Stevens Institute of Technology

School of Business

**AACSB
ASSURANCE OF LEARNING**

**Master of Science in**

**Financial Engineering**

 **(FE)**

**LEARNING GOAL # 3**

**Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.**

**Responsibility: Sveinn Olafsson**

May 2024

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# 1. INTRODUCTION: LEARNING GOAL #3

*Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.*

This goal is assessed in the “practicum” course FE 621 Computational Methods in Finance, which is a required course in the FE curriculum. This learning goal requires students to think analytically and to synthesize material from other courses in the curriculum.

The assessment takes place by evaluating the assignments and exams of students throughout the semester.

# 2. LEARNING OBJECTIVES AND TRAITS

|  |  |
| --- | --- |
| **FE 3:** | **Learning Goal, Objectives and Traits** |
| GOAL | Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering. |
| **Objective 1:** | *Students will demonstrate the capability of implementing and analyzing various numerical techniques and applying them to modern problems in financial engineering.*  |
| **Traits** |   |
| Trait 1: | Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. |
| Trait 2: | Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  |
| Trait 3: | Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. |
| Trait 4: | Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. |
| Trait 5: | Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language.  |

# 3. RUBRICS

|  |
| --- |
|  **FE LEARNING GOAL - 3: RUBRIC 1** |
| **FE 3** | Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering. |
| **Objective 1** | *Students will demonstrate the capability of implementing and analyzing various numerical techniques and applying them to modern problems in financial engineering.*  |
|   | **Trait** | **Poor** | **Good** | **Excellent** | **Score** |
|   | **Value** | **0** | **5** | **10** |  |
| Trait 1: | Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | Poor ability  | Sufficient ability  | Excellent ability  |   |
| Trait 2: | Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | Poor ability  | Sufficient ability  | Excellent ability  |   |
| Trait 3: | Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | Poor ability  | Sufficient ability  | Excellent ability |   |
| Trait 4: | Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | Poor ability  | Sufficient ability  | Excellent ability  |   |
| Trait 5: | Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | Poor ability  | Sufficient ability  | Excellent ability |  |
| **Criterion: Does not meet expectations: 0-19; Meets: 20-34 ; Exceeds: 35-50** |

# 4. ASSESSMENT PROCESS

|  |  |  |
| --- | --- | --- |
| **Where & when measured?** | **How measured?** | **Criterion** |
| Assessed during the Spring semester in the course FE 621: *Computational Methods in Finance*.  | Through assignments and exams.  | Course passed at 60% |

The FE program assesses these skills in FE621: *Computational Methods in Finance*. The assessment takes place by evaluating the assignments and exams of students.

# 5. RESULTS OF LEARNING GOAL ASSESSMENT - INTRODUCTION

The results of the initial learning goal assessments carried out to date are included below.

**Explanation of Direct Measurements**

Each learning goal has a number of learning objectives, and performance on each objective is measured using a rubric that, in turn, contains a number of desired “traits.” Students are scored individually on each trait.

The grading sheets for each student are used to develop a Summary Results Sheet for each learning goal objective. A selection of these summaries is included below.

The first table in the Summary Results Sheet for a learning objective/trait gives the counts of students falling in each of the three categories:

* Does Not Meet Expectations
* Meets Expectations
* Exceeds Expectations

The right-hand column in the table is used to record the average score of the students on each trait. This table provides an indication of the relative performance of students on each trait.

The second table on each sheet provides the counts of students who fall in each of the above three categories for the overall learning objective.

The person doing the assessment provides explanatory comments and recommendations on the bottom of the Results Summary Sheet. The recommendations improve content or pedagogy changes for the next time the course is given.

**Explanation of Indirect Measurements**

N/A

**6. Assessment Spring 2024:**

**LEARNING GOAL # 3:** Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.

**LEARNING OBJECTIVE #1:**
*Students will demonstrate the capability of implementing and analyzing various numerical techniques and applying them to modern problems in financial engineering.*

**ASSESSMENT DATE: 05/01/24**

**ASSESSOR: Sveinn Olafsson**

**NO. OF STUDENTS TESTED: 19 (on campus) + 11 (online)**

**The three tables below are for “on campus” / “online” / “on campus and online combined”**

**COURSE: FE 621 on campus**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 2 | 5 | 12 | 8.3 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 2 | 5 | 12 | 8.3 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 2 | 5 | 12 | 8.3 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 2 | 5 | 12 | 8.3 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 2 | 5 | 12 | 8.3 |
| **Average Grade (Maximum 10)** | 8.3 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **2** | **5** | **12** |
| **Students meeting or exceeding expectations:** | **17** |

**COURSE: FE 621 online**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 2 | 5 | 4 | 7.4 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 2 | 5 | 4 | 7.4 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 2 | 5 | 4 | 7.4 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 2 | 5 | 4 | 7.4 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 2 | 5 | 4 | 7.4 |
| **Average Grade (Maximum 10)** | 7.4 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **2** | **5** | **4** |
| **Students meeting or exceeding expectations:** | **9** |

