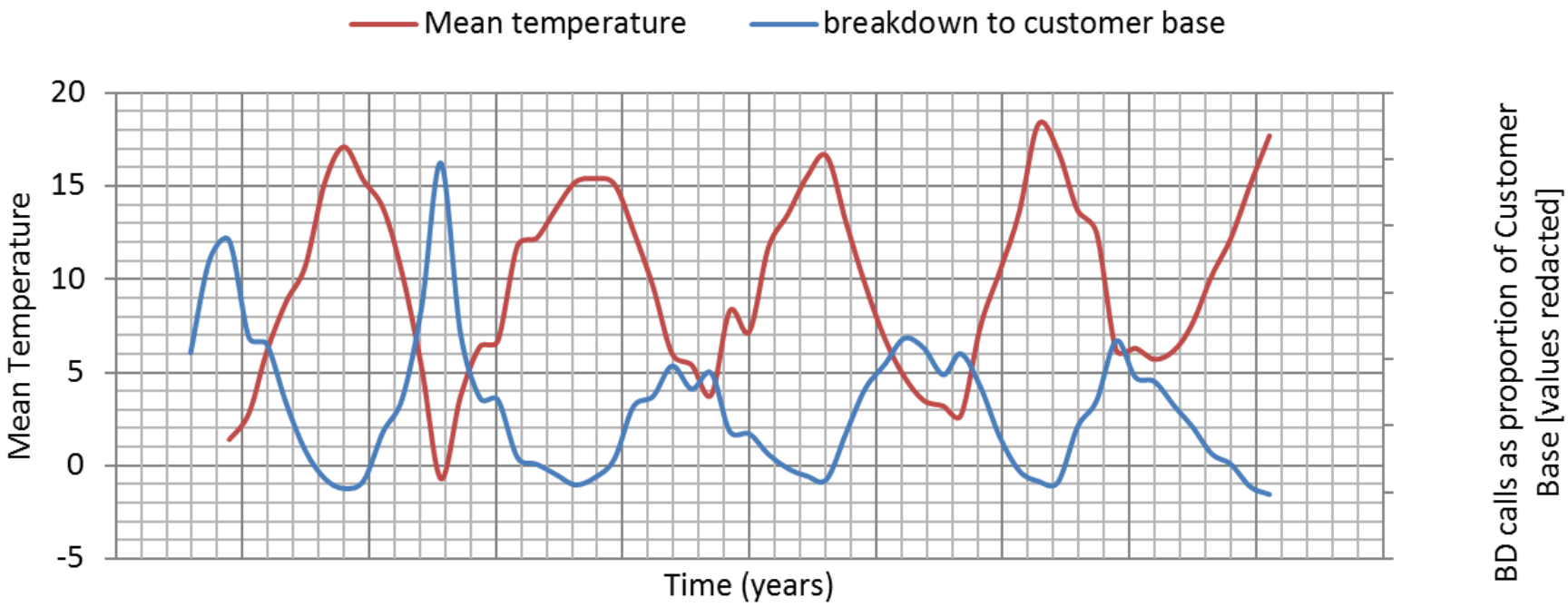
Call Type	Time Till Abandon
Service	entity.dblTimeTillAbandon = lognormal(4.11051, 1.36609, 0)/60;
Breakdown	entity.dblTimeTillAbandon = lognormal(4.56343, 1.44683, 0)/60;

Call Type	Service Time Distribution
Service	(lognormal(5.47917, 0.506602, 0)/60) * vServiceTimeModifier
Breakdown	(lognormal(5.79643, 0.614067, 0)/60) * vServiceTimeModifier
vServiceTimeModifier=((vStaffTraining*1.4)+(vStaffTrained*1.2)+(vStaffPermanent*1))/pNoCCAgentsAvailable	

CCAgent Object	Time till Leave			Effectiveness
	min	max	mode	
Permanent	4 weeks	3 year	1 years	1
Fixed-Term Training	2 weeks	7 months	6 months	0.6
Fixed-Term Experienced	2 weeks	7 months	6 months	0.8

Implementation

- Relationship between weather and incoming breakdown calls



Implementation

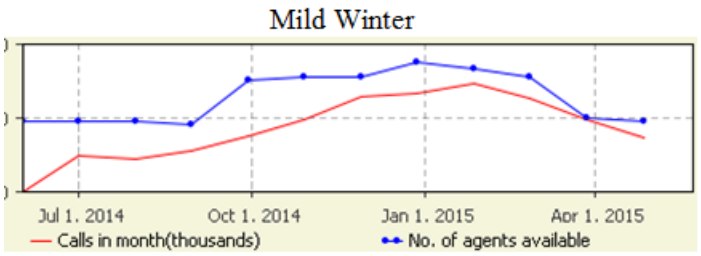
- With a bit of clever stats we were able to represent the relationship between calls and different severity of winters

