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i-SYNERGY: AN INTEGRATED PREDICTIVE MODEL OF TIME PRESSURE, PERSONALITY TYPES, GENDER, KNOWLEDGE AND TASK COMPLEXITY TO DETERMINE SOFTWARE DEVELOPER'S PERFORMANCE

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Abstrak

Faktor manusia memainkan peranan penting dalam kejuruteraan perisian (SE) kerana perisian dibangunkan dan digunakan oleh manusia. Salah satu sebab utama kegagalan projek perisian adalah tidak memberikan tugasan kepada individu yang sesuai untuk tugas yang tepat semasa perancangan projek. Isu ini menjadi lebih kritikal apabila pembangun perisian bekerja di bawah tekanan masa (TP), yang sering menyebabkan prestasi kurang baik dan kelewatan projek. Setiap jenis personaliti mempunyai cara tersendiri untuk mengatasi TP, dan perbezaan gender mempengaruhi cara pembangun perisian menangani TP, yang memberikan hasil yang berbeza. Di samping itu, kompleksiti tugasan dan pengetahuan pembangun saling berhubung dengan jenis personaliti dan gender, yang berpotensi mempengaruhi prestasi projek di bawah TP. Tujuan utama kajian ini adalah untuk mencadangkan model i-SYNERGY dengan mengkaji hubungan antara TP, jenis personaliti, gender, pengetahuan, dan kompleksiti tugasan. Untuk membangunkan model ini, bukti empirikal dikumpulkan daripada eksperimen terkawal yang dijalankan bersama pelajar SE, dan digeneralisasikan daripada data industri melalui dua kajian kes. Indikator jenis personaliti Myers-Briggs (MBTI) dan indeks beban tugas NASA (TLX) digunakan untuk mengukur jenis personaliti dan TP. Analisis data dibahagikan kepada dua peringkat. Peringkat pertama melibatkan pemeriksaan angka data untuk membangunkan model, manakala peringkat kedua melibatkan eksperimen ramalan untuk membangunkan model di bawah proses penemuan pengetahuan dalam pangkalan data (KDD). Lima teknik perlombongan data—rangkaian neural tiruan (ANN), mesin vektor sokongan (SVM), pokok keputusan, K-jiran terdekat (KNN), dan regresi logistik digunakan untuk mengenal pasti teknik yang paling sesuai untuk pembangunan model. Regresi logistik memberikan hasil paling signifikan dalam pembangunan model kajian, mengesahkan bahawa jenis personaliti dan perbezaan gender mempengaruhi keupayaan pembangun perisian untuk menangani TP. Kajian ini menawarkan bukti empirikal mengenai kesan tekanan masa terhadap aspek humanistik. Tambahan pula, model yang dibangunkan berupaya untuk meningkatkan kadar kejayaan projek perisian dalam bidang SE.

Kata Kunci: Tekanan masa, jenis personaliti, kerumitan tugas, gender, pengetahuan

Abstract

Human factors play a crucial role in software engineering (SE) as software is developed and utilized by people. One of the key reasons for software project failure is not assigning the right people to the right tasks during project planning. This issue becomes critical when developers work under time pressure (TP), often resulting in poor performance and delays. Each personality type approaches TP differently, and gender-based personality differences may further influence how developers handle TP, leading to varied outcomes. In addition, task complexity and developers' knowledge interrelate with personality types and gender, potentially affecting project performance under TP. The main aim of this study is to propose the i-SYNERGY model by investigating the relationship between TP, personality types, gender, knowledge, and task complexity. To develop this model, empirical evidence was gathered from controlled experiments conducted with SE students, and generalised from industrial data through two case studies. The Myers-Briggs Type Indicator (MBTI) and NASA task load index (TLX) were used to measure personality types and TP, respectively. The data analysis was divided into two stages. The first stage involved examining factual figures of data to develop the model, while the second stage involved predictive experiments for developing the model under the knowledge discovery in databases (KDD) process. Five data mining techniques—artificial neural network (ANN), support vector machine (SVM), decision tree, K-nearest neighbor (KNN) and logistic regression were employed to identify the most suitable technique for model development. Logistic regression yielded the most significant results for developing the study model, confirming that personality types and gender differences influence software developers' ability to handle TP. This study offers empirical evidence regarding the impact of TP on humanistic aspects. Furthermore, the model developed can be leveraged to enhance the success rate of software projects in the field of SE.

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Keywords: Time pressure, Personality types, Gender, Task complexity, Knowledge

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List of Abbreviations

AUC	Area Under Curve
ANN	Artificial Neural Network
BR	Boundary Region
CRD	Completely Randomize Design
CS	Computer Science
FP	False Positive
FPR	False Positive Rate
GPA	Grade Point Average
HIST	Hidaya Institute of Science and Technology
IT	Information Technology
i-SYNERGY	An Integrated Predictive Model of Time Pressure, Personality Types, Gender, Knowledge and Task Complexity to Determine Software Developer's Performance
KDD	Knowledge Discovery Database
KNN	K- Nearest Neighbor
MBTI	Myers-Briggs Type Indicators
NTP	No Time Pressure
NASA-TLX	Nasa Task Load Index
OOP	Object Oriented Programming
PM	Project Management
SPM	Support Project Management
SP	Structured Programming
SE	Software Engineering
SPSS	Statistical Packages of Social Science

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SVM	Support Vector Machine
SIBA	Sukkur Institute of Business Administration
TLX	Task Load Index
TPR	True Positive Rate (TPR)
TN	True Negative
TP	Time Pressure
UUM	Universiti Utara Malaysia
UoS	University of Sindh
WEKA	Waikato Environment Knowledge Analysis

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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter introduces the study's background and is followed by a discussion of the addressed problems. The research questions and constructs of the objectives of the study are discussed in the next sections. Furthermore, this chapter also addresses the scope and significance of the study. Moreover, this chapter includes the terms' operational definitions and the study's conceptual framework. Finally, this chapter gives an overview of the subsequent chapters of this study.

1.2 Background of the Study

The demand for software in human daily life is growing exponentially. Driven by the increasing reliance on digital technologies and the integration of software solutions into various aspects of daily routines. From communication and entertainment to work and education, software has become an integral part of modern life, shaping the way to interact, learn, and conduct daily activities. This surge in demand reflects the pivotal role that software plays in addressing the evolving needs and expectations of individuals in today's technologically driven world. Software engineering (SE) activities are significantly influenced by human aspects (Hidellaarachchi et al., 2023; Mello & Coelho, 2021; Zykov & Attakorah, 2020; Fuggetta & Di Nitto, 2014; Santos, Magalhaes, & Correia-Neto, 2017). Software is developed and used by a variety of people; therefore, understanding an individual’s behavior is necessary for software development (Hidellaarachchi et al., 2023;

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Appendix A

Consent to Take Part in Research

This appendix includes the consent form, which was used to ensure that all participants were fully informed about the study's objectives, their roles, and their rights. It highlights that participation was voluntary, and participants had the option to withdraw at any point without any consequences.

Thank you for volunteering as a participants in this research on I-SYNERGY Model for Software Development Projects. Project contact details for further information.

1. Ruqaya Gilal (ruqaya_gilal@ahsgs.uum.edu.my)
2. Assosiate Prof. Dr. Mazni Omar (mazni@uum.edu.my)
3. Dr.Mawarny Md. Rejab (mawarny@uum.edu.my)

This research is conducted as following conditions:

- Participation in this research will not impact in any way on their assessment.
- Participants can withdraw at any time or refuse to give answer about research, there will be no disadvantage if they do.
- Participants will not benefit directly from participating in this research.
- All information that student will provide for this study will be treated confidentially.
- In any report on the results of this research participants identity will remain anonymous. This will be done by changing their names.

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I (Full name) _____

Contact details _____

Declare that I am aware of the information provided above and have willingly served as a participants in the research. I am aware that the findings of this study might be published in academic sources, but that my name will not be disclosed.

Signature of the participant: _____

Date: _____

I believe the participant is giving informed consent to participate in this study

Signature of the researcher: _____ Date: _____

Appendix B

Personal Particulars

This appendix contains the form used to collect personal information from participants, including their age, gender, and academic background etc.

This study is about proposing i**-SYNERGY Model** for software development to reduce the failure rate in SE. The model is about which types of people personality can manage the TP in a better way. In this study, the collection of data will help to propose a model, all the data will be confidential.

Name: _____

Matric No: _____ Semester: _____

Age:_____ Gender: _____

Race:_____ First language: _____

Marital Status: (Bachelor/Married/Widow) _____

Education Background: Matriculation/ Intermediate/ Graduation /Diploma/ _____

Preferred e-mail address: _____

Signature:_____

Date: _____

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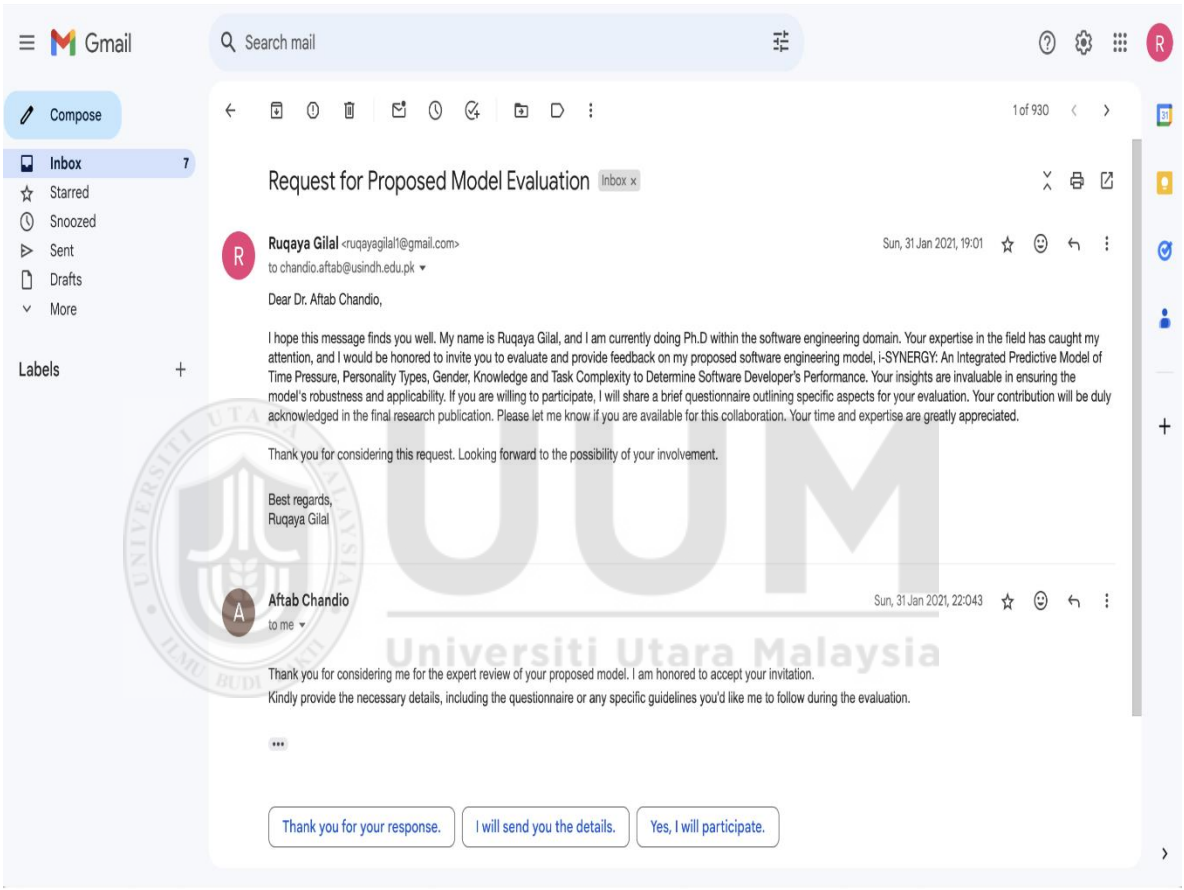
Appendix C

The sample of Expert's invitation E-mail and response

This appendix includes the email invitation sent to experts, requesting their participation in the review process, along with their responses. The purpose of this communication was to involve experts in validating the instruments and providing insights to ensure the model's relevance and accuracy.



