

**NANYANG TECHNOLOGICAL UNIVERSITY**  
**NANYANG BUSINESS SCHOOL**  
**BC2407**  
**ANALYTICS II: ADVANCED PREDICTIVE TECHNIQUES**

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<b>Academic Year</b>	: 2023/2024	<b>Semester</b>	: 2
<b>Course Coordinator</b>	: Neumann Chew		
<b>Pre-requisites</b>	: AB1202 and BC2406		
<b>No. of AUs</b>	: 4		
<b>Contact Hours</b>	: 52 hours		

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### **A) Course Aims/Description**

Previously, BC2406 introduced core concepts of Business Analytics and the standard predictive models in used by businesses and governments. However, there are more complex situations that require more sophisticated techniques. BC2407 is the continuation of BC2406. The main objective of BC2407 is to teach students more advanced techniques to extract more useful and deeper insights under more complex realistic situations. At the end of the course, students will see the strengths and weaknesses of standard models, and learn advanced techniques to overcome the weaknesses in various scenarios.

### **B) Intended Learning Outcomes (ILO)/Objectives**

By the end of this course, you should be able to:

1. Identify aspects of business problems that cause standard analytics models to become useless or less effective.
2. Apply advanced techniques to overcome or mitigate the weaknesses of standard analytics models.
3. Evaluate performance of the advanced predictive techniques.
4. Explain the workings and results of advanced predictive techniques in the context of the business problem to client/employer.
5. Propose business solutions and recommendations based on insights from the advanced predictive techniques.

### **C) Course Content**

1. Association Rules
2. Quantile Regression

3. Multivariate Adaptive Regression Splines (MARS)
4. Bootstrap
5. Neural Network
6. Random Forest
7. Time Series Forecasting
8. Customer Analytics Problem
9. Visualization and Dashboard [eLearning]

**D) Assessment (includes both continuous and summative assessment)**

Component	ILO Tested	NBS Learning Goal (Refer to Appendix 1 for list)	Weightage	Team/ Individual	Assessment Rubrics (attach rubrics in appendix)
1. Class Participation & Individual Presentation	ILO1, ILO4, ILO5.	Critical Thinking	30%	Individual	Critical Thinking rubric
2. Assignment	ILO2, ILO4, ILO5.	Problem Solving & Decision Making	10%	Team <sup>#</sup>	Problem Solving & Decision Making rubric
3. Project (w. individual Presentation)*	ILO2, ILO3, ILO5.	Written & Oral Communication	30%	Team <sup>#</sup>	Written & Oral Communication rubric
4. Computer Based Assessment	ILO2, ILO3, ILO5.	Problem Solving & Decision Making	30%	Individual	Problem Solving & Decision Making rubric
Total			100%		

**Important Notes:**

**\*: All students must present their work and individual presentation will be separately assessed, in addition to written project report, slides and team presentation as a whole.**

**#: Peer Evaluation is mandatory and team member marks may be adjusted based on ratings (as given in Peer Evaluation Rubrics) and peer comments. A sample is provided in Annex A(i). Peer evaluation will open in the last teaching week of the semester to be submitted by mid of the next week. Self-evaluation and self-reflection are also included.**

**E) Formative feedback**

Timely verbal feedback will be provided on assignments, projects and individual presentations. Verbal and written feedback will be provided on project proposal and in-class learning activities.

**F) Learning and Teaching approach**

Approach	How does this approach support you in achieving the learning outcomes?
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Seminars with quick check questions to validate understanding and stimulate discussions.	Interactive seminar sessions where there are ample opportunities for open discussion on the concepts. Open ended questions are strategic placed to stimulate critical thinking and discussions, and to emphasize the most important point. Quick poll questions allow instructor to gauge the level of understanding of a key concept.
Project	Opportunity to work in a team and develop an Analytics solution end-to-end (from business analysis, problem identification, data acquisition, analytics techniques, to written report, slides, presentation and recommendations) so as to understand how to do Analytics in the real world, and prepare students for future employment.
Assignment	Opportunity to apply and evaluate effectiveness of selected Analytics technique in a given business scenario with a given real-world large dataset.
In-Class Learning Activities	Analytics require skills which are practical in nature and cannot be achieved by reading only. In-Class learning activities provide instructor guided hands-on experience with specially designed problems and datasets to reinforce concept understanding and concept application. Immediate feedback at end of activities reinforce learning and illuminates common pitfalls, mistakes and misunderstanding.
End of Seminar Formative Quiz	Quiz to be taken by each student at end of each seminar validates each student understanding and reveal most difficult areas. Provide timely opportunities for instructor to quickly clarify mistakes and misunderstanding before they fester and snowball in future topics.

### G) Reading and References

#### Main Textbook:

Chew C.H. (2021 est.). Artificial Intelligence, Analytics and Data Science, Volume 2: Advanced Techniques. Cengage.

