Evaluating a New Approach to the Latin Honors Award Process

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Abstract:

A process control methodology for awarding university Latin honors was implemented in 2004. It replaced the previous approach that awarded honors after the graduation ceremony when final grades for the last semester became available. This alleviated a situation where honors actually awarded would not conform to those singled out for honors prior to graduation. The new graduation with distinction process was designed to ensure that Latin honor allocations are conducted fairly and deviate as little as possible from the traditional one, three and six percent targets.

This paper addresses the development of a simulation model for the evaluation of the decision making approach for updating the catalogue Graduation with Distinction cutoff GPAs. The methodology utilizes statistical process control to track GPA cutoff values for Summa, Magna and Cum Laude honors designations in each of eight colleges and signals the need for updates to the catalogue published cutoffs for the next four-year cycle.

In order to determine the best decision making approach going forward, a simulation model of this process was created using the simulation software SIGMA. This model was initially validated and verified via this new graduation with distinction experience. After completing this phase of the research, additional process control rules and performance measures were integrated into the SIGMA model. The model is currently being modified to address various long running GPA scenarios. A trade-off between Type I and Type II errors will be performed using the L1, L2 and L-infinite distance norms as performance measures and various auxiliary process control rules. Replicates of the simulation will be run over variable and fixed horizons to generate statistics on these measures and make comparisons of the candidate decision approach rules.

INTRODUCTION

Universities around the world award honors to students completing their studies as recognition of their academic excellence. The university awards three tiers of Academic Distinction for the top 1% (Summa Cum Laude), the next 3% (Magna Cum Laude) and finally the next 6% (Cum Laude) [1]. Significant grading differences between the different colleges require GPA breakpoint values for individual colleges. Based on university policies, the allocation of distinctions is reviewed using each of the three academic sessions every four years for a total of twelve academic semesters in a review period (T=12).

This paper will discuss the process of allocating distinctions via the application of Statistical Process Control (SPC) [2] and the creation and verification/validation of an event incremented simulation of the Graduation with Distinction process. This simulation will be used to assess the addition of various auxiliary SPC rules as potential enhancements to the existing decision approach by using the L1, L2 and L-infinity distance norms as performance measures. The research will contribute to the field of SPC knowledge since a search of the SPC literature revealed that this structure had not been previously analyzed.

MODELING THE GRADUATION WITH DISTINCTION PROCESS

The SPC methodology that ensures fairness in the process of awarding academic honors was implemented at the university in 2004. More recently, the SIGMA event oriented simulation was formulated to model this process. The two main events in this process are 1) allocation of distinctions and 2) determination of any necessary breakpoints for the next review period. The current decision approach includes collecting central tendency and dispersion measures which are then incorporated into an SPC process for the use of time phased control charts (CUSUM) and proportion control charts (P-charts). These enable the detection of statistically significant changes in the GPA distributions of qualifying for an honor [3]. When one of the SPC rules shows an out of control condition, one or more GPA breakpoints will require updating. The most recent review of this decision approach was made in 2018 in order to update the honors GPA breakpoints in the Fall catalog. Looking at tables 1 and 2 it may be seen that the CUSUM chart is the most discriminating predictor SPC chart, with out-of-control signals for most of the eight colleges.

Table 1: Results for the proportion control charts

x - out of control, blank - in control

College	Cum Laude	Magna Cum Laude	Summa Cum Laude
Agriculture Sciences			
Business		x	
Engineering			
Health & Human Sciences	x	x	
Liberal Arts			
Natural Resources			
Natural Sciences	x		
Veterinary Medicine& Biomedical Sciences			

Table 2: Results for the CUSUM control charts

x - out of control, blank - in control

College	Cum Laude	Magna Cum Laude	Summa Cum Laude
Agriculture Sciences	x	x	x
Business	x	x	x
Engineering	x	x	
Health & Human Sciences	x	x	
Liberal Arts	x	x	
Natural Resources	x	x	
Natural Sciences	x	x	x
Veterinary Medicine & Biomedical Sciences	x	x	

The breakpoint adjustments made are presented in table 3. The highlighted entry shows that only one college had a downward adjustment of the target GPA breakpoint.