**COURSE: FE 621 on campus and online combined**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 4 | 10 | 16 | 8.0 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 4 | 10 | 16 | 8.0 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 4 | 10 | 16 | 8.0 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 4 | 10 | 16 | 8.0 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 4 | 10 | 16 | 8.0 |
| **Average Grade (Maximum 10)** | 8.0 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **4** | **10** | **16** |
| **Students meeting or exceeding expectations:** | **26** |

**COMMENTS: N/A**

**REMEDIAL ACTIONS: N/A**

# 7. Outcomes from Previous Assessments:

**ASSESSMENT DATE: 05/20/23 (Spring 2023)**

**ASSESSOR: Sveinn Olafsson**

**NO. OF STUDENTS TESTED: 20 (on campus) + 21 (online)**

**The three tables below are for “on campus” / “online” / “on campus and online combined”**

**COURSE: FE 621 on campus**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 2 | 6 | 12 | 8.3 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 2 | 6 | 12 | 8.3 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 2 | 6 | 12 | 8.3 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 2 | 6 | 12 | 8.3 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 2 | 6 | 12 | 8.3 |
| **Average Grade (Maximum 10)** | 8.3 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **2** | **6** | **12** |
| **Students meeting or exceeding expectations:** | **18** |

**COURSE: FE 621 online**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 3 | 10 | 8 | 7.6 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 3 | 10 | 8 | 7.6 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 3 | 10 | 8 | 7.6 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 3 | 10 | 8 | 7.6 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 3 | 10 | 8 | 7.6 |
| **Average Grade (Maximum 10)** | 7.6 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **3** | **10** | **8** |
| **Students meeting or exceeding expectations:** | **18** |

**COURSE: FE 621 on campus and online combined**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| Students will implement and analyze tree- and lattice-based approximation methods for continuous-time stochastic processes. | 5 | 16 | 20 | 7.9 |
| Students will implement and analyze Monte Carlo simulation schemes for stochastic processes.  | 5 | 16 | 20 | 7.9 |
| Students will implement and analyze techniques for calibrating stochastic processes and option pricing models to financial data. | 5 | 16 | 20 | 7.9 |
| Students will apply numerical techniques to problems in derivatives pricing, risk management, asset allocation, and other areas of financial engineering. | 5 | 16 | 20 | 7.9 |
| Students will demonstrate the ability to (i) write, compile, and run computer programs for the numerical techniques covered in the course, and (ii) present and describe numerical results using both visual analytics and plain language. | 5 | 16 | 20 | 7.9 |
| **Average Grade (Maximum 10)** | 7.9 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **5** | **16** | **20** |
| **Students meeting or exceeding expectations:** | **36** |

**COMMENTS: N/A**

**REMEDIAL ACTIONS: N/A**

**ASSESSMENT DATE: 05/15/22 (Spring 2022)**

**ASSESSOR: Sveinn Olafsson**

**NO. OF STUDENTS TESTED: 20 (on campus) + 31 (online)**

**The three tables below are for “on campus” / “online” / “on campus and online combined”**

**COURSE: FE 621 on campus**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| The students will implement various tree approximation methods. | 1 | 15 | 4 | 8.2 |
| The students will implement PDE discretization methods to calculate derivative prices.  | 1 | 15 | 4 | 8.2 |
| The students will demonstrate understanding of transformation methods to solve PDE’s as well as calibrate stochastic processes to real data. | 1 | 15 | 4 | 8.2 |
| Students will demonstrate the ability to approximate derivative prices using Monte Carlo simulations. | 1 | 15 | 4 | 8.2 |
| The students will demonstrate the ability to write, compile, and execute computer programs to solve the problems in the course.  | 1 | 15 | 4 | 8.2 |
| **Average Grade (Maximum 10)** | 8.2 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **1** | **15** | **4** |
| **Students meeting or exceeding expectations:** | **19** |

**COURSE: FE 621 online**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| The students will implement various tree approximation methods. | 4 | 19 | 8 | 7.9 |
| The students will implement PDE discretization methods to calculate derivative prices.  | 4 | 19 | 8 | 7.9 |
| The students will demonstrate understanding of transformation methods to solve PDE’s as well as calibrate stochastic processes to real data. | 4 | 19 | 8 | 7.9 |
| Students will demonstrate the ability to approximate derivative prices using Monte Carlo simulations. | 4 | 19 | 8 | 7.9 |
| The students will demonstrate the ability to write, compile, and execute computer programs to solve the problems in the course.  | 4 | 19 | 8 | 7.9 |
| **Average Grade (Maximum 10)** | 7.9 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **4** | **19** | **8** |
| **Students meeting or exceeding expectations:** | **27** |