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Appendix D

The Instrument for Expert Review

This appendix contains the evaluation of proposed model by experts to review. The feedback collected was crucial in refining the model and ensuring the reliability of the results.

An Evaluation of i-SYNERGY: An Integrated Predictive Model of Time Pressure, Personality Types, Gender, Knowledge and Task Complexity to Determine Software Developer's Performance

---

Dear Prof/ Dr/ Sir/ Madam,

I am Ruqaya Gilal, matric no: 903684, currently enrolled in the PhD program in Computer Science at Universiti Utara Malaysia (UUM), Malaysia. I am thrilled to extend a cordial invitation to you for participation in an expert review. Your selection is based on your fulfillment of one or more of the following criteria:

1. Possession of a PhD or any advanced degree in Software Engineering (SE), Software Project Management (SPM), Computer Science (CS), or related fields.
2. Accumulation of at least five years of study or research experience in the aforementioned areas or any relevant field.
3. Accumulation of at least 3 to 5 years of practical experience in software project development.

My PhD research proposes **i-SYNERGY: An Integrated Predictive Model of Time Pressure, Personality Types, Gender, Knowledge and Task complexity to Determine Software Developer's Performance**. The primary objective of the model is to predict and understand the impact of various variables on the performance of software developers under time pressure conditions. The model aims to contribute valuable insights into the nuanced interplay between time pressure, personality types, gender, knowledge, task complexity, and software developer performance. The operational definitions used in this study are defined below:

- **Time pressure (TP)** refers to the perceived urgency and constraints imposed by deadlines or limited time frames within the software development context. In this study, time pressure is quantified using a Likert scale where participants rate their perceived time pressure levels.
- **Personality types** are distinctive patterns of behavior, cognition, and emotion that characterize individuals. Personality types are assessed using the Myers-Briggs Type Indicator (MBTI). Participants' responses categorize them into specific personality types such as Extroverted (E) or Introverted (I), Sensing (S) or Intuitive (N), etc.
- **Gender** refers to the social and cultural roles, behaviors, and expectations associated with being male or female. Gender is recorded as male or female based on participants' self-identification during the data collection process.
- **Knowledge** represents the information, skills, and expertise possessed by software developers relevant to their tasks. Knowledge levels are measured using their previous academic records and for professionals' years of experience in specific areas related to software development.

- **Task complexity** refers to the level of intricacy and difficulty involved in software development tasks. Task complexity is categorized into three levels—easy, medium, and hard—based on expert suggestions.

The model is constructed using advanced data mining techniques, considering its suitability for predicting binary outcomes. Data mining techniques allows us to understand the probability of effective software developer performance under varying conditions. This methodology allows us to delve into the intricacies of the probability associated with effective outcomes, shedding light on the multifaceted relationships between the variables at play. The outcomes derived from this analysis provide estimations, offering valuable insights into the nuanced interconnections and dependencies among the identified variables within the software development landscape.

This model's conceptual framework is organised around a series of well-considered hypotheses meant to clarify the intricate relationships present in the software development environment. With the purpose of examining certain connections and interactions between important variables, each hypothesis aims to advance our understanding of the variables that affect software engineers' performance. We set out to explore the hypotheses in order to find subtle insights that shed light on the intricate interactions between time pressure, personality types, gender, knowledge, task complexity, that affect software development endeavours as a whole. The study's alternative hypotheses are as follows:

H1: There is a significant association between time pressure (TP) and the performance of software developers.

H2: There is a significant moderation by different personality types on the effect of TP on software developer's performance.

H3: There is a significant moderation by different gender (male and female) on the effect of TP on the software developer's performance.

H4: There is a significant mediation by task complexity on the relationship between TP and software developer's performance.

H5: There is significant mediation by knowledge on the relationship between TP and software developer's performance.

These variables play a pivotal role in shaping the dynamics of the model, influencing the relationships between key variables. By elucidating on the mediating variables, specifically knowledge and task complexities, we aim to delve deeper into the underlying mechanisms through which these variables contribute to the performance of software developers under time pressure. Additionally, the explanation will encompass the moderating variables, such as personality types and gender, highlighting their role in influencing the strength and nature of the relationships within the model. This enhancement will provide a comprehensive understanding of the intricate interplay between these variables, fortifying the model's predictive capabilities. We anticipate that the model

will provide a robust foundation for predicting how software developers perform under time pressure based on their personality types, gender, knowledge levels, and task complexities. The outcomes aim to inform software managers, aiding in better task allocation, training strategies, and overall project management.

This assessment form plays a pivotal role in not only validating the model's effectiveness and assessing its practical applicability in real-world settings but also in evaluating its substantial theoretical contribution. Your valuable feedback and suggestions, as guided by the provided instructions, are crucial for refining and validating the model. It is essential to underscore that all information shared will be treated with the utmost confidentiality, exclusively used for research purposes. The model is designed to enhance software developer performance under time pressure, making noteworthy strides in theoretical understanding. By advancing our comprehension of the intricate relationships between time pressure, personality types, knowledge and task complexities in software development, the model delves into theoretical underpinnings. This dual commitment, addressing both practical and theoretical dimensions, positions the model as a valuable asset for practitioners and researchers alike, fostering advancements in both applied and academic domains. Your thoughtful input is highly valued and will contribute significantly to the credibility and robustness of this research endeavor, with any insights provided being presented anonymously in academic publications.

RUQAYA GILAL
PhD candidate
School of Computing
Universiti Utara Malaysia

Supervisors:
Associate Prof. Dr. Mazni Omar
Dr. Mawarny Md. Rejab

Universiti Utara Malaysia

PARTICIPANTS' DEMOGRAPHIC INFORMATION
Name: _____
E-mail: _____
Gender: ☐MALE ☐ FEMALE
Age: _____
Affiliation: _____
Position/Title: _____
Experience in the field: _____
Expertise level: ☐ Novice ☐ Intermediate ☐ Expert
Have you been involved in the assessment or evaluation of software developers' performance in the past? ☐Yes ☐NO
How often do you encounter challenges related to time pressure in your role within the context of software development? ☐Frequently ☐Rarely