Table 3: Percentage Difference in Breakpoints Fall 2018 through Spring 2022

College	Cum Laude	Magna Cum Laude	Summa Cum Laude
Agriculture Sciences	0.68%	1.24%	-0.10%
Business	1.05%	0.68%	0.31%
Engineering	0.85%	0.39%	No change
Health & Human Sciences	1.07%	0.89%	No change
Liberal Arts	1.24%	0.56%	No change
Natural Resources	1.08%	0.89%	No change
Natural Sciences	1.17%	0.61%	0.20%
Veterinary Medicine & Biomedical Sciences	1.42%	1.02%	No change

It was conjectured that there may be an opportunity to of enhance the existing decision approach to make the percent of honors awarded over time more closely match the desired 1, 3 and 6 percentile proportions. This analysis can be framed as a breakpoint selection process considering k GPA apportionment breakpoints in m intervals in j colleges in a t period non-stationary process. The current decision approach could potentially be enhanced with the selective addition of auxiliary SPC decision rules. That is, by altering the balance between the probability of a false alarm (α) and false process control intervention (β), the L1, L2 and L-infinity distance norms performance measures attained values can be improved. In the literature review it was found that Lunneborg [4] considered a decision approach to ensure fair admission of low income and minorities' population in a university allowing additional considerations for only academic performance by ranking of applicants. The research has a structure similar to our problem, but included only one decision rule.

SIMULATION DEVELOPMENT

This section will show the event-based modeling formalization presented in Choi & Kang [5] and Schruben [6]. The entity in this simulation is named "GRADUATING CLASS", with attributes of 1) Class size, 2) Total honors awarded, 3) Percentage honors awarded, 4) GPA per student and 4) Average GPA per distinction. The sequence of activities for a simulation experiment is shown in figure 1.

