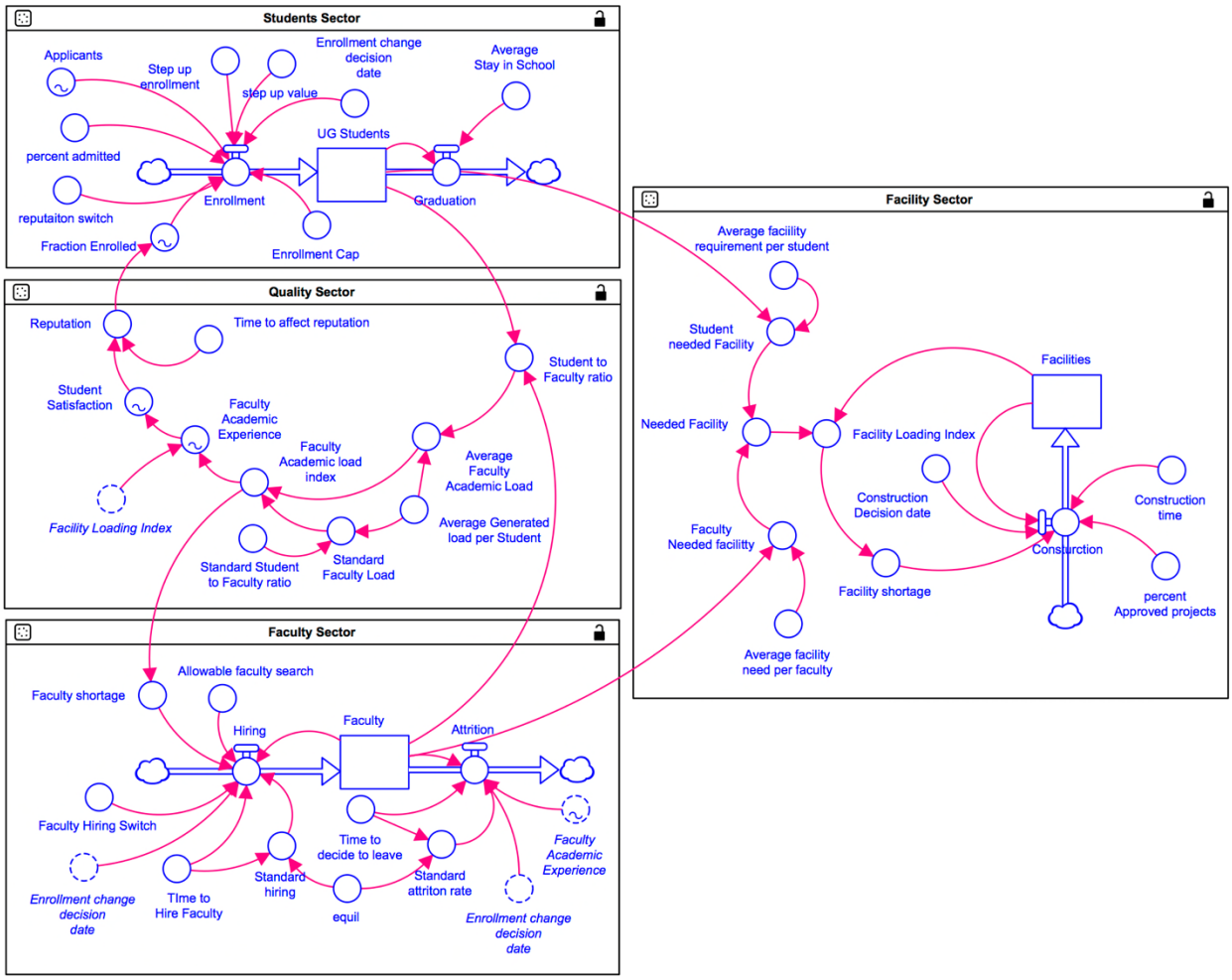
Appendix A: Model Structure and Equations for Chapter 2

Paper: Zaini, R. M., Pavlov, O. V., Saeed, K., Radzicki, M. J., Hoffman, A. H., & Tichenor, K. R. (2016). Let's Talk Change in a University: A Simple Model for Addressing a Complex Agenda. *Systems Research and Behavioral Science*, n/a–n/a. https://doi.org/10.1002/sres.2408

