Exam CFEFD
AFTERNOON SESSION

Date: Wednesday, October 30, 2019
Time: 1:30 p.m. – 3:45 p.m.

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This afternoon session consists of 4 questions numbered 8 through 11 for a total of 40 points. The points for each question are indicated at the beginning of the question. No questions pertain to the Case Study.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.

3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.

2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.

3. The answer should be confined to the question as set.

4. When you are asked to calculate, show all your work including any applicable formulas.

5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate morning or afternoon session for Exam CFEFD.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Recognized by the Canadian Institute of Actuaries.

Tournez le cahier d’examen pour la version française.
8. (11 points) Lemon Lu, a fitness apparel company, wishes to expand its market by becoming the first major brand to sponsor a professional bowler. Lemon Lu wants this to be a significant, long-term investment. Lemon Lu has asked you to select one of the top ten bowlers currently in the sport.

To evaluate the bowlers, you will use the following criteria:

- Average bowling score
- Popularity with fans
- Overall health
- Performance under pressure

Bowling scores from all tournaments are available in a database, while the other criteria are categorical measures provided by a bowling expert.

(a) (2 points) Explain four reasons why Data Envelopment Analysis (DEA) would help with your selection.

(b) (2 points)

(i) Describe non-dominated alternatives in a DEA context.

(ii) Describe the steps of a linear programming model used to identify which bowlers are non-dominated.

Lemon Lu is concerned about how to account for average bowling score because some bowlers often fluctuate between high and low scores.

(c) (3 points) Explain how to modify the linear programming model in (b)(ii) to be stochastic, assuming bowlers' scores are normally distributed.

(d) (2 points) Explain two pros and two cons of using the deterministic linear programming model in (b)(ii) instead of the stochastic model in (c).

Lemon Lu wants to understand if data mining of social media would provide insights on what factors affect a bowler's popularity.

(e) (2 points) Explain the approach you would use to study a social media data set.
9. (11 points) Adam has recently joined a large bank as a risk analyst. On his first day, the CRO assigns a new project, which involves analyzing defaults in a relatively new loan portfolio of the bank. The bank expects to offer this product online, where customers can apply and receive approval for a loan almost immediately.

The CRO suggests that loan approvals be based on an internal credit rating. She asks Adam to build a model to derive these credit ratings for loan applicants.

(a) (2 points) Describe the six phases of the CRISP-DM process.

Adam has collected customer-specific and loan-specific data from internal sources, and macroeconomic data from external sources.

(b) (2 points)

   (i) Identify two approaches to select the key features to include in the credit rating model.

   (ii) Recommend which approach from (i) should be implemented. Justify your recommendation.
9. Continued

The CRO expects the model to classify applicants based on the risk of default. Given the business implications of misclassification, she believes that model accuracy should be at least 80%.

Adam intends to test a k-nearest neighbor, a logistic regression, and a support vector machine model for the data.

Confusion matrices of initially fitted models are as follows:

<table>
<thead>
<tr>
<th>k-nearest neighbor model</th>
<th>Prediction</th>
<th></th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Logistic regression</th>
<th>Prediction</th>
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<tbody>
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<td>Default</td>
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<tr>
<td>Target</td>
<td></td>
<td></td>
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<td>Non-Default</td>
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<td>739</td>
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<tr>
<td>Default</td>
<td>143</td>
<td>147</td>
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</table>

<table>
<thead>
<tr>
<th>Support vector machine</th>
<th>Prediction</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-Default</td>
<td>Default</td>
</tr>
<tr>
<td>Target</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Default</td>
<td>4,129</td>
<td>581</td>
</tr>
<tr>
<td>Default</td>
<td>133</td>
<td>157</td>
</tr>
</tbody>
</table>

(c) (5 points)

(i) Calculate the classification accuracy and the average class accuracy of each model. Show your work.

(ii) Evaluate each model above in terms of accuracy.

(iii) Explain how to improve the performance of the models.

Adam has further refined all three models so that accuracy levels are above the CRO’s threshold. He must select one model to integrate into the bank’s online loan approval module.