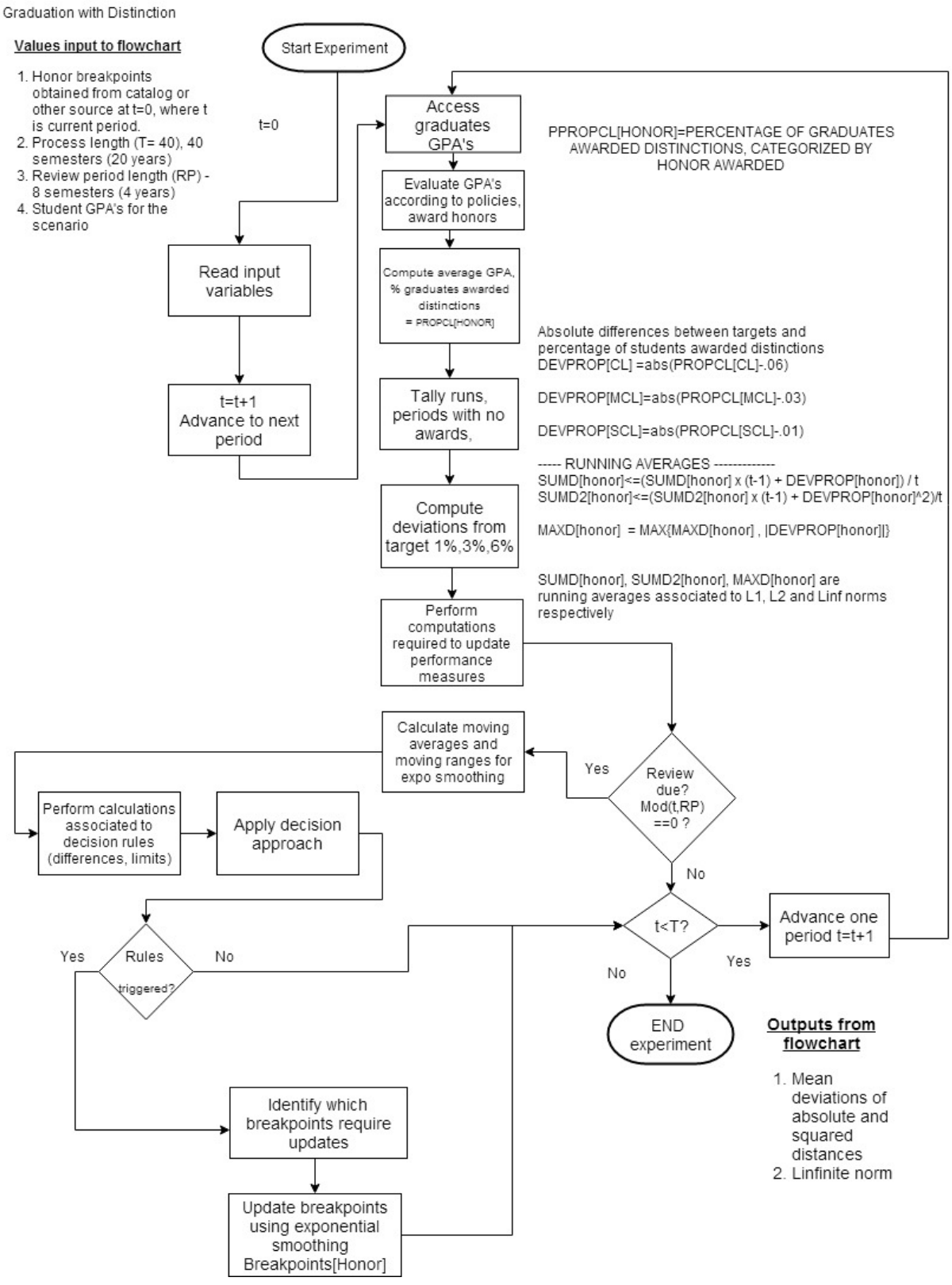

Figure 1: Flowchart of graduation with distinction process

Event graph

Figure 2 presents an event graph for the Graduation with Distinction process. The event graph consists of vertices, which perform logical or mathematical operations to update state variables, and edges that facilitate the logical flow between the vertices. For one experiment the user can include one or more auxiliary decision rules to the existing SPC based decision approach.

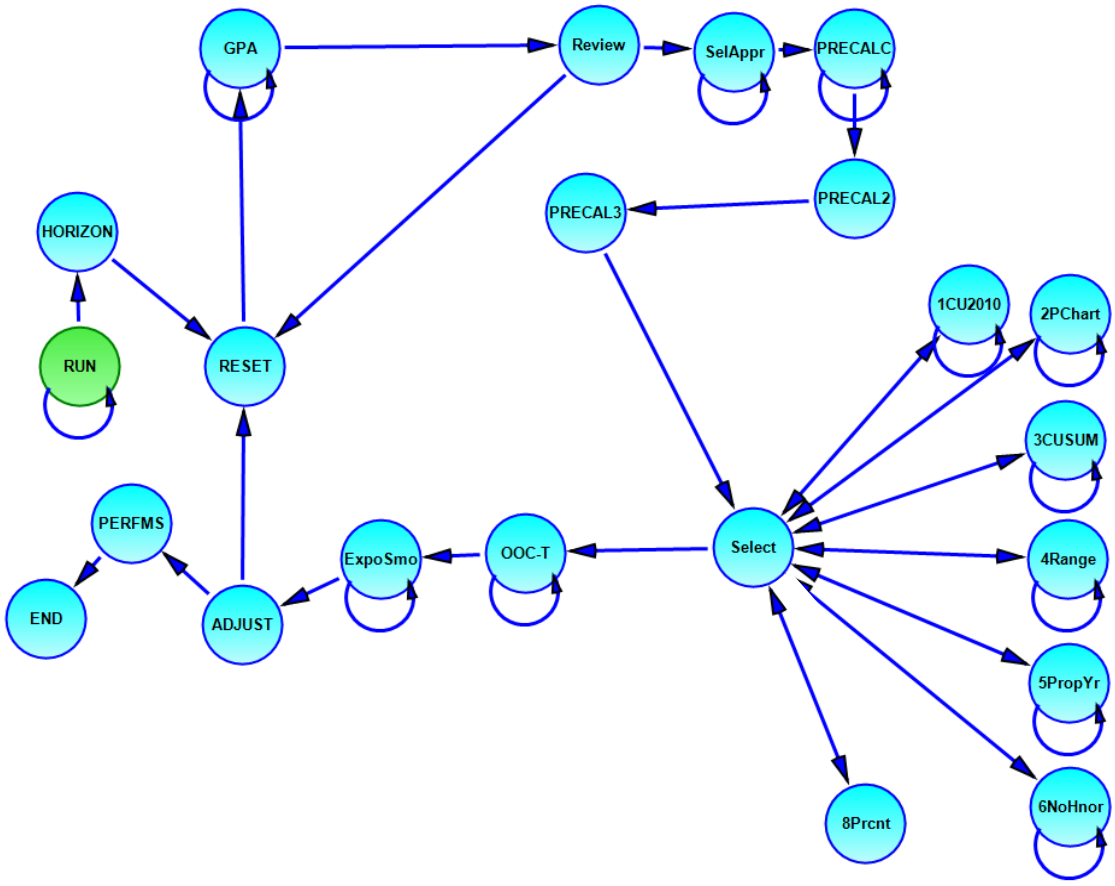

Figure 2: Event graph representation of the graduation with distinction process with SPC rules