The model is composed of 4 sectors with a total of 3 stocks

File: Ch2_St_Fac_Facility_Q_equil_2016.itmx

Best run by iThink 10.1



1. Students Sector

UG_Students(t) = UG_Students(t - dt) + (Enrollment - Graduation) * dt

INIT UG_Students = 3375

Units: Student

INFLOWS:

Enrollment = IF (TIME> Enrollment_change_decision__date) and Step_up_enrollment = 1 then

step_up_value

ELSE IF TIME> Enrollment_change_decision__date and reputaiton_switch =1 then

MIN(Fraction_Enrolled*Applicants*percent_admitted/100,Enrollment_Cap)

else 750

Units: student/yr

OUTFLOWS:

Graduation = UG_Students/Average__Stay_in_School

Units: student/yr

Average__Stay_in_School = 4.5

Units: years

Enrollment_Cap = 750

Units: student/yr

Enrollment_change_decision__date = 2005

Units: years

percent_admitted = 60

Units: Unitless

reputaiton_switch = 0

Units: Unitless

Step_up_enrollment = 0

Units: Unitless

step_up_value = 1000

Units: student/yr

Applicants = GRAPH(TIME)

(2012, 8000), (2014, 8500), (2016, 9000), (2017, 9500), (2019, 10000), (2021, 10500), (2023, 11000), (2025, 11500), (2026, 12000), (2028, 12500), (2030, 13000)

Units: student/yr

Fraction_Enrolled = GRAPH(Reputation)

(0.00, 0.03), (0.1, 0.033), (0.2, 0.048), (0.3, 0.063), (0.4, 0.09), (0.5, 0.132), (0.6, 0.168), (0.7, 0.184), (0.8, 0.195), (0.9, 0.201), (1.00, 0.203)

Units: Unitless

2. **Quality Sector**

Average__Faculty__Academic_Load =

Average_Generated_load_per_Student*Student_to__Faculty_ratio

Units: units per faculty

Average_Generated_load_per_Student = 100

Units: units per student

Faculty__Academic_load__index = Average__Faculty__Academic_Load/Standard'__Faculty_Load

Units: Unitless

Reputation = SMTH1(Student__Satisfaction,Time_to_affect_reputation)

Units: Unitless

Standard'__Faculty_Load = Standard_Student_to_Faculty_ratio*Average_Generated_load_per_Student

Units: units per faculty

Standard_Student_to_Faculty_ratio = 5

Units: student per faculty

Student_to__Faculty_ratio = UG_Students/Faculty

Units: student per faculty

Time_to_affect_reputation = 4

Units: years

Faculty__Academic__Experience =

GRAPH((Faculty__Academic_load__index+0.5*Facility_Loading_Index)/1.5)

(1.00, 1.00), (1.10, 0.975), (1.20, 0.92), (1.30, 0.805), (1.40, 0.68), (1.50, 0.515), (1.60, 0.355), (1.70, 0.23), (1.80, 0.135), (1.90, 0.085), (2.00, 0.075)

Units: Unitless

3. **Faculty Sector**

Faculty(t) = Faculty(t - dt) + (Hiring - Attrition) * dt

INIT Faculty = UG_Students/Standard_Student_to_Faculty_ratio

Units: Faculty

INFLOWS:

Hiring = if time > Enrollment_change_decision__date and Faculty_Hiring_Switch = 1then

Allowable_faculty_search*(Faculty* (Faculty_shortage+Standard__hiring))/TIme_to__Hire_Faculty

else 68

Units: faculty/yr

OUTFLOWS:

Attrition = IF time > Enrollment_change_decision__date then

((1-Faculty__Academic__Experience)+Standard__attriton_rate)*Faculty/Time_to__decide_to_leave

else 68

Units: faculty/yr

Allowable_faculty_search = 1

Units: Unitless

equil = 10

Units: years

Faculty_Hiring_Switch = 1

Units: Unitless

Faculty_shortage = Faculty__Academic_load__index-1.0

Units: Unitless

Standard__attriton_rate = Time_to__decide_to_leave/equil

Units: Unitless

Standard__hiring = TIme_to__Hire_Faculty/equil

Units: Unitless

Time_to__decide_to_leave = 2

Units: years

TIme_to__Hire_Faculty = 2

Units: years

4. **Facility Sector**

Facilities(t) = Facilities(t - dt) + (Construction) * dt

INIT Facilities =

UG_Students*Average_faciility_requirement_per_student+Faculty*Average_facility_need_per_faculty