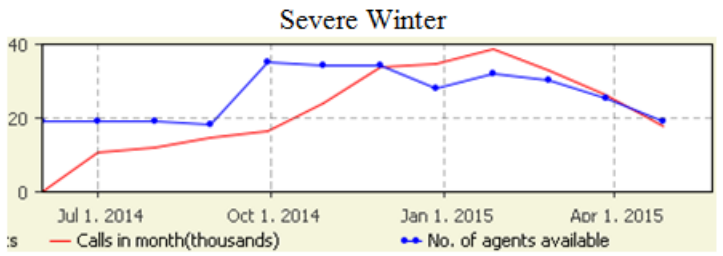
$$y=0.0406304264574+0.00035647283404701*x \quad (1)$$

$$degreeDayVal=(degreeDayDistr\_peak-degreeDayDistr\_min)*exp(-pow(month-degreeDayDistr\_month,2)/(2*pow(degreeDayDistr\_width,2)))+degreeDayDistr\_min \quad (2)$$

$$bdFrac=0.0406304264574+(0.00035647283404701*degreeDayVal) \quad (3)$$

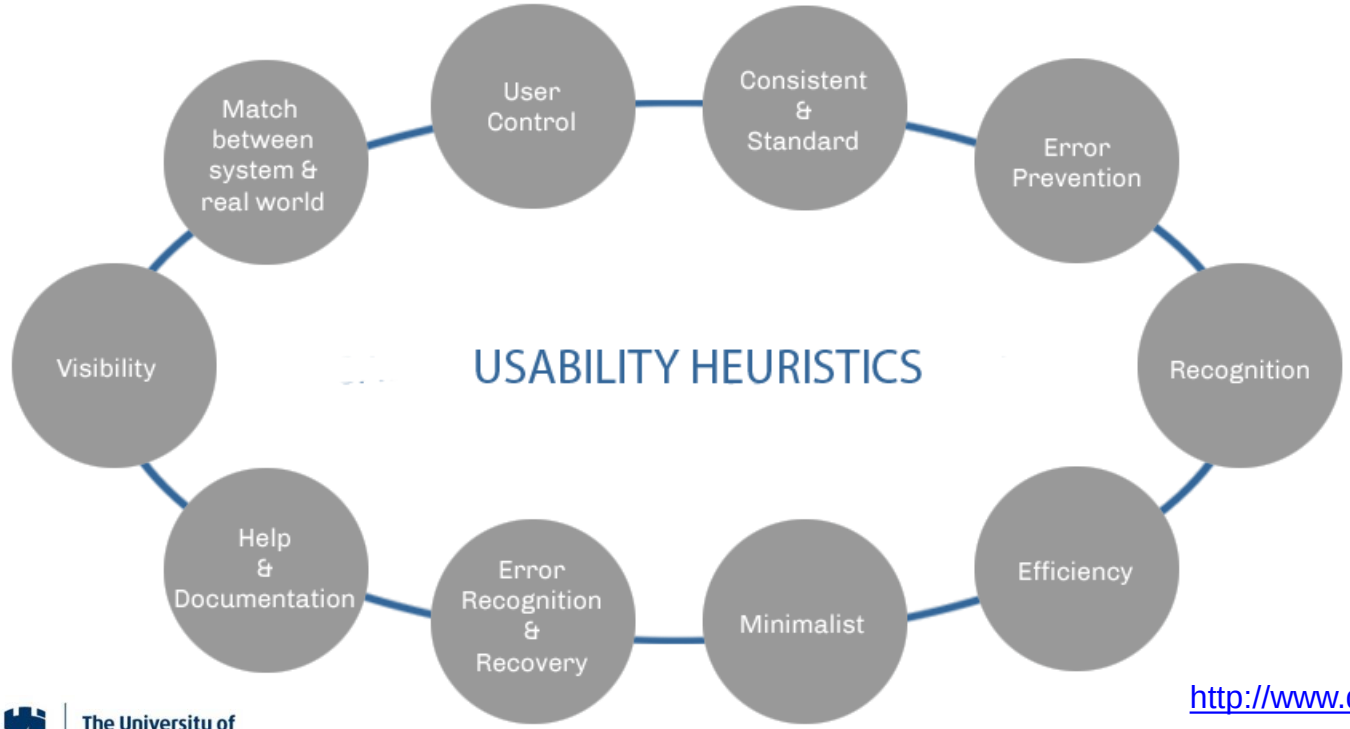
$$feedbackMonth=(initCustBase*bdFrac)+(initCustBase*0.08) \quad (4)$$