Currently, the following auxiliary SPC rules are being considered:

1. 1CSU2010 –Deviations from target 1%, 3% and 6% proportions
2. 4Range rules related to range of percentage of students awarded distinctions within a review period exceeds certain values.
3. 5PropYr event includes rules related to the year by year changes in proportion of students receiving distinctions.
4. 6NoHnor event occurs when no honors are awarded during review period.
5. 8Prcnt event occurs when percentage of class honors are above/below 5% of expected10%.

Figure 3 shows the event graph logic for events related to updating the GPA breakpoints. The vertex **ExpoSmo** performs calculations used in the exponential smoothing method to provide new breakpoint targets for distinctions. A self-scheduling edge creates a loop within the current review period. Afterwards, event **ADJUST** is scheduled and state variables are updated if process control rules show an out of control condition. Event **PERFMS** (to finalize any calculations of performance measures) is scheduled if all decision rules have been computed and all periods have been evaluated. If there are still periods pending consideration, a **RESET** event will be scheduled and the process will allocate distinctions for an additional period.

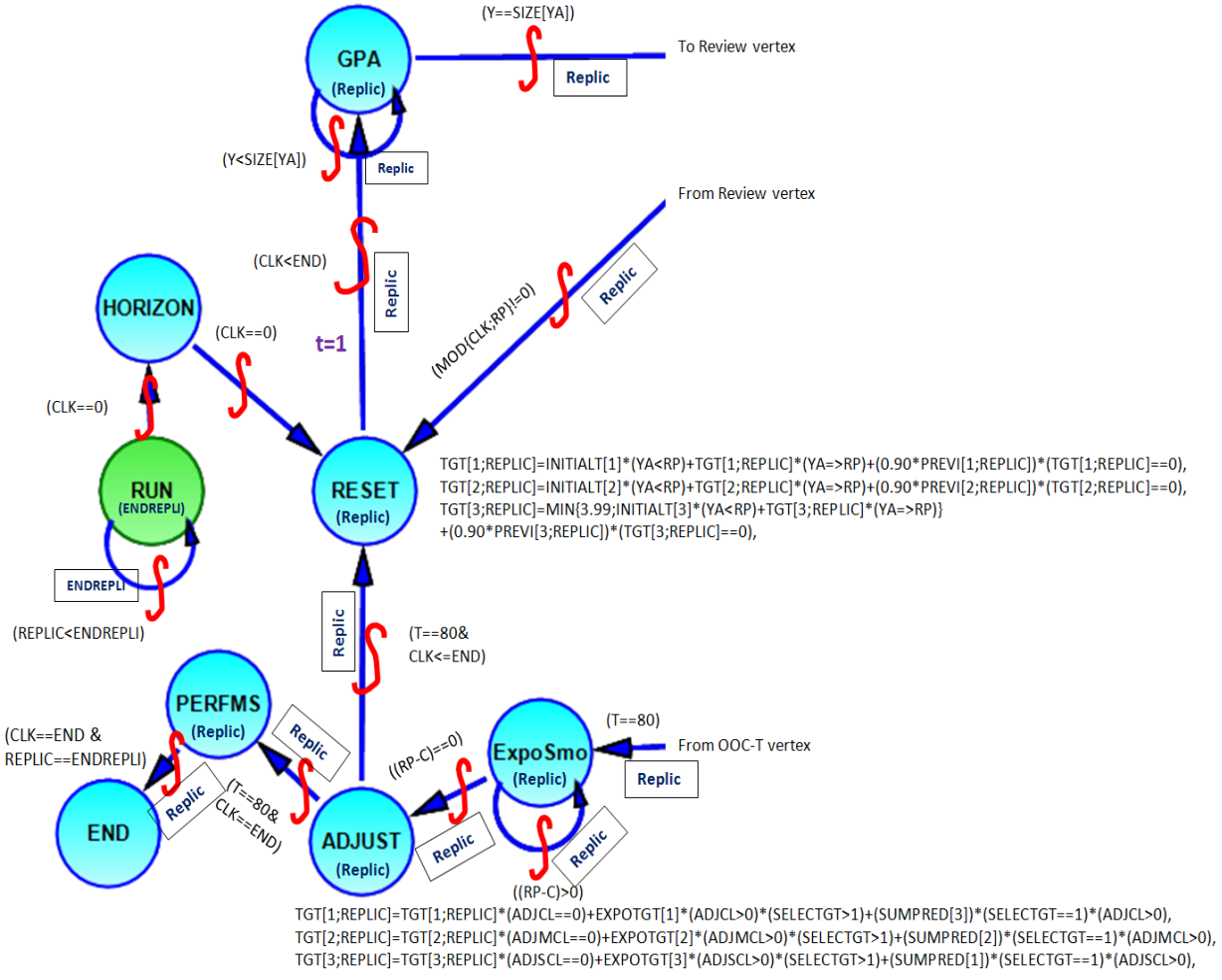

Figure 3: Event graph logic for the update of breakpoints

Performance measures

We want to determine how closely a decision approach achieves the 1, 3 and 6 percent honors targets. Pairwise comparisons of performance measures statistics will test if the differences in the following measures are statistically significant.

1. Mean absolute normalized distance between the actual percentage of students receiving a distinction from the respective 1, 3 and 6 percent breakpoints.
2. Mean squared normalized distance between the actual percentage of students receiving a distinction from the respective 1, 3 and 6 percent breakpoints.
3. Maximum absolute normalized difference between the actual percentages of students receiving a distinction from the existing breakpoints.

Validation and verification

Verification ensures the correctness in the development an event graph for the Graduation with Distinction Process. Verifying event graph logic was accomplished by inspecting the Sigma English translation and from the detailed simulation traced outputs. Validation included reviewing the event graph logic with the stakeholders and reviewing mathematical calculations for determination of breakpoint GPA's using Exponential Smoothing, with a smoothing constant α=0.20. Table 4 shows the breakpoints for the simulation and the actual decision process.