#### Supplementary References:

[1] Chew C.H. (2020). Artificial Intelligence, Analytics and Data Science, Volume 1: Core Concepts and Models. Cengage.

[2] SAS Institute (2009). Data Mining Using SAS Enterprise Miner: A Case Study Approach, 3ed. SAS Institute.

[3] Hastie, T., Tibshirani, R., & Friedman, J. H. (2009). The elements of statistical learning: data mining, inference, and prediction. 2nd ed. New York: Springer. Textbook PDF at: <https://web.stanford.edu/~hastie/ElemStatLearn/>

[4] James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning: With applications in R. Textbook PDF at: <http://faculty.marshall.usc.edu/gareth-james/ISL/>

## H) Course Policies and Student Responsibilities

### (1) General

You are expected to complete all assigned pre-class readings and activities, attend all seminar classes punctually, submit graded assessments and peer evaluation form by due dates. You are expected to take responsibility to follow up on course notes, activities, assignments and course related announcements for seminar sessions you have missed. You are expected to participate in all seminar discussions and activities.

### (2) Absenteeism

Absence from class without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate, LOA and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.

If you miss a seminar or assessment, you must inform the course instructor via email prior to the start of the class or at the earliest opportunity feasible.

## I) Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [academic integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

## J) Course Instructors

Instructor	Office Location	Phone	Email	Consultation Hours

Neumann Chew (Course Coordinator)	ABS-06-018		neumann.chew@ntu.edu.sg	By prior appointment via email.
Hyeokkoo Eric Kwon	ABS-06-026		eric.kwon@ntu.edu.sg	By prior appointment via email.

**K) Planned Weekly Schedule**

Week	Topic	ILO	Readings/ Activities
1	Overview of Advanced Predictive Analytics and Project Brainstorming	ILO1	Main Textbook Preface.
2	Intro to SAS EM; Review of R & Python.	ILO2, ILO3.	Main Textbook Appendix; Supp ref 1 & 2.
3	Association Rules	ILO2, ILO3, ILO4.	Main Textbook Chap 2.
4	Quantile Regression	ILO1, ILO2, ILO3.	Main Textbook Chap 3.
5	Multivariate Adaptive Regression Splines (MARS)	ILO1, ILO2, ILO3.	Main Textbook Chap 4.
6	Bootstrap for Analytics	ILO1, ILO2, ILO3.	Main Textbook Chap 7.
7	Neural Network	ILO1, ILO2, ILO3.	Supp ref 1 Chap 9.
8	Random Forest	ILO1, ILO2, ILO3.	Main Textbook Chap 8.
9	Time Series Forecasting	ILO1, ILO2, ILO3.	Main Textbook Chap 9.
10*	Visualization & Dashboard	ILO3, ILO4, ILO5.	eLearning [week TBC].
11	Customer Analytics Proposed Solution Presentation	ILO4, ILO5.	Requirements PDF.
12	Computer Based Assessment	ILO2, ILO3, ILO5.	
13	Project Presentation	ILO2, ILO3, ILO5.	

### ***Sample Peer Evaluation Used in an Undergraduate Course***

#### **Peer Evaluation Instructions**

All members are required to complete a peer evaluation for each member of the team (including a separate self-assessment section) for all Graded Team Submissions (team assignments and team project). The form will be provided by the instructor in week 13 and you should complete and submit after project presentation and before mid-week 14. Evaluation is confidential and will not be revealed to other team members.

We may use a student's ratings (on a scale ranging from 0 to 7) to award marks to other team members by computing the average rating that a team member receives from other members (i.e., excluding self-rating). A member's mark for the Graded Team Submission will be computed as follows:

1. If a member's average rating is  $\geq 4$ , the member may receive **100%** of the overall mark awarded to the team project.
2. If a member's average rating is  $< 4$  but  $\geq 3$ , the member may receive **80%** of the overall mark awarded to the team project.
3. If a member's average rating is  $< 3$  but  $\geq 2$ , the member may receive **50%** of the overall mark awarded to the team project.
4. If a member's average rating is  $< 2$  but  $> 1$ , the member may receive **30%** of the overall mark awarded to the team project.
5. If a member's average rating is between 0 to 1 (inclusive), the member may receive **0%** of the overall mark awarded to the team.

The exact marks depend on the details as provided in the peers' comments.

*Any student who has concerns with the possible ratings given by other team members should consult his/her instructor at the earliest opportunity. Provide evidence e.g. MCs, LOAs, letters, etc. The information should be provided latest by end of last teaching week.*

**CONFIDENTIAL PEER EVALUATION FORM FOR GRADED TEAM SUBMISSION**

Student name: \_\_\_\_\_

Seminar group and team number: \_\_\_\_\_

Please use the attached Peer Evaluation Rubric to evaluate your team members on each of the 5 stated attributes (on a scale of 0 to 7). State your ratings for each of your other team members in the table below. One table for each graded team submission. Do not rate yourself in this section. You will do your self-rating and reflection in another section.