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i-SYNERGY: CONCEPTUAL MODEL

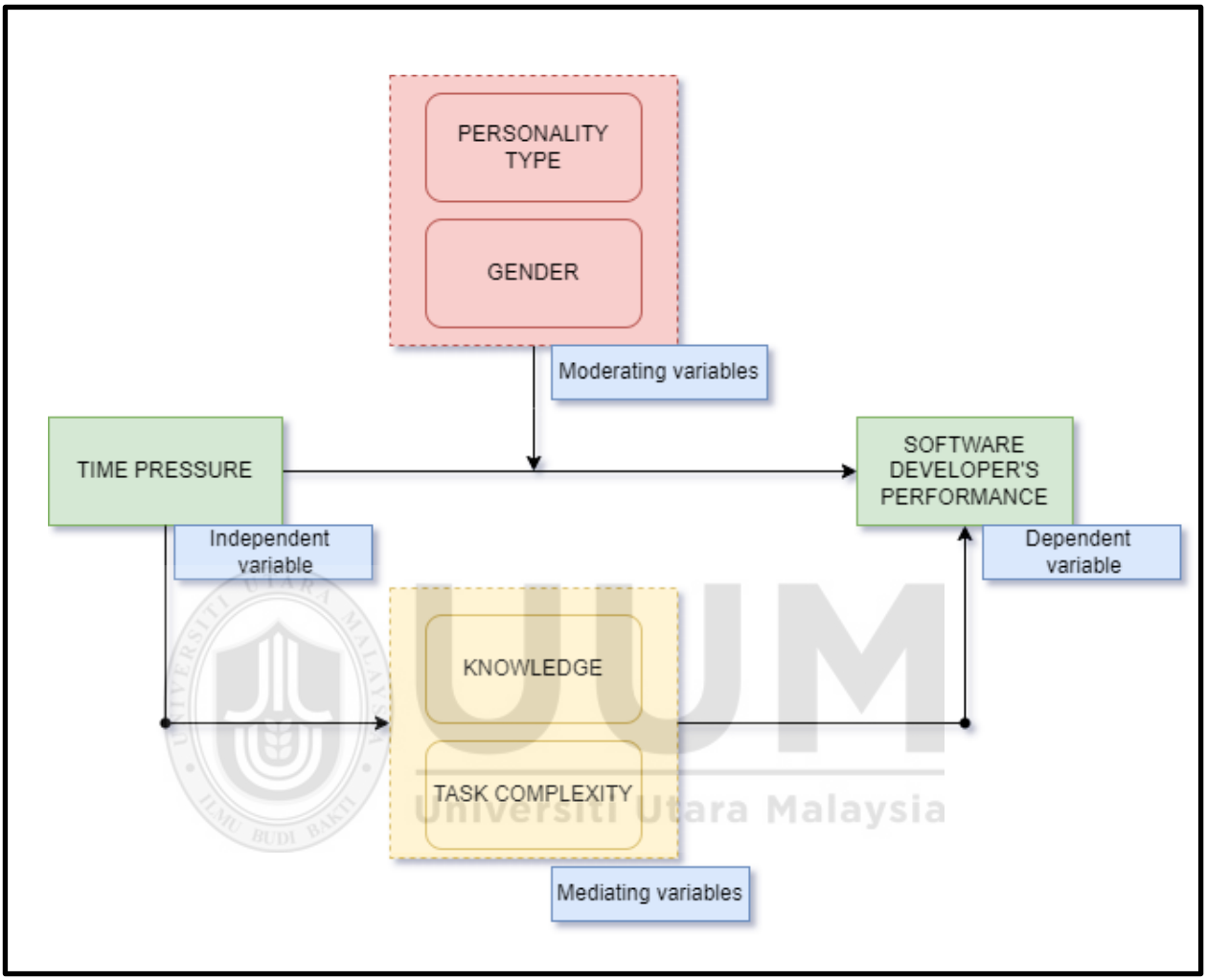

Figure 1. Conceptual Model

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Model with hypotheses

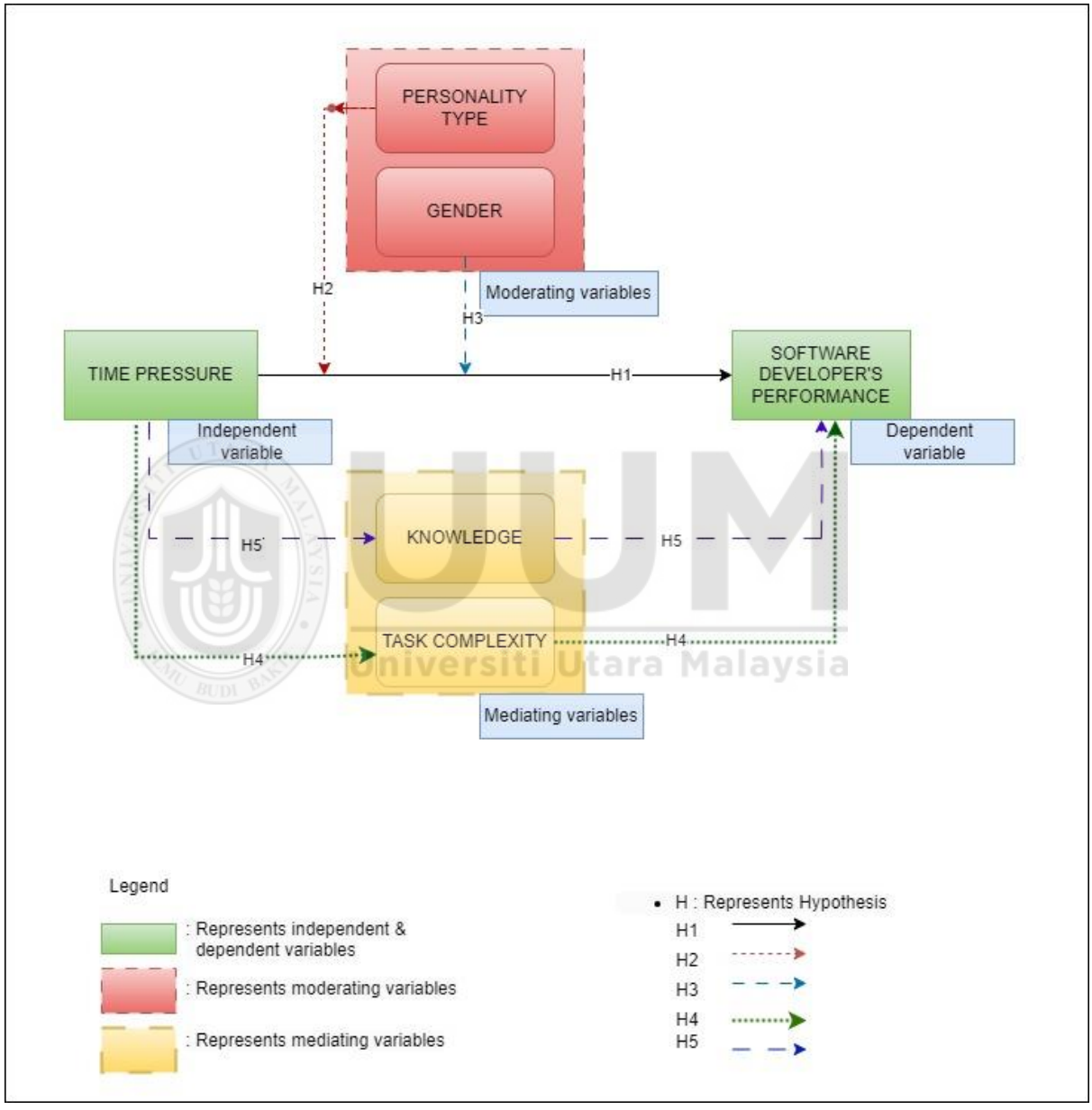

FIGURE 2. Model with Hypotheses

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MODEL EVALUATION

Dear Respondent,

Kindly review the i-SYNERGY model Figure 1 & 2 attentively. Following your expertise, please provide feedback for all questions in the designated spaces. This section aims to assess the effectiveness of i-SYNERGY model across five dimensions:

- **Understandability:** Ensuring that all terms used in i-SYNERGY model are clear and unambiguous.
- **Relevance:** Examining the consistency between variables and study objectives, as well as assessing the relationship between variables within i-SYNERGY model.
- **Feasibility:** Evaluating the practical suitability of using the criteria in i-SYNERGY model.
- **Organization:** Verifying that all variables of i-SYNERGY model are well-organised.
- **Comprehensiveness:** Confirming the inclusion of all necessary variables within i-SYNERGY model.

1.	**Understandability**			
Please tick (✔) your choice				
No	**Terminology**	**It is easy to understand**	**Needs some explanation**	**Needs very detailed explanation**
1.	How clear is the term "time pressure" in the context of the i-SYNERGY model?			
2.	Does the term "personality types" require additional explanation for better understanding?			
3.	How easily understood is the variable "gender" in the context of the i-SYNERGY model?			
4.	How straightforward is the term "knowledge" in your interpretation within the i-SYNERGY model?			
5.	How well do you understand the concept of "task complexity" in the i-SYNERGY model?			
6.	How clear is the term "software developer's performance" within the i-SYNERGY model?			

Comment / Suggestion: ----------

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2.	**Relevance**			
Please tick (✔) your choice				
No	**Components**	**Not relevant**	**Relevant**	**Highly Relevant**
1.	To what extent is "time pressure" significantly associated with software developer performance in the i-SYNERGY model, as proposed in H1?			
2.	How well does "personality types" align with the i-SYNERGY model's focus on software developer performance, considering H2 that suggests a moderation effect of different personality types on the relationship between time pressure and performance?			
3.	In the context of H3, which posits that gender significantly impacts the performance of software developers under time pressure conditions, how essential is the variable "gender" in studying its impact within i-SYNERGY?			
4.	Considering H4, which suggests that the effect of time pressure on software developer performance is significantly influenced by task complexity, how crucial is "task complexity" in providing insights into software developer performance within i-SYNERGY?			
5.	How relevant is "knowledge" to the i-SYNERGY model's objective of assessing software developer performance, particularly with regard to H5, which proposes that knowledge significantly mediates the relationship between time pressure and software developer performance?			

Comment / Suggestion: ----------

3.	**Feasibility**				
	1 Strongly Disagree, 2 Disagree, 3 Agree, 4 Strongly Agree				
No	**Model Practicability**	**SD**	**D**	**A**	**SA**

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1.	The i-SYNERGY model is suited to determine software developer performance.	1	2	3	4
2.	Time pressure in i-SYNERGY model in real-world scenarios impact the software developer's performance.	1	2	3	4
3.	Personality and gender moderating the impact of TP on software developer's performance real-world scenarios.	1	2	3	4
4.	The i-SYNERGY model might encounter limitations or difficulties when applied to different software development projects?	1	2	3	4
5.	The i-SYNERGY model suitable for assessing software developer performance in projects with varying levels of complexity and time pressure.	1	2	3	4
6.	The task complexity and knowledge mediating the impact of TP on software developer's performance real-world scenarios.	1	2	3	4
7.	There are no adjustments or modifications to enhance the feasibility of implementing the i-SYNERGY model in a software development context.	1	2	3	4
8.	The i-SYNERGY model has ability to provide meaningful insights into software developer performance in real-world situations?	1	2	3	4

4. Organisation

The connections and flows of all the components in i-SYNERGY are well organised.
Yes [ ] No [ ]

If No, please give a comment. ----------

5. Comprehensiveness

Overall, i-SYNERGY model is a comprehensive model. Yes [ ] No [ ]

If No, please give a comment. ----------

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Other comments
Please write further comments (if any) : ---

THANK YOU

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Appendix E

The Application Letter for Conducting a Case Study at APTECH

This appendix provides the formal application letter submitted to APTECH, requesting permission to conduct a case study at their software development institute. The letter outlines the purpose of the study and the data collection methods to be employed.

PUSAT PENGAJIAN PENGKOMPUTERAN
SCHOOL OF COMPUTING
College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM SINTOK
KEDAH DARUL AMAN
MALAYSIA

Tel: 604-928 5056/5058/5060
Faks (Fax): 604-928 5067
Laman Web (Web): www.soc.uum.edu.my

Director
Aptech Institute of Learning
Jamshoro, Hyderabad

Dear Sir,

REQUEST FOR PERMISSION TO CONDUCT CASE STUDY AT APTECH INSTITUTE OF LEARNING

I hope this letter finds you well. I am writing to seek your permission on behalf of **Ruqaya Gilal (903684),** a Ph.D. student under my supervision, to conduct a case study at Aptech Institute of Learning.

Her research focuses on the development of *A Predictive Model to Assess Software Developer Performance*. The main goal of this study is to propose a model that assists in mitigating the impact of time pressure on various aspects within the software development process. The investigated factors also encompass personality types, gender, knowledge, and task complexity. It is anticipated that the implementation of this model will aid software managers in effectively strategizing for the humanistic aspects crucial to the success of software projects.

Aptech, being a prominent software house, provides an ideal environment for her to gather valuable insights and data for their research. The case study at Aptech will specifically aim to analyze how time pressure influences different personality types of male and female with the different way of dealing with the things in software development which impact the overall project success.

We believe that conducting this case study at Aptech will significantly contribute to the depth and breadth of the research, allowing for a comprehensive understanding of the real-world implications of time pressure in software development.

I assure you that she will adhere to all ethical standards and guidelines throughout the research process. Additionally, any sensitive information obtained during the case study will be treated with utmost confidentiality and used solely for academic purposes. If you require any further information or have specific concerns regarding the case study, please do not hesitate to contact me at mazni@uum.edu.my.

Thank you for considering this request, and I look forward to your positive response.

Sincerely,

Dr. Mazni Omar
Associate Professor
School of Computing (SOC)
Universiti Utara Malaysia

Appendix F

Acceptance Letter from APTECH

This appendix contains the official acceptance letter from APTECH, granting permission to conduct the case study.