Graphical User Interface

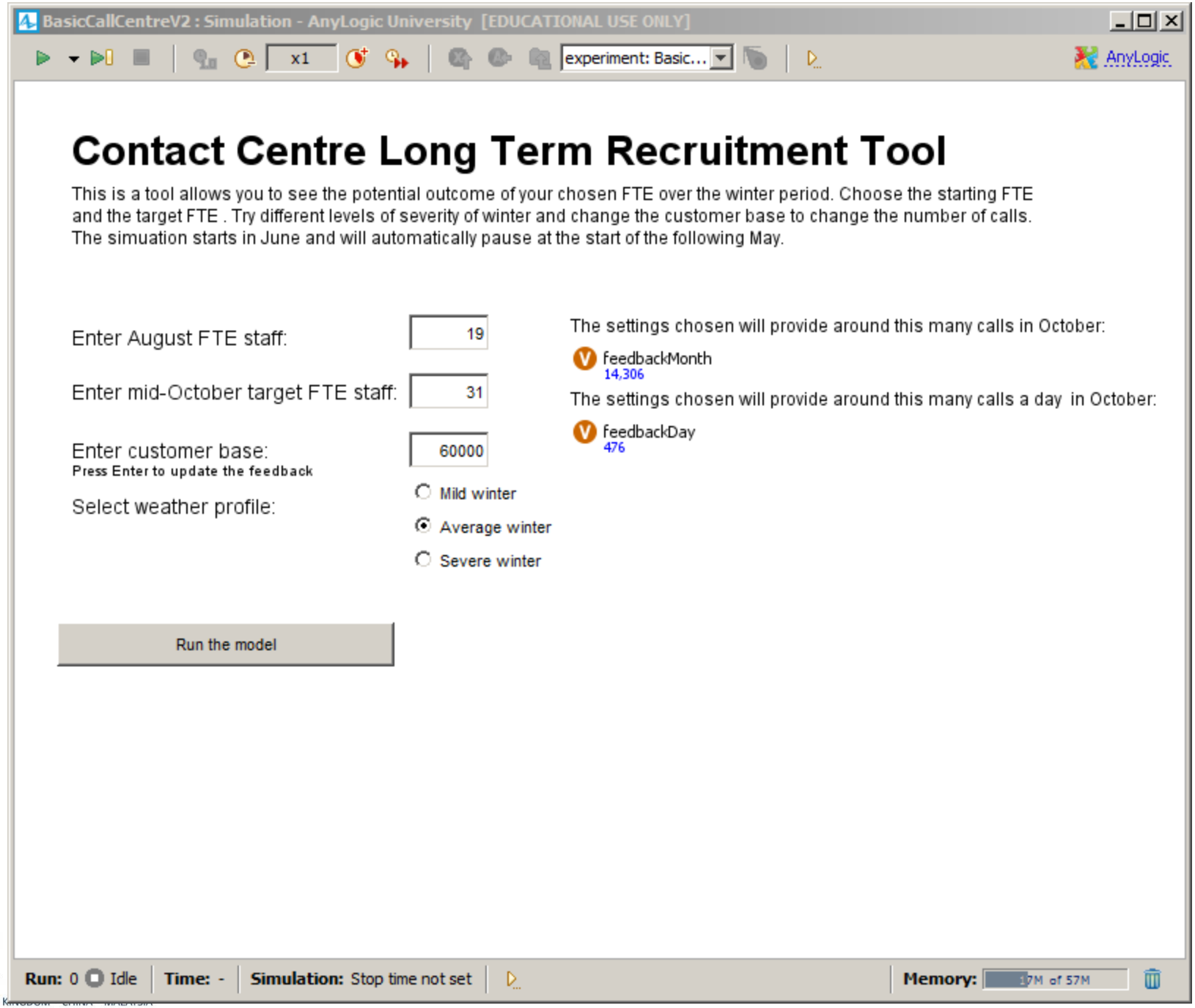
- Tool is supposed to be used by managers
  - We used Nielson's heuristic usability principles (Nielson 1993)
  - Usability tests confirmed usefulness of tool for management