	Name of team member (excluding yourself)	1 - RR	2 - CM	3 - CR	4 - CT	5 - RS	Average Rating
1							
2							
3							
4							
5							
6							

If any of your ratings above is **< 4**, you must provide detailed comments to justify the ratings.

Name of team member	Detailed comments to justify a rating of <b>&lt; 4</b>

*You may attach supporting documents (like emails and screen shots), if any, to support your explanations above.*

If there are exceptional teammate(s) who contributed significantly and substantially above all other teammates, please write his/her name(s) and provide sufficient details in the comments. Depending on your descriptions, he/she may get additional bonus marks.

Name of team member	Detailed comments about exceptional contributions

Self Evaluation

Graded Team Submission	1 - RR	2 - CM	3 - CR	4 - CT	5 - RS	Average Rating
My contribution in Team Assignment						
My contribution in Team Project						

Self Reflection

What did I do well for the graded team submissions?

What did I do badly for the graded team submissions? How can it be improved?



Do you think other teammates view you as a contributing team member? Why?

**Teamwork & Interpersonal Skills (Peer Evaluation) Rubric**

**Learning Objective: The ability to work effectively with others in a group setting. Scale: 0 ,1 ,2 ... 7.**

Traits	Performance	
<p><b><u>1. Roles and Responsibility (RR)</u></b> Behaves professionally by upholding responsibility and assuming accountability for self and others in progressing towards the team's goal.</p>	<p><b>Scant</b> Unclear about his/her own role; refuses to take a role in the group; insists to work individually and has limited coordination or communication with others.</p>	<p><b>Substantially Developed</b> Always fulfills responsibilities; performs his/her role within the group with enthusiasm and demonstrates willingness to work collaboratively.</p>
<p><b>Evaluation: Absent 0 ___ Scant 1 2 3 4 5 6 7 Substantially Developed</b></p>		
<p><b><u>2. Communication (CM)</u></b> Identifies appropriate mechanisms to coordinate and correspond with team members.</p>	<p><b>Scant</b> Modes of communication are not appropriate, causing confusion and miscommunication among team members.</p>	<p><b>Substantially Developed</b> Modes of communication are appropriate, and maintaining timely communication and correspondence with team members.</p>
<p><b>Evaluation: Absent 0 ___ Scant 1 2 3 4 5 6 7 Substantially Developed</b></p>		
<p><b><u>3. Conflict Resolution (CR)</u></b> Resolves conflicts using a variety of approaches.</p>	<p><b>Scant</b> Does not recognize conflicts or is unwilling to resolve conflicts.</p>	<p><b>Substantially Developed</b> Consistently resolves conflicts through facilitating open discussion and compromise.</p>
<p><b>Evaluation: Absent 0 ___ Scant 1 2 3 4 5 6 7 Substantially Developed</b></p>		
<p><b><u>4. Contributions (CT)</u></b> Contributes positive input for the team; effectively utilizes one's knowledge and expertise.</p>	<p><b>Scant</b> Largely disinterested in working in a group and refuses to participate; observes passively or is unwilling to share information with other team members.</p>	<p><b>Substantially Developed</b> <u>Actively attends and participates in all activities and provides meaningful contribution in articulating ideas and opinions.</u></p>
<p><b>Evaluation: Absent 0 ___ Scant 1 2 3 4 5 6 7 Substantially Developed</b></p>		
<p><b><u>5. Relationship (RS)</u></b> Maintains cooperative interaction with other team members regardless of</p>	<p><b>Scant</b> Rarely listens to others and does not acknowledge the opinions that differ from his/her own.</p>	<p><b>Substantially Developed</b> Engages in respectful relationships with all other members in the team. Embraces and accepts diverse points of view without prejudice.</p>
<p><b>Evaluation: Absent 0 ___ Scant 1 2 3 4 5 6 7 Substantially Developed</b></p>		

individual /cultural differences and respects diverse perspectives.	
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**References:**

*Teamwork Value Rubric - Association of American Colleges and Universities.* Retrieved from <http://www.aacu.org/value/rubrics/pdf/teamwork.pdf>