**COURSE: FE 621 on campus and online combined**

|  |  |  |
| --- | --- | --- |
|  | **Number of Students** |  |
| **Learning Goal Traits** | **Not Meet Expectat-ions** | **Meet Expectat-ions** | **Exceed Expectat-ions** | **Avg. Grade on Trait** |
| The students will implement various tree approximation methods. | 5 | 34 | 12 | 8.0 |
| The students will implement PDE discretization methods to calculate derivative prices.  | 5 | 34 | 12 | 8.0 |
| The students will demonstrate understanding of transformation methods to solve PDE’s as well as calibrate stochastic processes to real data. | 5 | 34 | 12 | 8.0 |
| Students will demonstrate the ability to approximate derivative prices using Monte Carlo simulations. | 5 | 34 | 12 | 8.0 |
| The students will demonstrate the ability to write, compile, and execute computer programs to solve the problems in the course.  | 5 | 34 | 12 | 8.0 |
| **Average Grade (Maximum 10)** | 8.0 |

**Criterion: Does not meet expectations: 0-6; Meets: 7-8; Exceeds: 9-10**

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Not meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category***(Based on Average score across all traits)* | **5** | **34** | **12** |
| **Students meeting or exceeding expectations:** | **36** |

**COMMENTS: The ability of students to present their thoughts and numerical results in a clear and understandable way is lacking.**

**REMEDIAL ACTIONS:**

The following table shows the average scores on each goal objective.

|  |  |
| --- | --- |
|  | Objective 1*Students will demonstrate the capability of implementing and analyzing various numerical techniques and applying them to modern problems in financial engineering.* |
| *Spring 2022* | 8.2 (in-class) / 7.9 (online) / 8.0 (combined) |

# 8. Close Loop Process – Continuous Improvement Record

Assurance of Learning

Assessment/Outcome Analysis

Close Loop Process - Continuous Improvement Record

**Program:** Master of Science in Financial Engineering

**Goal 3:** Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.

**Goal Owner:** Sveinn Olafsson

**Where Measured:** In the courseFE621: *Computational Methods in Finance*

**How Measured:** By evaluating the assignments and exams of students.

**Closing the Loop: Actions taken on specific objectives**

|  |  |
| --- | --- |
| **Objective 1** | *Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.* |
| **When Assessed:** | *Spring 2024* |
| **Remedial****Action** | Remedial actions to further improve the ability of students to achieve Objective 1 through the course FE621:1. Introduce a course project that students work on individually or in small groups, with a recorded presentation at the end of the semester. Topics should be carefully chosen based on the interests of students and industry needs, with the aim of strengthening students’ portfolio for job-hunting.
2. Formally make “Computational aspects of cutting-edge machine learning applications in finance” one of the “learning traits” of the course.
 |
| **Outcome from previous assessment** | Remedial actions on the Spring 2023 assessment were successfully implemented: 1. *Keep working on the ability of students to present numerical results using graphs and tables, and to present their thoughts and ideas in a clear and coherent manner.*
2. *Spend 2-3 weeks on the numerical aspects of cutting-edge machine learning applications in financial engineering.*
3. *Target copying/cheating among students. Specify a clear policy at the beginning of the semester and involve the TA in identifying academic dishonesty.*

“Presentation” was incorporated into the grading of assignments, and the presence of cheating/copying/chat-GPT was carefully monitored by instructor and TA. The last 3-4 weeks of the course were successfully used for machine learning applications, and this material will become one of the “learning traits” in the next round of evaluation.  |

**Closing the Loop: Actions taken on specific objectives**

|  |  |
| --- | --- |
| **Objective 1** | *Students will achieve mastery of the foundational computational methods required for quantitative analysis in Financial Engineering.* |
| **When Assessed:** | *Spring 2023* |
| **Remedial****Action** | Remedial actions to further improve the ability of students to achieve Objective 1 through the course FE621:1. Keep working on the ability of students to present numerical results using graphs and tables, and to present their thoughts and ideas in a clear and coherent manner.
2. Spend 2-3 weeks on the numerical aspects of cutting-edge machine learning applications in financial engineering.
3. Target copying/cheating among students. Specify a clear policy at the beginning of the semester and involve the TA in identifying academic dishonesty.
 |
| **Outcome from previous assessment** | Remedial actions on the Spring 2022 assessment were successfully implemented: 1. *“Reduce emphasis on derivatives pricing. Consider applications in risk management, trading, and asset allocation.”*
2. *“Increase emphasis on Monte Carlo simulation.”*
3. *“Emphasize the importance of presenting numerical results using graphs and tables in a clear and readable manner.”*

Change 1 was motivated by industry needs where the demand for “derivative quants” has declined. Change 2 was in particular done at the expense of “numerical PDEs”, which currently is a topic of low relevance in the financial industry, while Monte Carlo simulation is important and useful in virtually all areas of finance. Change 3 was motivated by students’ inability to present their results in a manner that would be considered acceptable in industry.The “desired traits” listed on this assessment form have been updated to reflect the above changes.  |