Table 4: Comparison of breakpoints results in validation stage

Decision Approach			Simulation			% Difference		
Cum	Magna	Summa	Cum	Magna	Summa	Cum	Magna	Summa
3.78	3.90	3.98	3.781	3.902	3.978	-0.03%	-0.05%	0.05%

Table 5 compares the simulation and actual decision approach for the P-chart and shows only negligible differences. Similarly, as shown in Table 6, the differences are negligible for the Cumulative Sum (C+ and C-) charts.

Table 5: Comparison of results for the p-chart – College of Business

Source	Center line of p-chart			Percentage of difference		
	Cum	Magna	Summa	Cum	Magna	Summa
Decision Approach	0.06013	0.05313	0.02183	3.54%	0.24%	-0.78%
Simulation	0.058	0.053	0.022			

Table 6: CUSUM comparison (Magna Cum Laude)

Year	C+			C-		
	Dec Approach	Simulation	% Diff	Dec Approach	Simulation	% Diff
1	0.050908	0.052	-2%	0	0	0
2	0.097622	0.1	-2%	0	0	0
3	0.139103	0.145	-4%	0	0	0
4	0.190459	0.197	-3%	0	0	0

CONCLUSIONS

This paper discussed the successful development of an event incremented simulation that can be used to test candidate decision approaches for the new Graduation with Distinction process. The results from the validation and verification stage confirm the simulation closely tracks the current Graduation with Distinction process by correctly estimating process control parameters and breakpoints. Performance measures based on normalized distances will measure the closeness between the SPC produced and target percentiles. The necessary strategy to test these approaches has been created to maintain a fair process of allocating distinctions.

NEXT STEPS

We will start creating scenarios that serve as inputs for experimental runs such as, but not limited to: 1) a sustained 20% change in average GPA for two years, 2) a sustained increase/decrease of 0.05 in the average GPA for one year and others. Steady-state and replicated experiments will be used to conduct appropriate statistical analysis on decision approaches and performance measures and for determining a terminating horizon. Replicates of a terminating simulation will allow pairwise comparisons of decision approaches.

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