Units: square feet

INFLOWS:

Construction = IF(TIME<= Construction__Decision_date) THEN 0.0

ELSE (Facility_shortage*Facilities*(percent__Approved_projects/100))/Construction__time

Units: ft^2/yr

Average_faciility_requirement_per_student = 100

Units: square feet per student

Average_facility_need_per_faculty = 315

Units: square feet per faculty

Construction__Decision_date = 2005

Units: years

Construction__time = 3

Units: years

Facility_Loading_Index = Needed_Facility/Facilities

Units: Unitless

Facility_shortage = Facility_Loading_Index-1

Units: Unitless

Faculty__Needed_facilitty = Faculty*Average_facility_need_per_faculty

Units: square feet

Needed_Facility = Faculty__Needed_facilitty+Student__needed_Facility

Units: square feet

percent__Approved_projects = 50

Units: Unitless

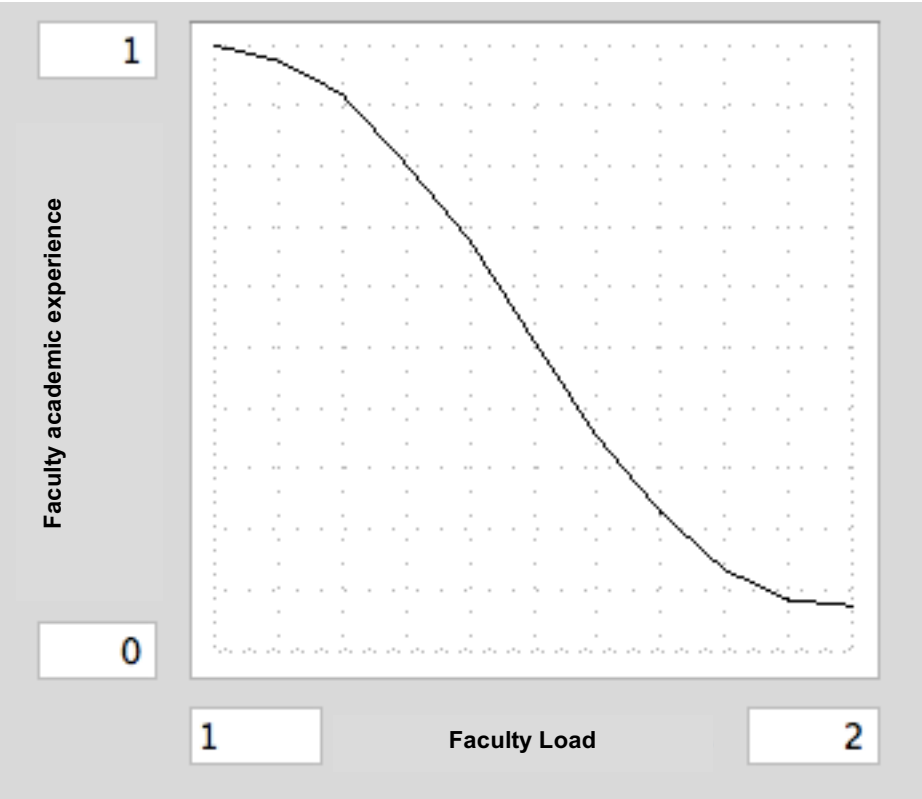
Student__needed_Facility = UG_Students*Average_faciility_requirement_per_student