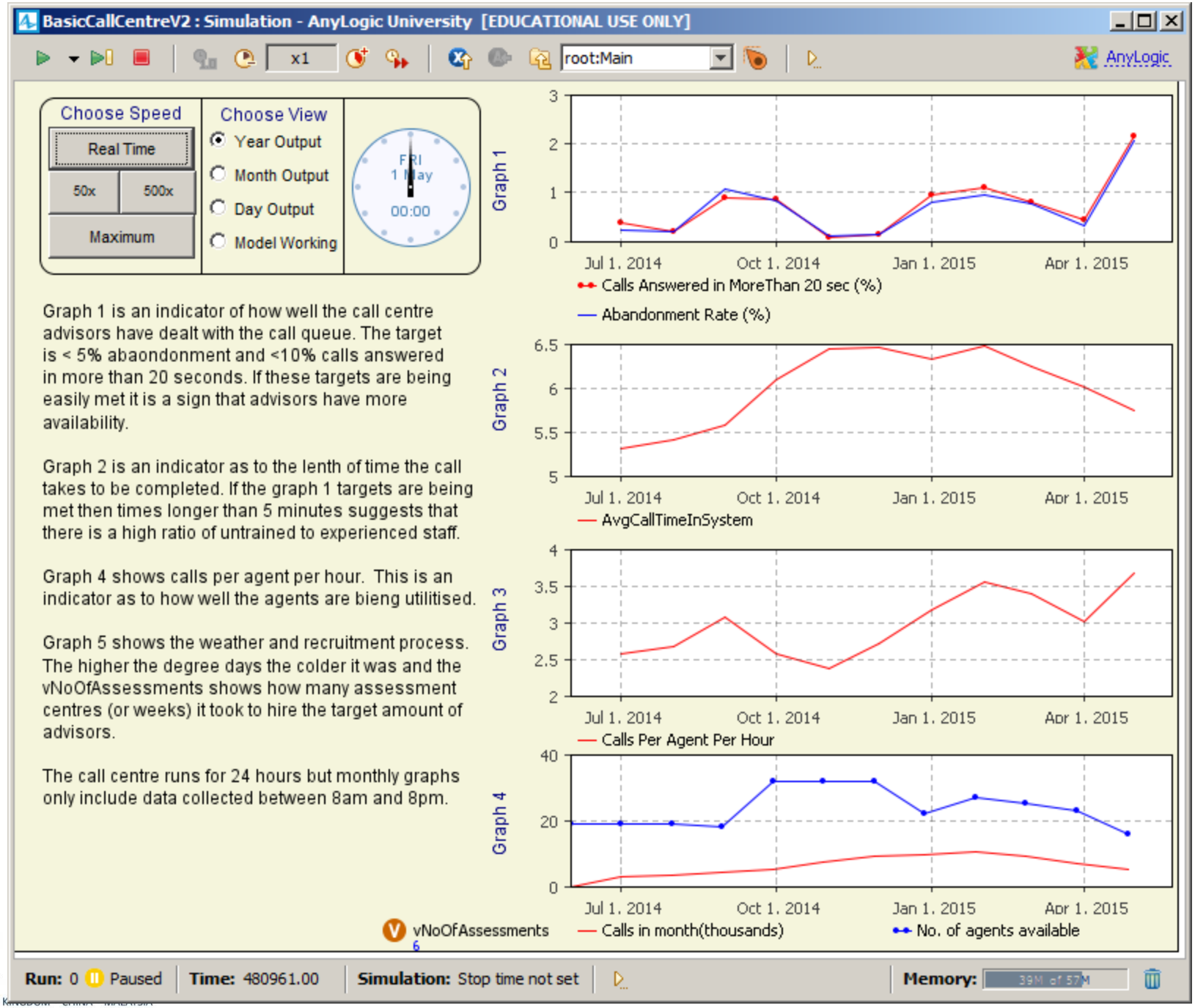


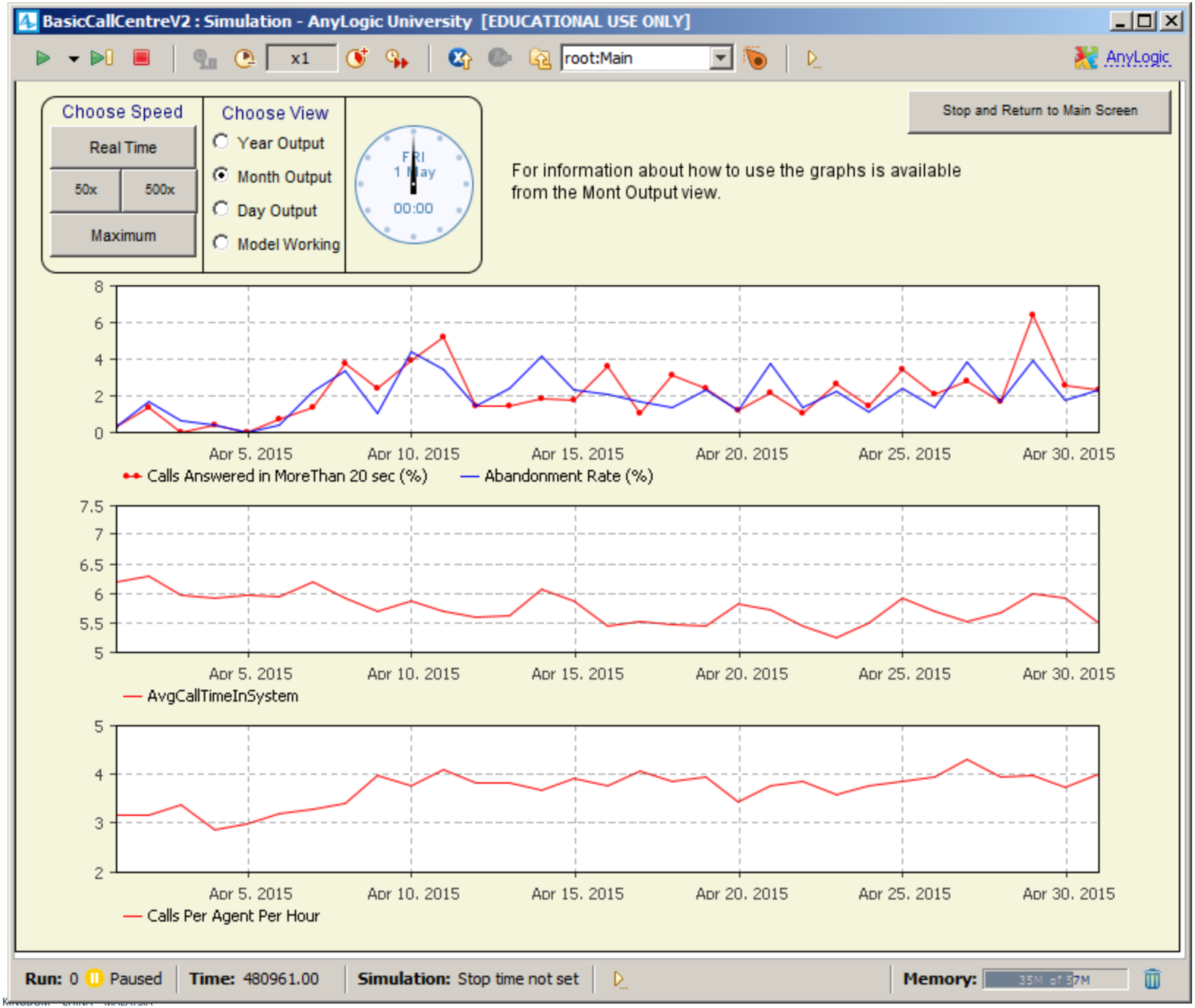
http://www.designui.net/process.html

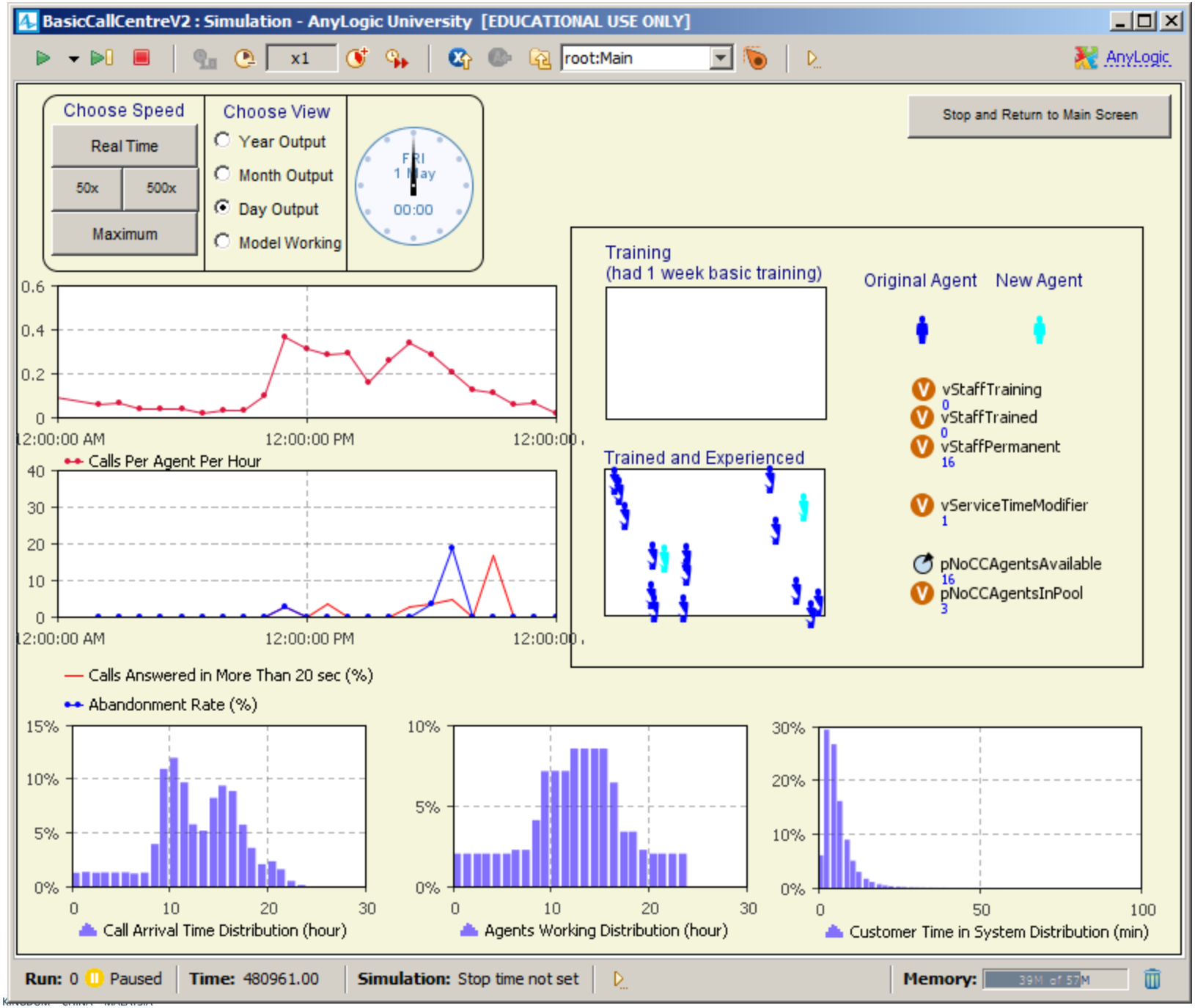