Aptech®
Unleash your potential

Dr Mazni Omar

Associate professor

School of Computing (SOC)

Universiti Utara Malaysia

Acceptance of Request for Case Study at APTECH learning

We are pleased to acknowledge and accept your request for case study collaboration with Aptech for the research project proposed by your Ph.D. student Ruqaya Gilal.

Having reviewed the details of the research project, we believe that Aptech can provide a valuable and conducive environment for the successful execution of the study. We understand the importance of fostering research initiatives and are committed to supporting academic endeavors that contribute to the advancement of knowledge in the field.

We appreciate the opportunity to contribute to the academic community through this collaboration and are confident that the outcomes of the research will be beneficial to both parties involved.

Thank you for choosing Aptech as the partner for this case study endeavor. We are eager to commence this collaboration and look forward to a fruitful and successful research project.

Best regards,

Shabir Shaikh

Director

Aptech Learning

Jasmhoro,Hyderabad

www.aptech-education.com/pk 111-APTECH (278324)

Universiti Utara Malaysia

Appendix G

The Application Letter for Conducting a Case Study at HIST

This appendix provides the formal application letter submitted to HIST, requesting permission to conduct a case study at their software development institute.

PUSAT PENGAJIAN PENGKOMPUTERAN
SCHOOL OF COMPUTING
College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM SINTOK
KEDAH DARUL AMAN
MALAYSIA

Tel: 604-928 5058/5058/5060
Faks (Fax): 604-928 5067
Laman Web (Web): www.soc.uum.edu.my

Director
Hidaya Institute of Science and Technology
Jamshoro, Hydearabad

Dear Sir,

REQUEST FOR PERMISSION TO CONDUCT CASE STUDY AT HIDAYA SOFTWARE HOUSE (HIST)

I hope this letter finds you well. I am writing to seek your permission on behalf of **Ruqaya Gilal (903684),** a Ph.D. student under my supervision, to conduct a case study at Hidaya Software House (HIST).

Her research focuses on the development of *A Predictive Model to Assess Software Developer Performance*. The main goal of this study is to propose a model that assists in mitigating the impact of time pressure on various aspects within the software development process. The investigated factors also encompass personality types, gender, knowledge, and task complexity. It is anticipated that the implementation of this model will aid software managers in effectively strategizing for the humanistic aspects crucial to the success of software projects.

HIST, being a prominent software house, provides an ideal environment for her to gather valuable insights and data for their research. The case study at HIST will specifically aim to analyze how time pressure influences different personality types of male and female with the different way of dealing with the things in software development which impact the overall project success.

We believe that conducting this case study at HIST will significantly contribute to the depth and breadth of the research, allowing for a comprehensive understanding of the real-world implications of time pressure in software development.

I assure you that she will adhere to all ethical standards and guidelines throughout the research process. Additionally, any sensitive information obtained during the case study will be treated with utmost confidentiality and used solely for academic purposes. If you require any further information or have specific concerns regarding the case study, please do not hesitate to contact me at mazni@uum.edu.my.

Thank you for considering this request, and I look forward to your positive response.

Sincerely,

Dr. Mazni Omar
Associate Professor
School of Computing (SOC)
Universiti Utara Malaysia

Universiti Pengurusan Terkemuka
The Eminent Management University

Appendix H

Acceptance letter from HIST

This appendix includes the acceptance letter from HIST, allowing the case study to be conducted at their institute.

Hidaya Institute Of Science & Technology

Email: software.hist@hidayatrust.org **Phone**: (022) 2115476

Dr Mazni Omar

Associate professor

School of Computing (SOC)

Universiti Utara Malaysia

Acceptance of Request for Case Study at Hidaya Institute of Science and Technology (HIST)

I trust this message finds you well. We have received your request regarding the proposed case study to be conducted by Ruqaya Gilal, your Ph.D. student, at Hidaya.

After careful consideration, we are pleased to grant permission to conduct the case study at HIST. We understand the importance of academic research and appreciate the opportunity to collaborate in advancing knowledge in the field of software development. HIST is committed to supporting research endeavors, and we will provide the necessary cooperation to facilitate a smooth and productive case study.

She will have the full cooperation of our team during the research period. We look forward to the outcomes of the study and hope that it proves beneficial not only her academic pursuits but also to the broader research community.

If there are any specific requirements or arrangements needed for the case study, please do not hesitate to reach out to our team. We are eager to contribute to the success of this research initiative.

Thank you for considering HIST as the chosen location for the case study, and we look forward to a fruitful collaboration.

Best regards,

Imran Baloch

Hidaya Institute of Science and Technology (HIST)

Jamshoro, Hyderabad

Universiti Utara Malaysia

Appendix I

Personality Test Questionnaire

This appendix contains the Myers-Briggs Type Indicator (MBTI) questionnaire, which was used to assess the personality types of participants.

PERSONALITY TEST QUESTIONNAIRE

This questionnaire takes about 30 minutes to complete. Please tick (✔) one box for each question. This questionnaire is NOT to assess people, their work, or knowledge. Please answer ALL the questions. The data collected from this questionnaire is strictly CONFIDENTIAL and will be used for research purposes only.

Thank you for your participation and valuable time in completing this questionnaire.

……

Name: _____

Matric Number: _____

E-Mail Address: _____

All the questions answer like: YES or NO

1. You are almost never late for your appointments

□ YES □ NO

2. You like to be engaged in an active and fast-paced job

□ YES □ NO

3. You enjoy having a wide circle of acquaintances

□ YES □ NO

4. You feel involved when watching TV soaps

□ YES □ NO

5. You are usually the first to react to a sudden event: the telephone ringing or unexpected question

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□ YES □ NO

6. You feel that the world is founded on compassion

□ YES □ NO

7. You think that everything in the world is relative

□ YES □ NO

8. Strict observance of the established rules is likely to prevent attaining a good outcome

□ YES □ NO

9. It is difficult to get you excited

□ YES □ NO

10. When making a decision, you rely more on your feelings than on analysis of the situation

□ YES □ NO

11. You often think about humankind and its destiny

□ YES □ NO

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12. You believe the best decision is one which can be easily changed

□ YES □ NO

13. You often ponder the root cause of phenomena and things

□ YES □ NO

14. You prefer to act immediately rather than speculate about various options 15. You trust reason rather than feelings

□ YES □ NO

16. You are inclined to rely more on improvisation than on prior planning

□ YES □ NO

17. You spend your leisure time actively socializing with a group of people, attending parties, shopping, etc.

□ YES □ NO

18. You usually plan your actions in advance

□ YES □ NO

19. Your actions are frequently influenced by your emotions

□ YES □ NO

20. You are a person somewhat reserved and distant in communication

□ YES □ NO

21. You know how to put every minute of your time to good purpose

□ YES □ NO

22. You often contemplate the complexity of life

□ YES □ NO

23. After prolonged socializing you feel you need to get away and be alone

□ YES □ NO

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24. You often do jobs in a hurry

□ YES □ NO

25. You easily see the general principle behind specific occurrences

□ YES □ NO

26. You frequently and easily express your feelings and emotions

□ YES □ NO

27. You find it difficult to speak loudly

□ YES □ NO

28. You get bored if you have to read theoretical books

□ YES □ NO

29. You tend to sympathize with other people

□ YES □ NO

30. You value justice higher than mercy

□ YES □ NO

31. You rapidly get involved in the social life of a new workplace

□ YES □ NO

32. The more people you speak to, the better you feel

□ YES □ NO

33. You tend to rely on your experience rather than on theoretical alternatives

□ YES □ NO

34. As a rule, you proceed only when you have a clear and detailed plan

□ YES □ NO

35. You easily empathize with the concerns of other people

□ YES □ NO

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36. Often you prefer to read a book than go to a party

□ YES □ NO

37. When with a group of people, you enjoy being directly involved and being at the center of attention

□ YES □ NO

38. You are more inclined to experiment than to follow familiar approaches

□ YES □ NO

39. You are strongly touched by the stories about people's troubles

□ YES □ NO

40. Deadlines seem to you to be of relative rather than absolute importance

□ YES □ NO

41. You prefer to isolate yourself from outside noises

□ YES □ NO

42. For you, it is easier to gain knowledge through hands-on experience than from books or manuals

□ YES □ NO

43. You think that almost everything can be analysed

□ YES □ NO

44. For you, no surprises is better than surprises - bad or good ones

□ YES □ NO

45. You take pleasure in putting things in order

□ YES □ NO

46. You feel at ease in a crowd

□ YES □ NO

47. You have good control over your desires and temptations

□ YES □ NO

48. You easily understand new theoretical principles

□ YES □ NO

49. You usually place yourself nearer to the side than in the center of the room

□ YES □ NO

50. When solving a problem you would rather follow a familiar approach than seek a new one

□ YES □ NO

51. A thirst for adventure is something close to your heart

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□ YES □ NO

52. When considering a situation you pay more attention to the current situation and less to a possible sequence of events

□ YES □ NO

53. When solving a problem you consider the rational approach to be the best

□ YES □ NO

54. You find it difficult to talk about your feelings

□ YES □ NO

55. Your decisions are based more on the feeling of a moment than on the thorough planning

□ YES □ NO

56. You prefer to spend your leisure time alone or relaxing in a tranquil atmosphere

□ YES □ NO

57. You feel more comfortable sticking to conventional ways

□ YES □ NO

58. You are easily affected by strong emotions

□ YES □ NO

59. You are always looking for opportunities

□ YES □ NO

60. As a rule, current preoccupations worry you more than your future plans

□ YES □ NO

61. It is easy for you to communicate in social situations

□ YES □ NO

62. You rarely deviate from your habits

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□ YES □ NO

63. You willingly involve yourself in matters which engage your sympathies

□ YES □ NO

64. You easily perceive various ways in which events could develop

□ YES □ NO

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Appendix J

Academic Achievements/ Records

This appendix presents the academic record form, which was used to assess the participants' knowledge in specific subjects relevant to software development. The form captured their grades in key subjects, such as structured programming, object oriented programming, and C++, which were used as a measure of their knowledge and expertise.