(d) (2 points) Recommend which model Adam should select. Justify your recommendation.
10. **(9 points)** Raptor, Inc. is considering three options to manage its excess capital:

   I. Retain the funds to boost the company’s capital solvency ratio
   II. Execute a one-time share repurchase
   III. Pay a one-time dividend to shareholders

(a) **(1 point)** Explain the difference between options II and III above, assuming perfect capital markets.

The use of the excess capital could impact the following Raptor stakeholders:

A. Management with stock options
B. Employees with a defined benefit pension plan
C. Debt holders

(b) **(3 points)** Assess which option (I-III) is the most advantageous for each stakeholder (A-C).

(c) **(1 point)** Identify the additional information needed to assess which option is most advantageous to common stockholders. Justify your response.

Raptor’s CFO alternatively suggests that the excess capital should be reinvested in an internal opportunity. It is expected to earn a 10% after-tax ROIC in perpetuity while maintaining the company’s current risk profile. You are given the following information:

<table>
<thead>
<tr>
<th>WACC</th>
<th>16%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Capital</td>
<td>$2 billion</td>
</tr>
<tr>
<td>Shares Outstanding</td>
<td>1 billion</td>
</tr>
<tr>
<td>Current Share Price</td>
<td>$100</td>
</tr>
</tbody>
</table>

(d) **(2 points)** Calculate the impact to Raptor’s stock price for each of the following scenarios:

(i) The excess capital is used for share repurchases at the current share price.

(ii) The excess capital is used for the internal investment opportunity and returns are realized as expected and distributed to shareholders annually.

Show your work.
10. Continued

Josh, on the CFO’s staff, says, “If we use the Market Value Added (MVA) to evaluate the proposed internal investment opportunity and it is positive, we should invest!”

(e) (2 points)

(i) Critique Josh’s statement.

(ii) Calculate the MVA of the proposal. Show your work.

(iii) Recommend whether Raptor should proceed with the proposal, based on the result in (ii).
11. (9 points) You are an actuarial consultant. Your client, Toonie Corporation, has asked you to create a stochastic model to project its fixed-income portfolio for internal required capital.

(a) (1 point) Describe two advantages of using a stochastic simulation model.

As a first step, you must develop models to measure Toonie’s fixed-income portfolio risks.

(b) (2 points)

(i) Recommend a stochastic process to model interest rates. Justify your selection.

(ii) Describe a limitation of the interest rate model you recommended in (i).

(c) (2 points) Describe four factors that complicate the modelling of credit risk.

After building the stochastic model, Toonie identifies the need to develop a lighter version of the model to meet tight reporting deadlines.

(d) (1 point) Compare and contrast a light model with a heavy model.

Information from Toonie’s stochastic model and two potential light models is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Stochastic Model</th>
<th>Replicating Portfolio</th>
<th>Polynomial Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VaR(99)</td>
<td>105</td>
<td>103</td>
<td>117</td>
</tr>
<tr>
<td>CTE(95)</td>
<td>130</td>
<td>133</td>
<td>140</td>
</tr>
<tr>
<td>Interest Rates +100bps</td>
<td>-25</td>
<td>-27</td>
<td>-23</td>
</tr>
<tr>
<td>Interest Rates -100bps</td>
<td>28</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>Interest Rates +600bps</td>
<td>-76</td>
<td>-82</td>
<td>-79</td>
</tr>
<tr>
<td>Credit defaults +10%</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Credit defaults x2</td>
<td>30</td>
<td>34</td>
<td>32</td>
</tr>
<tr>
<td>r-Squared</td>
<td>0.85</td>
<td>0.80</td>
<td>0.95</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov Value</td>
<td>n/a</td>
<td>0.87</td>
<td>0.54</td>
</tr>
<tr>
<td>Cost of model implementation</td>
<td>n/a</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Model run-time (hours)</td>
<td>24</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

(e) (3 points) Recommend which light model Toonie should select. Justify your recommendation.
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