Graphical User Interface

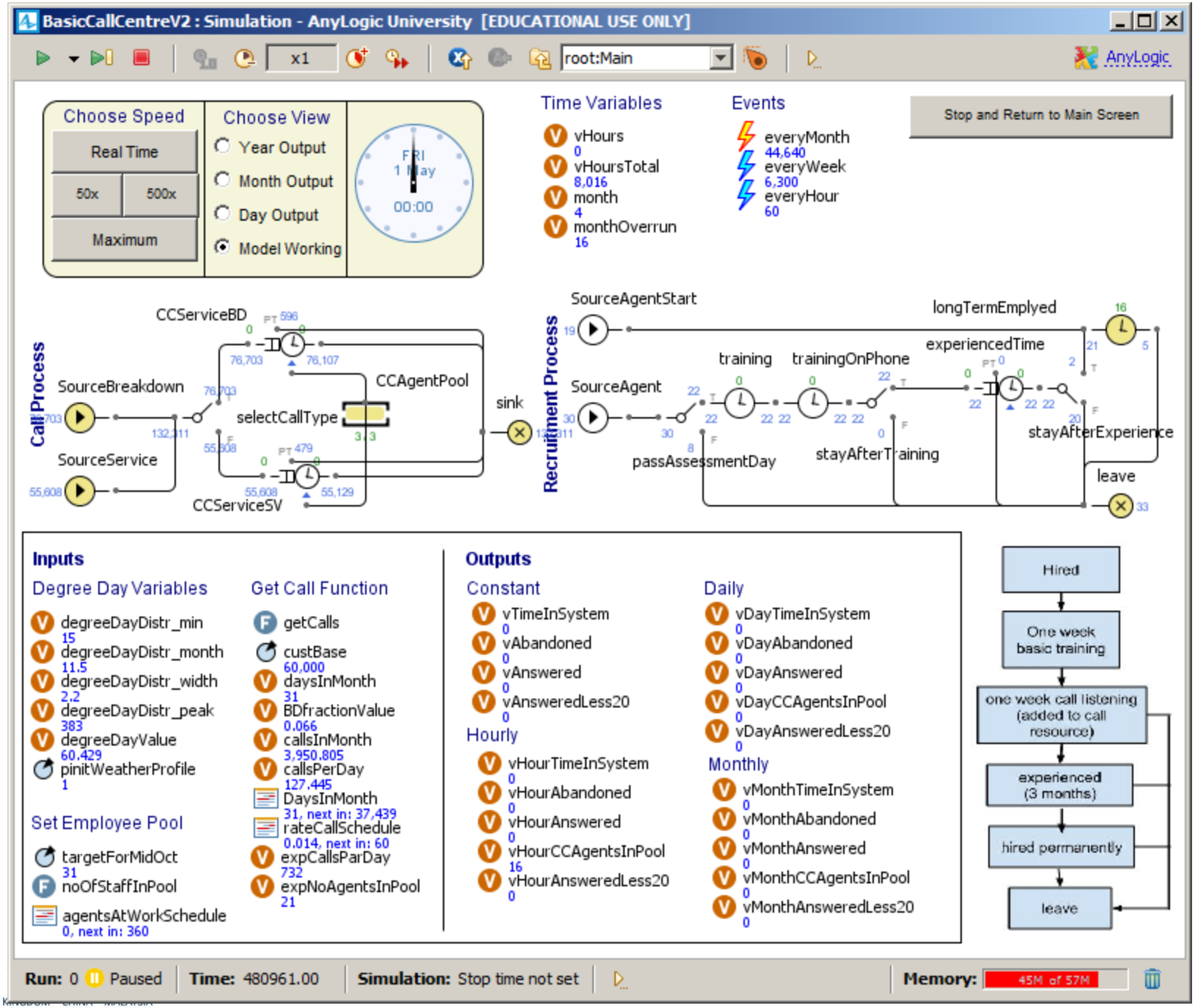
- Input screen
  - Allows to set up scenarios
- Output Screens
  - Key information available from Year screen; additional information available from Month screen and Day screen
- Process screen
  - Provides real time information about variables within the processes + all inputs/outputs