Please fill in your previous grade for the following courses:

Structured Programming	**Object Oriented Programming**	**Programming languages (C++)**

*Please mention the obtained results in GRADE or GPA

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Name: _____

Matric No: _____

E-mail address: _____

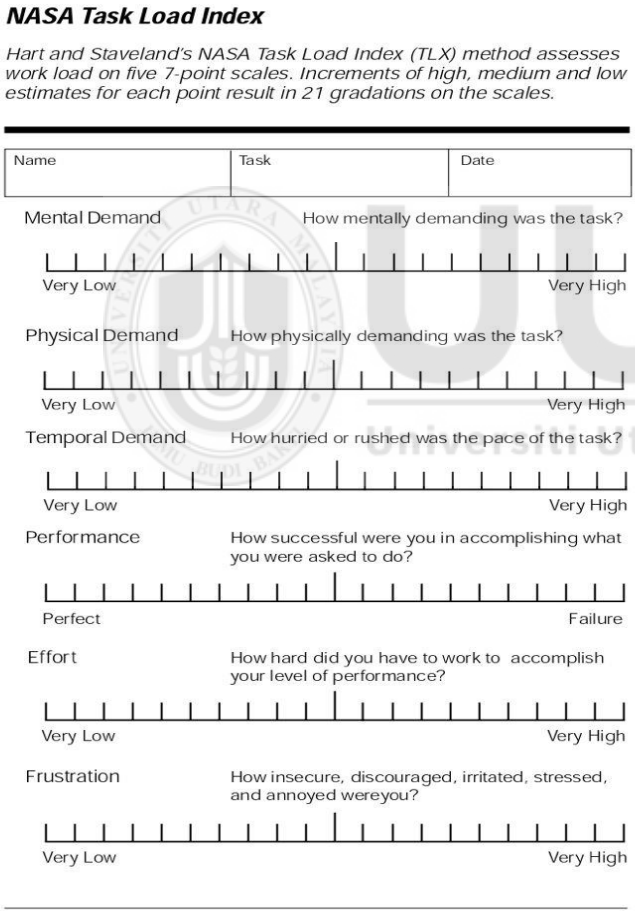
Signature: _____

Date: _____

Appendix K

NASA Task Load Index (NASA-TLX)

The NASA Task Load Index (TLX) included in this appendix was used to measure participants' perceived workload during tasks. This tool helped to quantify cognitive load and stress levels, allows to understand how time pressure (TP) influences performance under different conditions.



NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

Name	Task	Date

Mental Demand — How mentally demanding was the task?
Very Low — Very High

Physical Demand — How physically demanding was the task?
Very Low — Very High

Temporal Demand — How hurried or rushed was the pace of the task?
Very Low — Very High

Performance — How successful were you in accomplishing what you were asked to do?
Perfect — Failure

Effort — How hard did you have to work to accomplish your level of performance?
Very Low — Very High

Frustration — How insecure, discouraged, irritated, stressed, and annoyed wereyou?
Very Low — Very High

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Appendix L

Software Developers' Knowledge and Experience Assessment Questionnaire/Form

This appendix contains the questionnaire used to assess the knowledge and experience of the participating software developers. It captures their years of experience, technical skills, and familiarity with specific programming languages, contributing to the analysis of their performance.

Dear Participant's, Thank you for participating in our study.

Purpose Statement: The purpose of the questionnaire is to assess and gather information about participants' experience and background in the field of software development within software development houses. This information is valuable for understanding their professional backgrounds and how it may relate to various aspects of our study.

Confidentiality Assurance: Rest assured that all responses you provide will be kept confidential and used solely for research purposes.

Instructions: Please read each question carefully and answer honestly to the best of your knowledge. Your feedback will help us better understand the dynamics between time pressure, knowledge, and software developer performance.

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1. Name (Optional): _____
2. Age: _____
3. Gender: _____
4. Educational Background: _____
5. Current Job Title: _____
6. Job Role: _____
7. Current project: _____
8 Years of Professional Experience: _____
9. Industry/Field: _____
10. How many years have you worked in your current field/industry?

_____

11. How would you rate your overall work experience on a scale of 1 to 10 (1 being least experienced, 10 being highly experienced)?

_____

12. What software development methodologies have you worked with?

_____

13. Which programming languages are you proficient in?

_____

Appendix M

Questions for Experimental Tasks for Dataset A&B

This appendix presents the set of experimental tasks which were in C++ programming language with the estimated time and allocated time given to participants, which were designed to evaluate their performance under time pressure and no time pressure.

Questions	Task complexity	TP/NTP	Estimated time	Allocated time
Write a C program that asks the user to input their name and age, and then displays the information in the following format: Your name is [name] and you are [age] years old.	Easy	NTP	30 minutes	1 hour
Write a C program that generates 5 random numbers between 1 and 10, displays them to the user, and then prompts the user to enter the sum of those numbers within a time limit of 5 seconds.	Easy	TP	30 minutes	15 minutes
Write a C program that takes an integer input from the user, and then calculates and prints the sum of all the even numbers between 1 and the input number (inclusive).	Medium	NTP	45 minutes	75 minutes
Write a C program that generates a random 4-digit number and prompts the user to guess the number within a time limit of 10 seconds. The program should provide feedback to the user after each guess indicating if the guess is too high or too low.	Medium	TP	45 minutes	30 minutes
Write a C program that simulates a simple inventory system. The program should allow the user to add new items to the inventory, remove items from the inventory, and display the current inventory. Each item in the inventory should have a name, a quantity, and a price.	Hard	NTP	1hour 30 minutes	2 hours
Write a C program about what is the sum of the diagonal elements in the 5*5 grid of random numbers?	Hard	TP	1hour 30 minutes	1 hour

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Tasks for group B dataset

Questions	Task complexity	TP/NTP	Estimated time	Allocated time
Write a C program that takes in two integers from the user and outputs their sum.	Easy	NTP	10 minutes	20 minutes
Write a program that generates a random integers between 1 and 10. And asks the user to guess the number. The program should give the feedback on whether the guess was too high or too low, and continue the correct number is guessed.	Easy	TP	10 minutes	5 minutes
Write a program that reads in a list of integer from the user, and output the average of the result.	Medium	NTP	30 minutes	1 hour
Write a C program that generates a random list of integers and sorts them in ascending order, the program should output both the original list and the sorted list.	Medium	TP	20 minutes	12 minutes
Write a C program that simulates a game of blackjack. The program should allow the user to play against computer and should keep track the user's score and dealer's score.	Hard	NTP	2 hour	3 hours
Write a C program that read in a string from the user and output the longest substring that is a palindrome(a word that is the same forward and backwards)	Hard	TP	45 minutes	30 minutes

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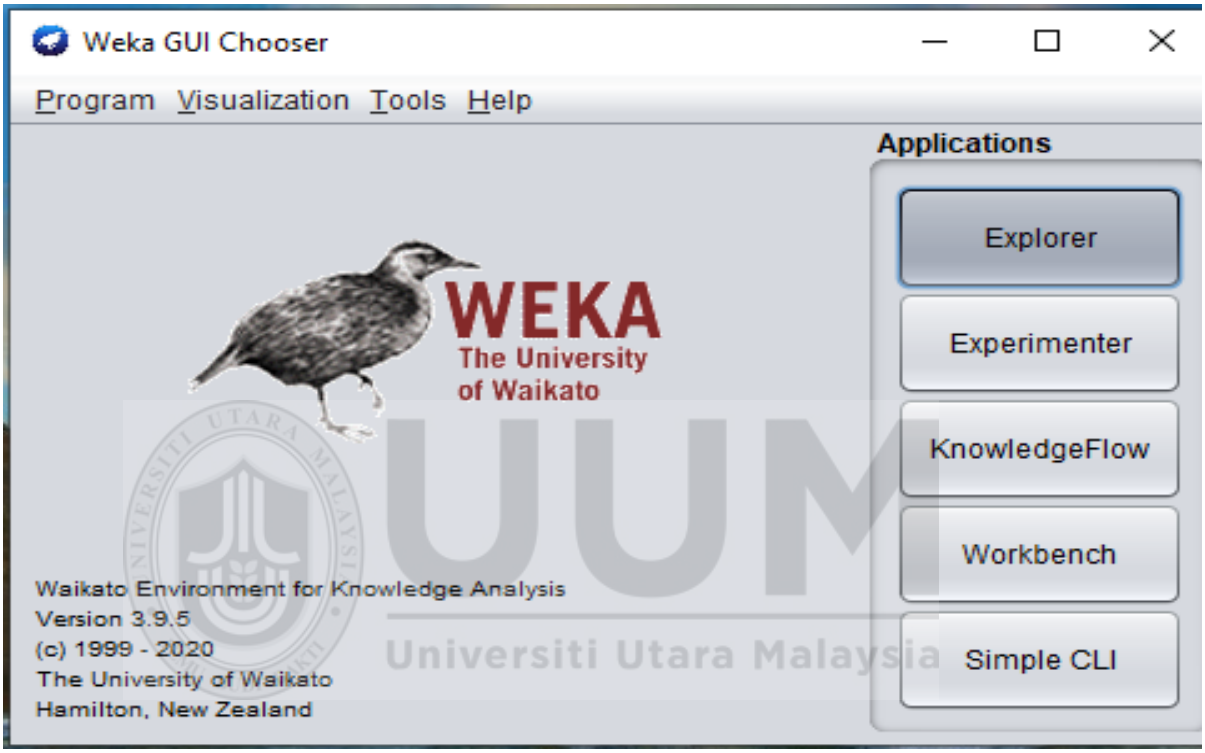
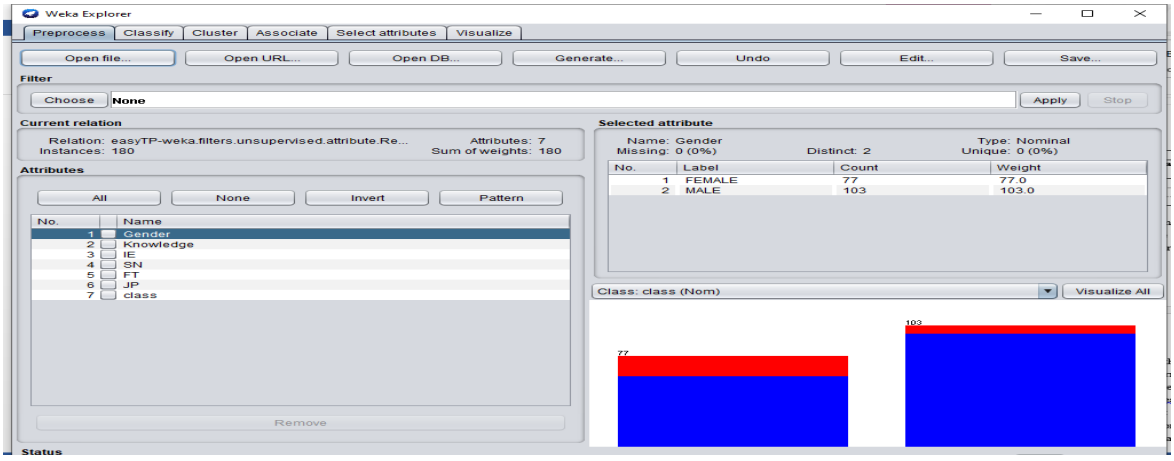
Appendix N