**Rubric for Class Participation & Individual Presentation (Critical Thinking)**

Traits	Performance	
Identifies and summarizes the issue at hand.	<b>Not Yet</b> Does not identify and summarize the issue, is confused.	<b>Substantially Developed</b> Identifies the main issue and its implicit aspects, addresses their relationships to each other and recognizes nuances of the issue.
	Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed	
Identifies and considers key assumptions and the influence of the context on the issue.	<b>Not Yet</b> Does not surface the assumptions of the model and does not examine the contexts, e.g., cultural and political.	<b>Substantially Developed</b> Identifies and questions the validity of the assumptions and analyzes the issue with a clear sense of scope and context.
	Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed	
Identifies and assesses conclusions, implications and consequences	<b>Not Yet</b> Fails to identify conclusions, implications, and consequences of the issue or the key relationships among the various elements such as context, evidence or assumptions. Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.	<b>Substantially Developed</b> Identifies and discusses conclusions, implications, and consequences, considering context, assumptions, data, and evidence. Objectively reflects upon own assertions. Draw warranted, judicious, non-fallacious conclusions.
	Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed	

**Rubric for Assignment (Problem Solving and Decision Making)**

Traits	Performance	
Define the Problem	<p><b>Not Yet</b> Does not identify the problem clearly; demonstrates limited understanding of the problem or related contextual factors.</p>	<p><b>Substantially Developed</b> Identifies the problem clearly and thoroughly; demonstrates the ability to construct a clear and insightful problem statement with evidence of all relevant context factors.</p>
	<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>	
Devise Strategies to Solve the Problem	<p><b>Not Yet</b> Selects a strategy without regard to fit; does not demonstrate the ability to consider new strategies even if his/her approach is clearly not appropriate; identifies alternatives that reflect limited understanding of the situation.</p>	<p><b>Substantially Developed</b> Identifies multiple strategies for solving the problem that apply within a specific context; demonstrates the ability to invert a process to form a plan and clearly articulates his/her decision making process; identifies alternatives that reflect an in depth understanding of the situation.</p>
	<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>	
Evaluate Outcomes	<p><b>Not Yet</b> Reviews results superficially in terms of the problem defined with no consideration of need for further work.</p>	<p><b>Substantially Developed</b> Reviews results relative to the problem defined with thorough, specific considerations of need for further work.</p>
	<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>	

**Rubric for Project (Written and Oral Communication)**

Traits	Performance	
<p><b><u>Design Factors – Content (Written)</u></b></p> <ul style="list-style-type: none"> <li>• Presents relevant information.</li> <li>• Substantiates claims with strong evidence</li> </ul>	<p><b>Not Yet</b> Uses inappropriate and irrelevant content to develop simple ideas in some parts of the work.</p>	<p><b>Substantially Developed</b> Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, conveying the writer’s understanding, and shaping the whole work.</p>
<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>		
<p><b><u>Communication Outcome</u></b></p> <ul style="list-style-type: none"> <li>• Has a clear message for audience</li> <li>• Maximizes likelihood of audience accepting the message</li> </ul>	<p><b>Not Yet</b> Central message is not explicitly stated in the presentation. Main points are not clearly identified, audience unsure of the direction of the message.</p>	<p><b>Substantially Developed</b> Central message if precisely stated; main points are clearly identified.</p>
<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>		
<p><b><u>Design Factors – Content (Oral)</u></b></p> <ul style="list-style-type: none"> <li>• Presents relevant information.</li> <li>• Supports main points with strong evidence</li> </ul>	<p><b>Not Yet</b> Content is erroneous or irrelevant; references and supporting materials are absent. Lacks of depth in content and little insights are exhibited. Presentation falls outside set time parameters.</p>	<p><b>Substantially Developed</b> Content is accurate, thorough, and directly on point; strong support and references are provided. Exhibits depth and insight in content. Effective use of time and stays within time parameters.</p>
<p>Evaluation: Not Yet ___1___2___3___4___5___6___7___8___9___10 Substantially Developed</p>		

**Rubric for Computer Based Assessment (Problem Solving and Decision Making)**

Traits	Performance	
Define the Problem	<b>Not Yet</b> Does not identify the problem clearly; demonstrates limited understanding of the problem or related contextual factors.	<b>Substantially Developed</b> Identifies the problem clearly and thoroughly; demonstrates the ability to construct a clear and insightful problem statement with evidence of all relevant contextual factors.
	Evaluation: Not Yet ___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10 Substantially Developed	
Devise Strategies to Solve the Problem	<b>Not Yet</b> Selects a strategy without regard to fit; does not demonstrate the ability to consider new strategies even if his/her approach is clearly not appropriate; identifies alternatives that reflect limited understanding of the situation.	<b>Substantially Developed</b> Identifies multiple strategies for solving the problem that apply within a specific context; demonstrates the ability to invert a process to form a plan and clearly articulates his/her decision making process; identifies alternatives that reflect an in depth understanding of the situation.
	Evaluation: Not Yet ___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10 Substantially Developed	
Evaluate Outcomes	<b>Not Yet</b> Reviews results superficially in terms of the problem defined with no consideration of need for further work.	<b>Substantially Developed</b> Review results relative to the problem defined with thorough, specific considerations of need for further work.
	Evaluation: Not Yet ___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___ 7 ___ 8 ___ 9 ___ 10 Substantially Developed	