Units: square feet

Model Assumptions

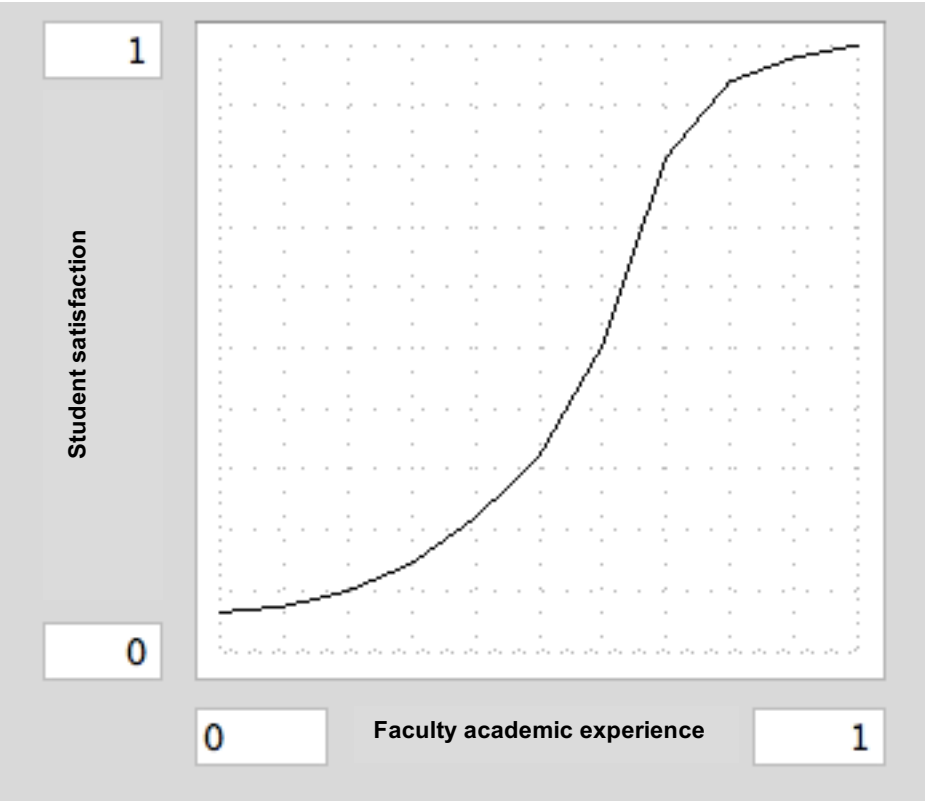
A list of graphical functions and their descriptions is presented here.

1. **Faculty academic experience**



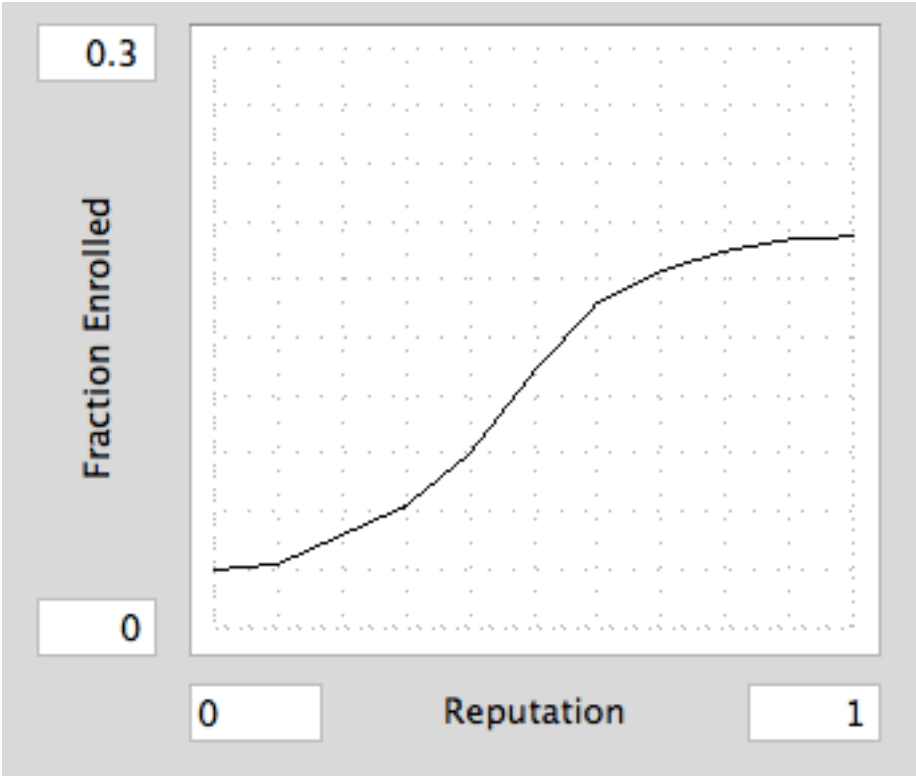
It is assumed that faculty load above their nominal load degrades their academic experience at a slow yet accelerated rate. Faculty academic experience continues to decline as the faculty load increases but slows down as new norms are established, and low academic experience becomes the norm at the institution.