Decision Tree Using WEKA Tool

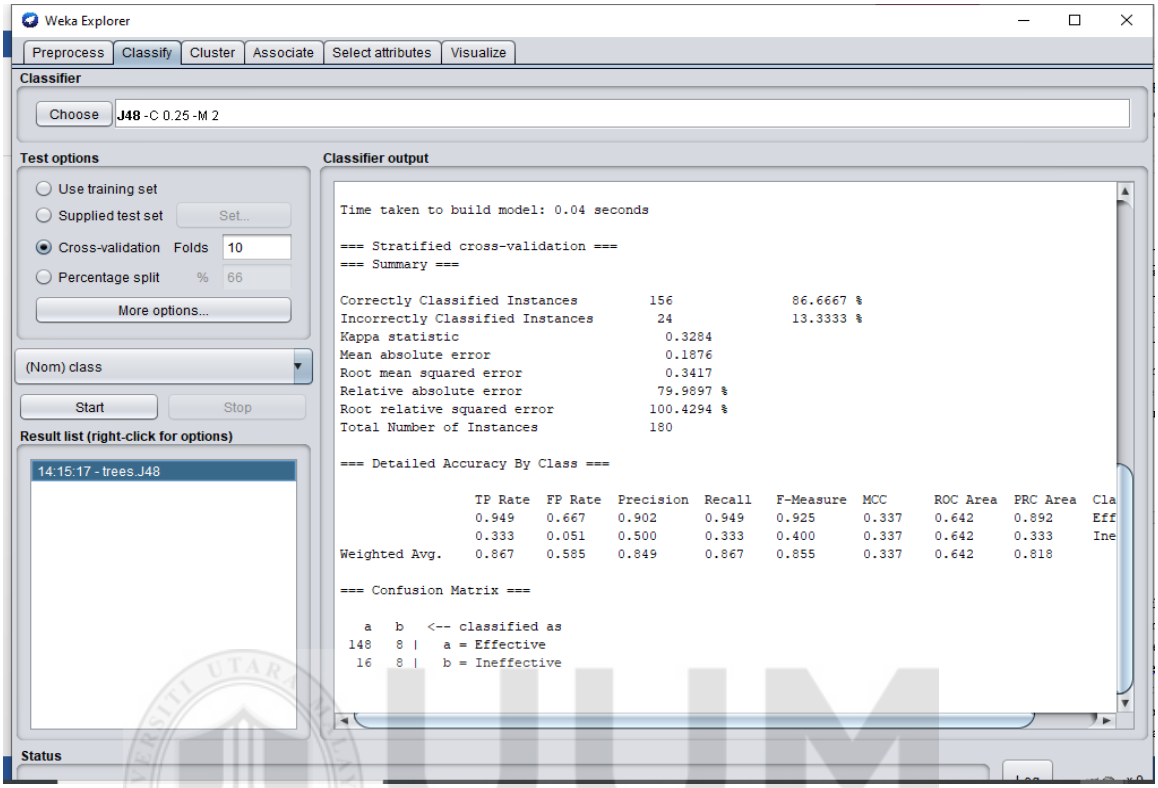
This appendix shows the decision tree generated using the WEKA tool, which was applied to classify and predict software developers' performance based on the collected data.



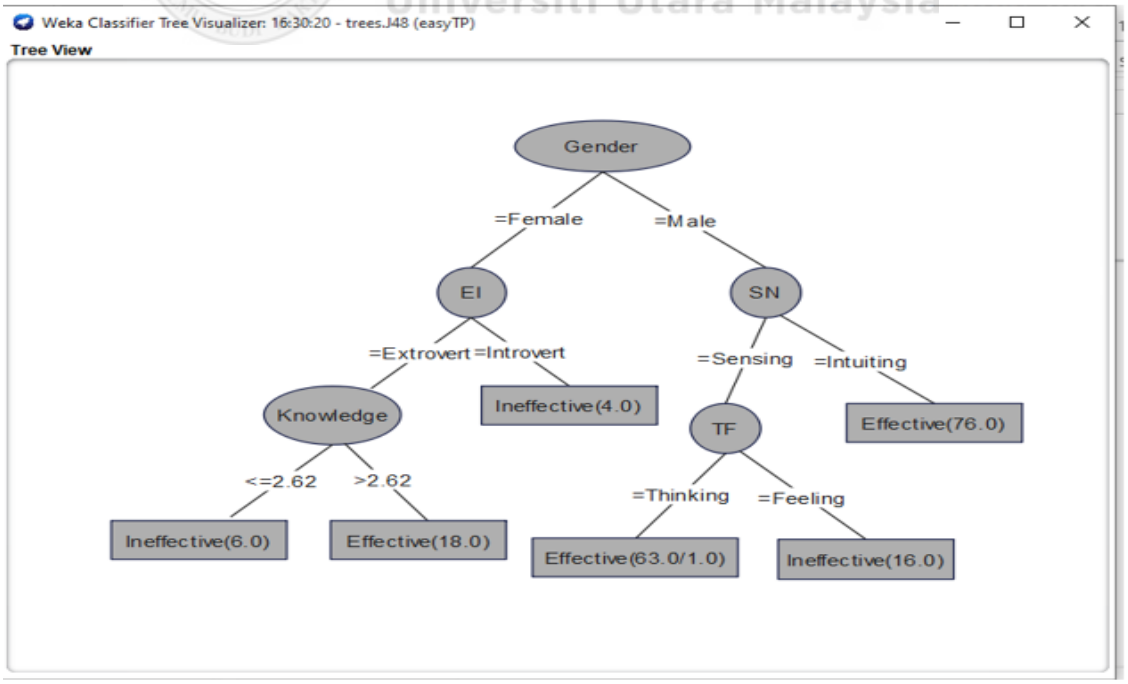
WEKA main interface



Select Dataset



Select Classification Decision Tree Algorithm (J48)



Sample of decision tree of easy TP

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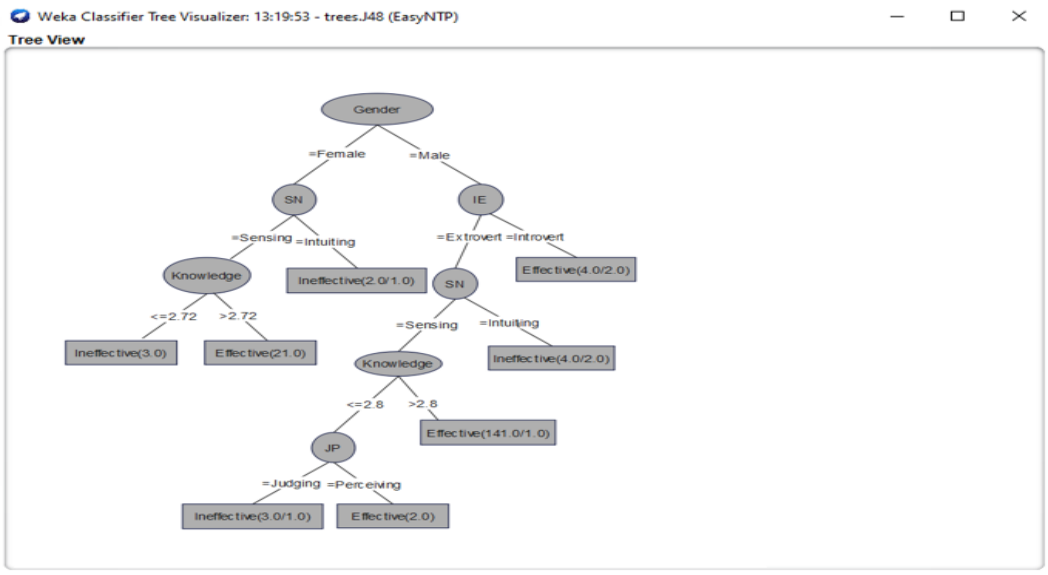
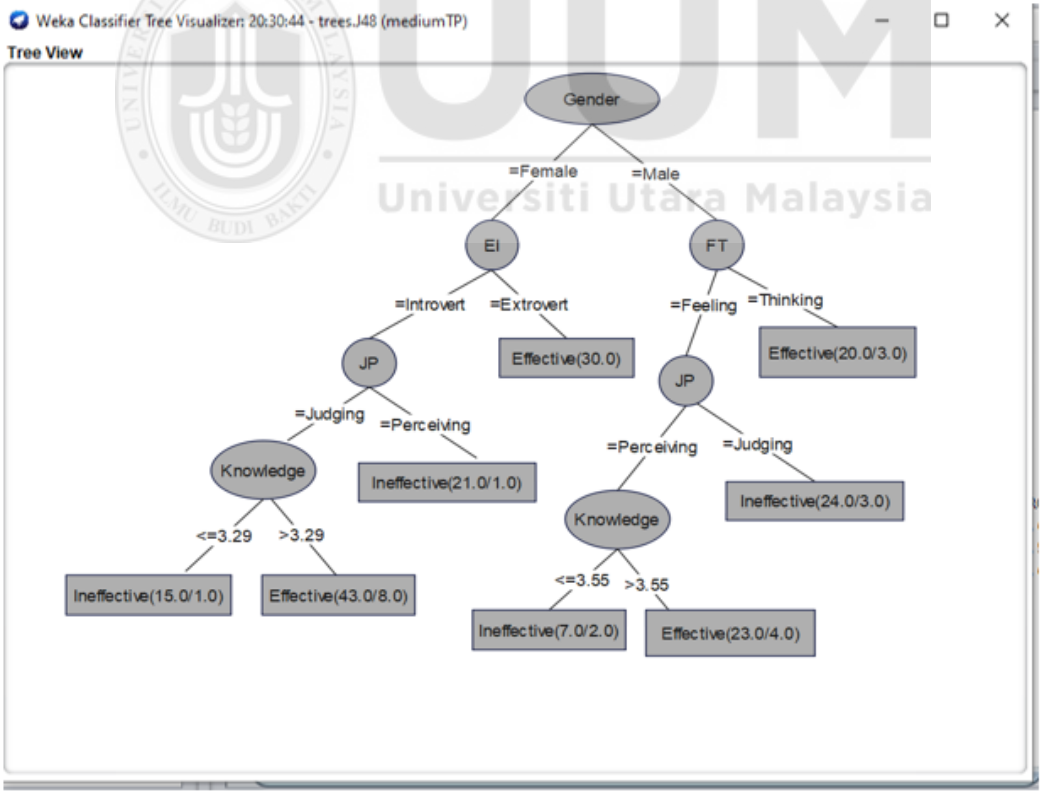