BasicCallCentreV2 : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]
x1
experiment: Basic...
AnyLogic
Contact Centre Long Term Recruitment Tool
This is a tool allows you to see the potential outcome of your chosen FTE over the winter period. Choose the starting FTE and the target FTE . Try different levels of severity of winter and change the customer base to change the number of calls.
The simuation starts in June and will automatically pause at the start of the following May.
Enter August FTE staff:
19
Enter mid-October target FTE staff:
31
Enter customer base:
Press Enter to update the feedback
60000
Select weather profile:
Mild winter
Average winter
Severe winter
Run the model
The settings chosen will provide around this many calls in October:
feedbackMonth
14,306
The settings chosen will provide around this many calls a day in October:
feedbackDay
476
Run: 0 Idle
Time: -
Simulation: Stop time not set
Memory:
57M of 57M


BasicCallCentreV2 : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]
x1
root:Main
AnyLogic
Choose Speed
Real Time
50x
500x
Maximum
Choose View
Year Output
Month Output
Day Output
Model Working
FRI
1 May
00:00
Graph 1 is an indicator of how well the call centre advisors have dealt with the call queue. The target is < 5% abaondonment and <10% calls answered in more than 20 seconds. If these targets are being easily met it is a sign that advisors have more availability.
Graph 2 is an indicator as to the lenth of time the call takes to be completed. If the graph 1 targets are being met then times longer than 5 minutes suggests that there is a high ratio of untrained to experienced staff.
Graph 4 shows calls per agent per hour. This is an indicator as to how well the agents are bieng utilitised.
Graph 5 shows the weather and recruitment process. The higher the degree days the colder it was and the vNoOfAssessments shows how many assessment centres (or weeks) it took to hire the target amount of advisors.
The call centre runs for 24 hours but monthly graphs only include data collected between 8am and 8pm.
Graph 1
Jul 1. 2014
Oct 1. 2014
Jan 1. 2015
Apr 1. 2015
Calls Answered in MoreThan 20 sec (%)
Abandonment Rate (%)
Graph 2
AvgCallTimeInSystem
Graph 3
Calls Per Agent Per Hour
Graph 4
vNoOfAssessments
Calls in month(thousands)
No. of agents available
Run: 0 Paused
Time: 480961.00
Simulation: Stop time not set
Memory:


BasicCallCentreV2 : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]
x1
root:Main
AnyLogic
Choose Speed
Real Time
50x
500x
Maximum
Choose View
Year Output
Month Output
Day Output
Model Working
FRI
1 May
00:00
Stop and Return to Main Screen
For information about how to use the graphs is available from the Mont Output view.
8
6
4
2
0
Apr 5, 2015
Apr 10, 2015
Apr 15, 2015
Apr 20, 2015
Apr 25, 2015
Apr 30, 2015
Calls Answered in MoreThan 20 sec (%)
Abandonment Rate (%)
7.5
7
6.5
6
5.5
5
AvgCallTimeInSystem
5
4
3
2
Calls Per Agent Per Hour
Run: 0 Paused
Time: 480961.00
Simulation: Stop time not set
Memory:


BasicCallCentreV2 : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]
x1
root:Main
AnyLogic
Choose Speed
Real Time
50x
500x
Maximum
Choose View
Year Output
Month Output
Day Output
Model Working
FRI
1 May
00:00
Stop and Return to Main Screen
Training
(had 1 week basic training)
Original Agent
New Agent
Trained and Experienced
vStaffTraining
0
vStaffTrained
0
vStaffPermanent
16
vServiceTimeModifier
1
pNoCCAgentsAvailable
16
pNoCCAgentsInPool
3
0.6
0.4
0.2
0
12:00:00 AM
12:00:00 PM
Calls Per Agent Per Hour
40
30
20
10
Calls Answered in More Than 20 sec (%)
Abandonment Rate (%)
15%
10%
5%
0%
Call Arrival Time Distribution (hour)
Agents Working Distribution (hour)
30%
20%
50
100
Customer Time in System Distribution (min)
Run: 0 Paused
Time: 480961.00
Simulation: Stop time not set
Memory:


BasicCallCentreV2 : Simulation - AnyLogic University [EDUCATIONAL USE ONLY]
x1
root:Main
AnyLogic
Choose Speed
Real Time
50x
500x
Maximum
Choose View
Year Output
Month Output
Day Output
Model Working
FRI
1 May
00:00
Time Variables
vHours
0
vHoursTotal
8,016
month
4
monthOverrun
16
Events
everyMonth
44,640
everyWeek
6,300
everyHour
60
Stop and Return to Main Screen
Call Process
CCServiceBD
SourceBreakdown
SourceService
selectCallType
CCAgentPool
sink
CCServiceSV
Recruitment Process
SourceAgentStart
SourceAgent
longTermEmployed
experiencedTime
training
trainingOnPhone
passAssessmentDay
stayAfterTraining
stayAfterExperience
leave
Inputs
Degree Day Variables
degreeDayDistr_min
15
degreeDayDistr_month
11.5
degreeDayDistr_width
2.2
degreeDayDistr_peak
383
degreeDayValue
60,429
pinitWeatherProfile
1
Set Employee Pool
targetForMidOct
31
noOfStaffInPool
agentsAtWorkSchedule
0, next in: 360
Get Call Function
getCalls
custBase
60,000
daysInMonth
31
BDfractionValue
0.066
callsInMonth
3,950,805
callsPerDay
127,445
DaysInMonth
31, next in: 37,439
rateCallSchedule
0.014, next in: 60
expCallsParDay
732
expNoAgentsInPool
21
Outputs
Constant
vTimeInSystem
0
vAbandoned
0
vAnswered
0
vAnsweredLess20
0
Hourly
vHourTimeInSystem
0
vHourAbandoned
0
vHourAnswered
0
vHourCCAgentsInPool
16
vHourAnsweredLess20
0
Daily
vDayTimeInSystem
0
vDayAbandoned
0
vDayAnswered
0
vDayCCAgentsInPool
0
vDayAnsweredLess20
0
Monthly
vMonthTimeInSystem
0
vMonthAbandoned
0
vMonthAnswered
0
vMonthCCAgentsInPool
0
vMonthAnsweredLess20
0
Hired
One week basic training
one week call listening (added to call resource)
experienced (3 months)
hired permanently
leave
Run: 0 Paused
Time: 480961.00
Simulation: Stop time not set
Memory:
45M of 57M

Validation Experiment

- Testing the relationship between length of fixed term contract and weather severity (10 replications; 1 year runtime)

Calls answered less 20 seconds	Low weather severity	Avg. Weather severity	High weather severity
3 month contract	93.1%	90.8%	89.0%
6 month contract	92.0%	89.7%	88.0%
9 month contract	93.3%	89.7%	88.2%

Calls per agent per hour	Low weather severity	Avg. Weather severity	High weather severity
3 month contract	4.3	4.6	4.8
6 month contract	4.4	4.7	4.9
9 month contract	4.3	4.7	4.9

Avg. time in system (minutes)	Low weather severity	Avg. Weather severity	High weather severity
3 month contract	6.01	6.14	6.20
6 month contract	6.01	6.11	6.18
9 month contract	6.00	6.13	6.20

Results

- A full cost benefit analysis is recommended as it is suggested that contract length has an effect on CC key performance indicators.
  - The 9 month contracts give time for advisors to become better trained over the winter period and this may result in better service times for customers.
  - However, 3 month contracts are more adaptable and allow managers to lose staff quickly if a winter turns out to be mild.

- The tool is now used by the company to better understand and coordinate their recruitment strategies

Future Plans

- Agent design
  - Creating active agents by extending the existing passive agents
    - Designing archetypes
    - Considering bounded rationality
    - Consider agent memory (e.g. about service quality)

- Impact of using intelligent agents
  - Test the impact of such agents on output accuracy

RF/PhD Offer: Urban Social Simulation

- Sustaining Urban Habitats: An Interdisciplinary Approach
  - The aim of this project is to develop a distinctively interdisciplinary approach to producing and evaluating scenarios for sustainable living in urban habitats. With two growth cities in China (Chengdu, Shanghai) and two transition cities in Europe (Nottingham, Stuttgart) as our empirical focus, we will explore ways of combining environmental and economic modelling with social and cultural ethnographic work

http://web.stanford.edu/group/suss/cgi-bin/main/blog/?p=4429

References

- Nielson (1993)
- Robinson (2004)