2. Student satisfaction



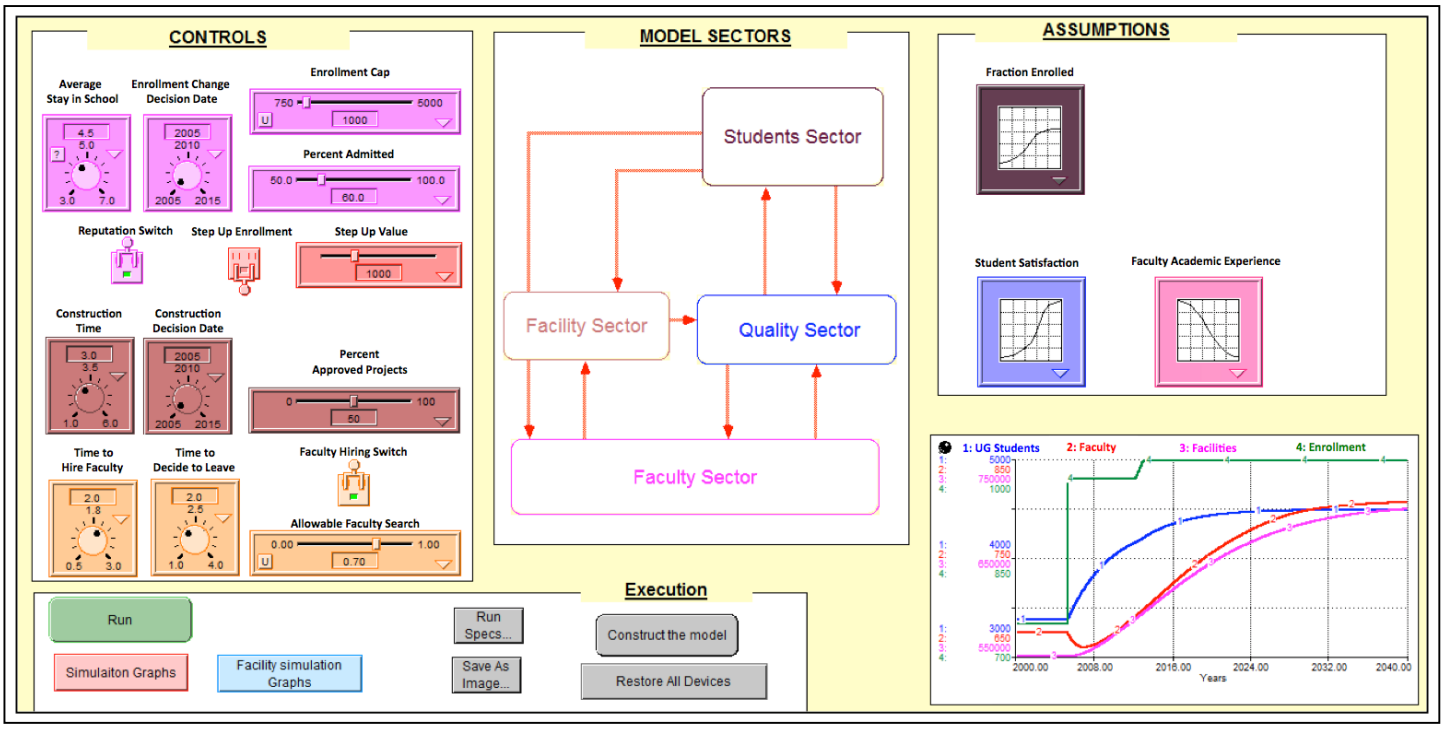
As faculty academic experience improves, student satisfaction improves slowly then rapidly and slows down as it approaches its max value. Both the faculty academic experience and student satisfaction have an upper value of unity.

3. Fraction enrolled



As the institution reputation improves, the fraction of admitted students who end up enrolling improves and reaches an asymptotic value as there are other factors not included in this model which impact the fraction enrolled like the availability of students aid, etc.

Model Interface



Model interface showing the sectors and input sliders for testing the model behavior under different scenarios.