Sample of decision tree of easy NTP



Sample of decision tree of Medium TP

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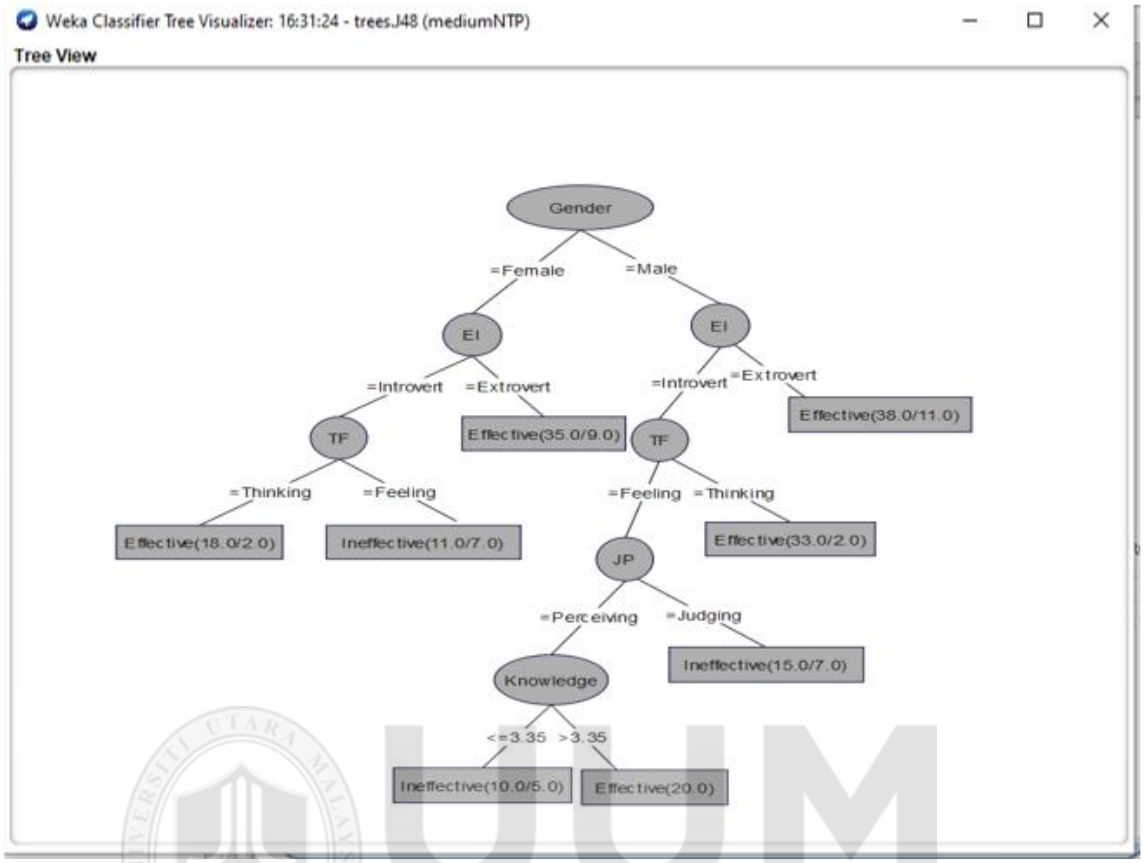
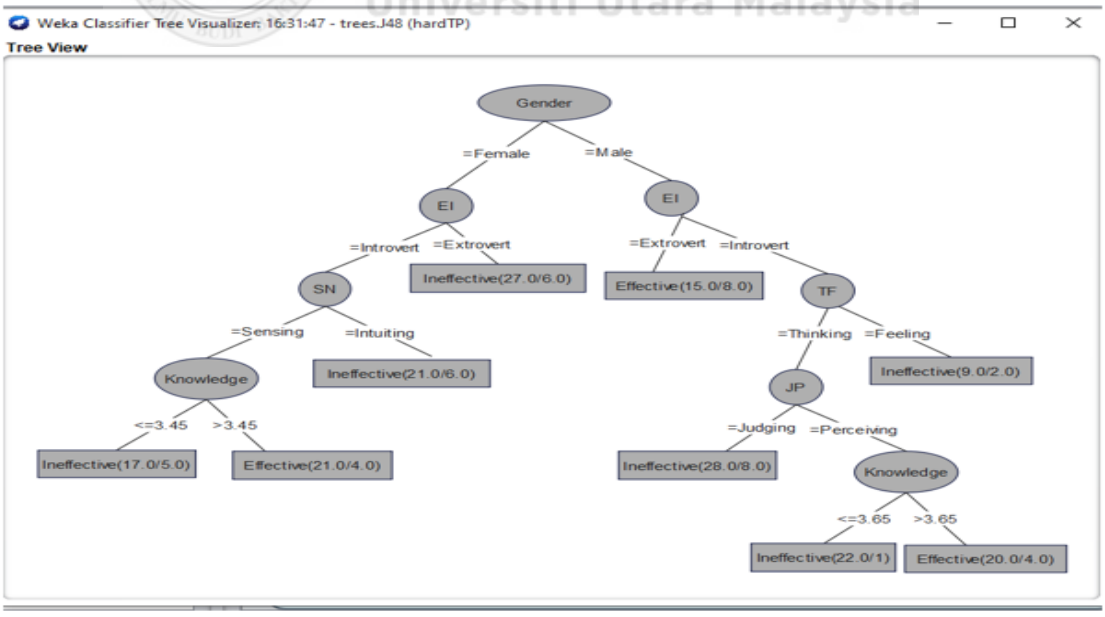


Sample of decision tree of Medium NTP



Sample of decision tree of hard TP

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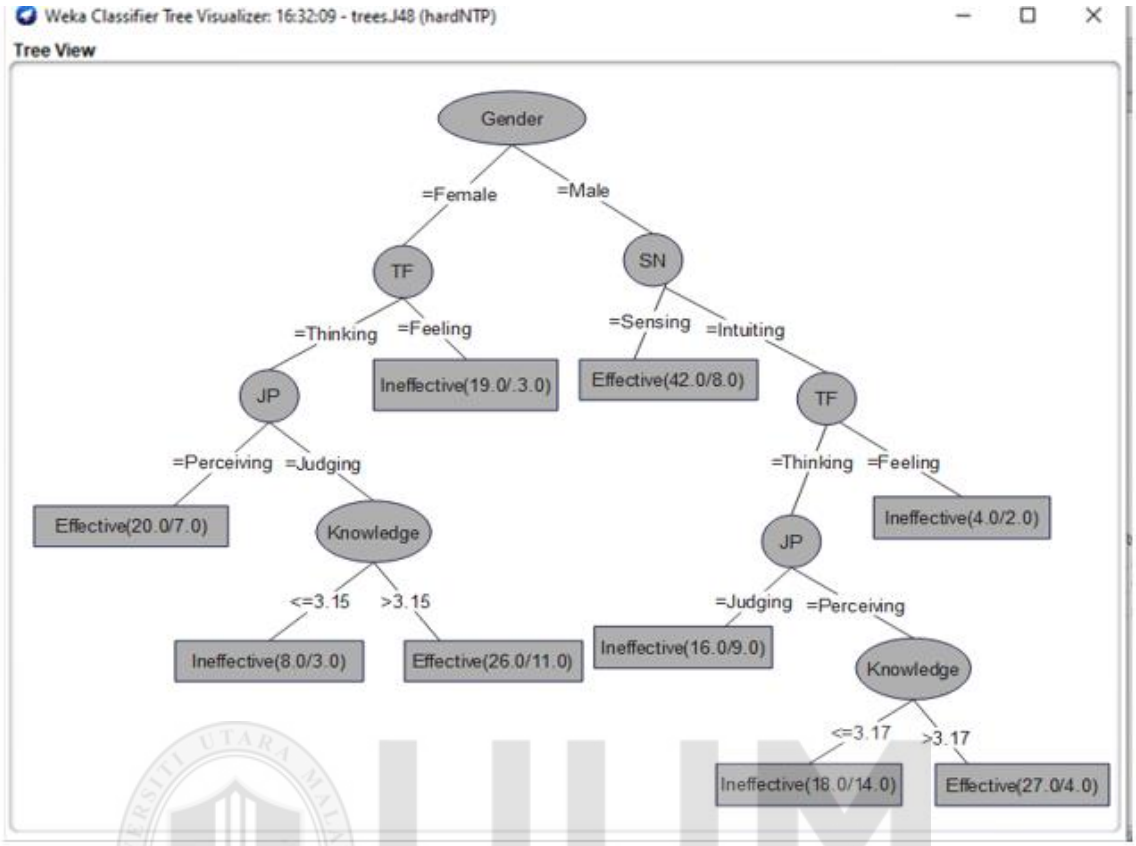

Sample of decision tree of hard NTP

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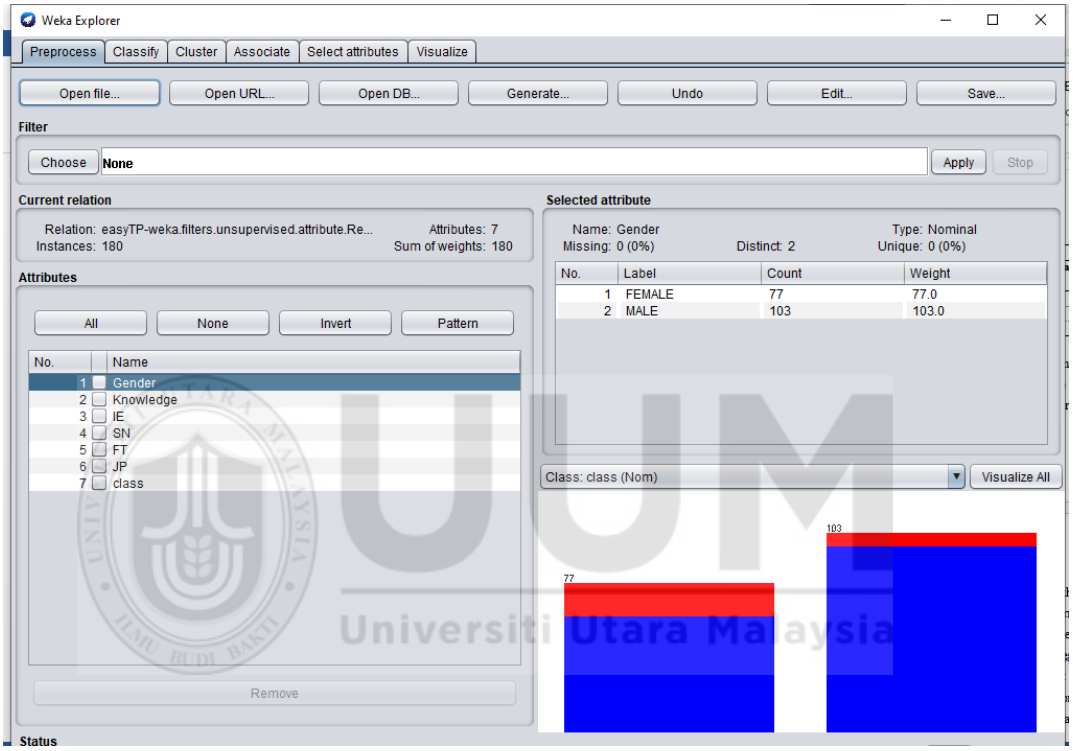
Appendix O

Artificial Neural Network Using WEKA Tool

This appendix provides the screenshots of applying Artificial Neural Network (ANN) model generated using WEKA



Select dataset

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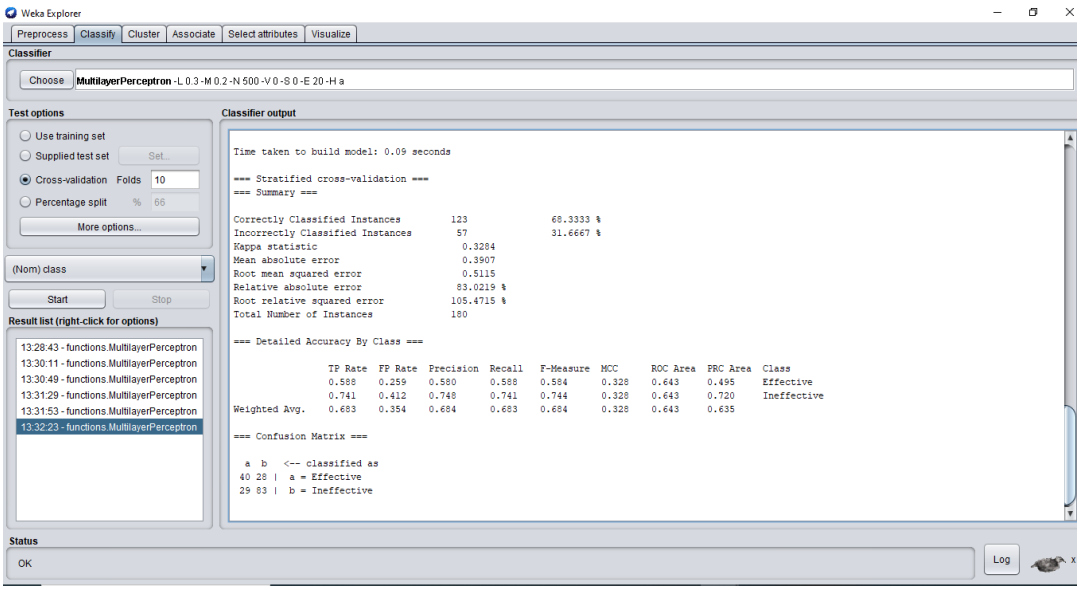

Select multilayer perceptron algorithm (ANN) in WEKA tool

Appendix P

K-Nearest Neighbour Using WEKA Tool

This appendix provides the screenshots of K-Nearest Neighbour (KNN) model generated using WEKA.

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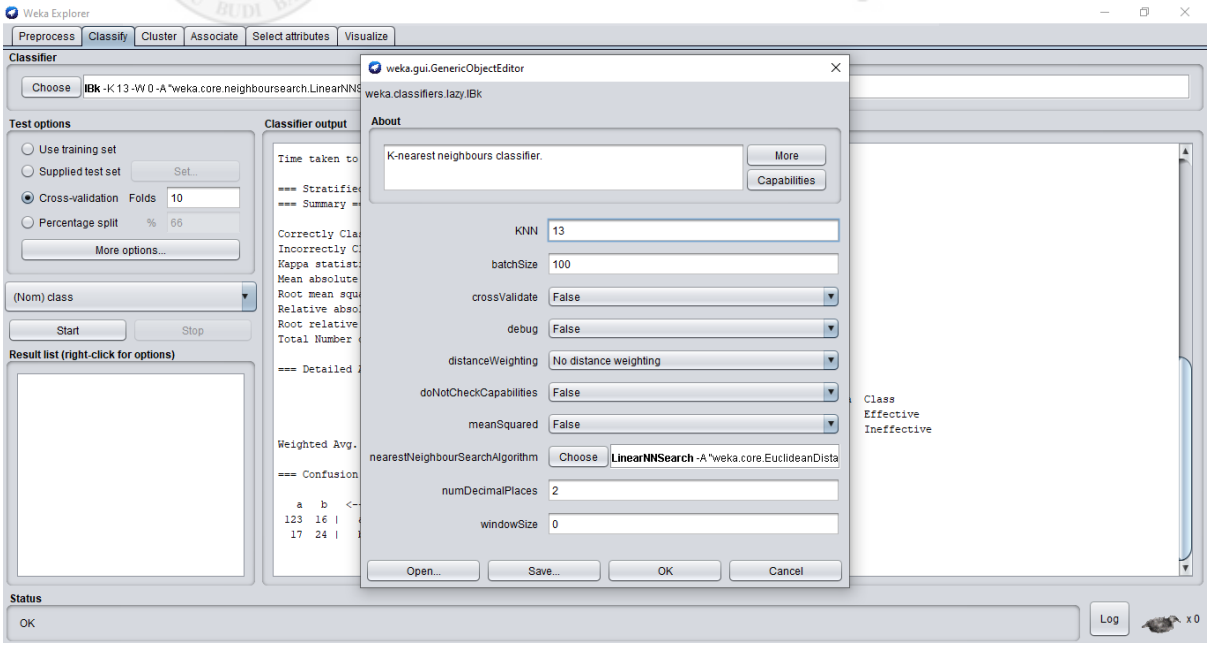
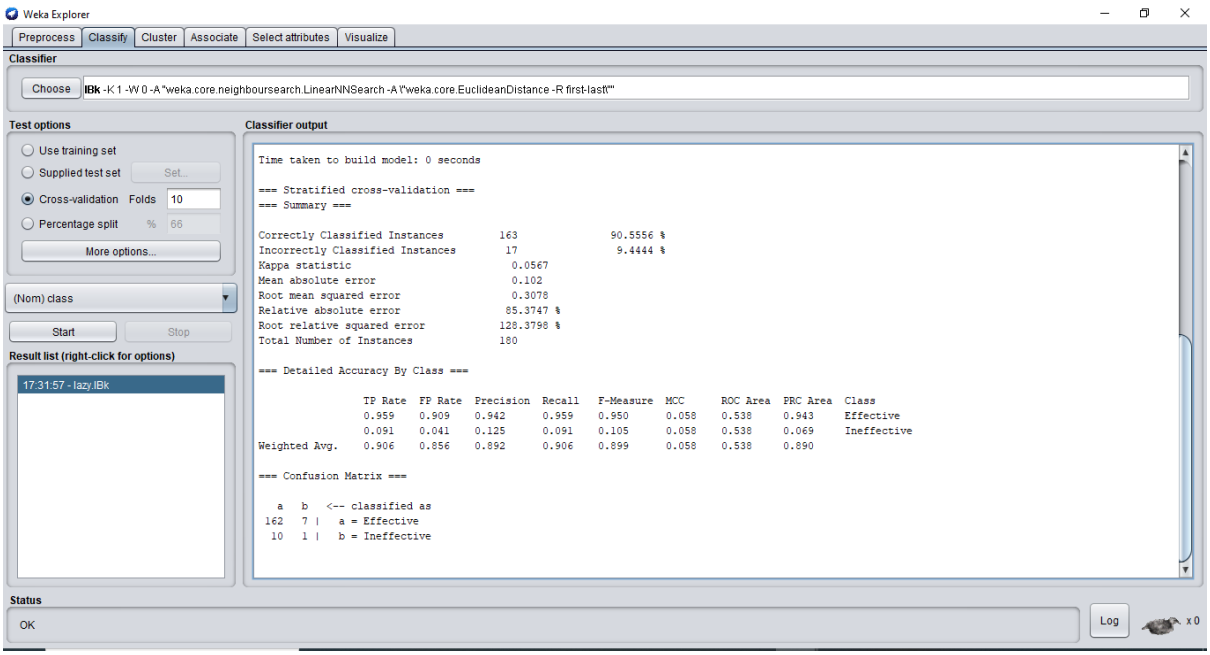


Select K value



Select IBK (KNN) in WEKA tool

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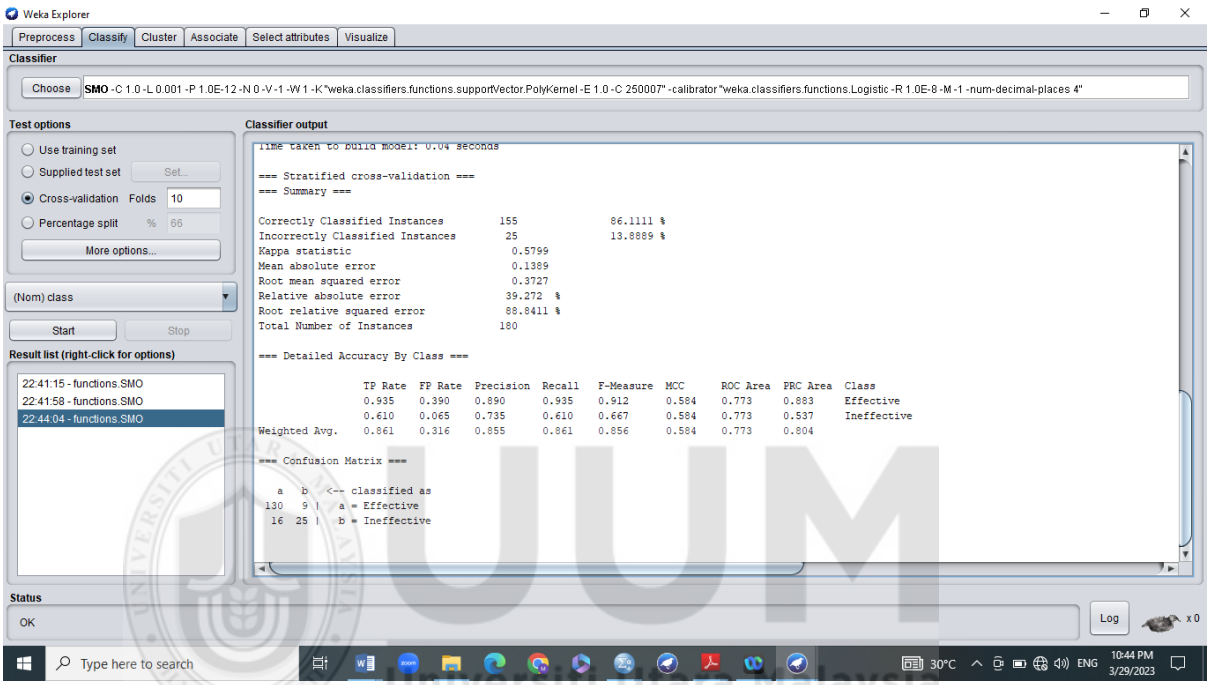
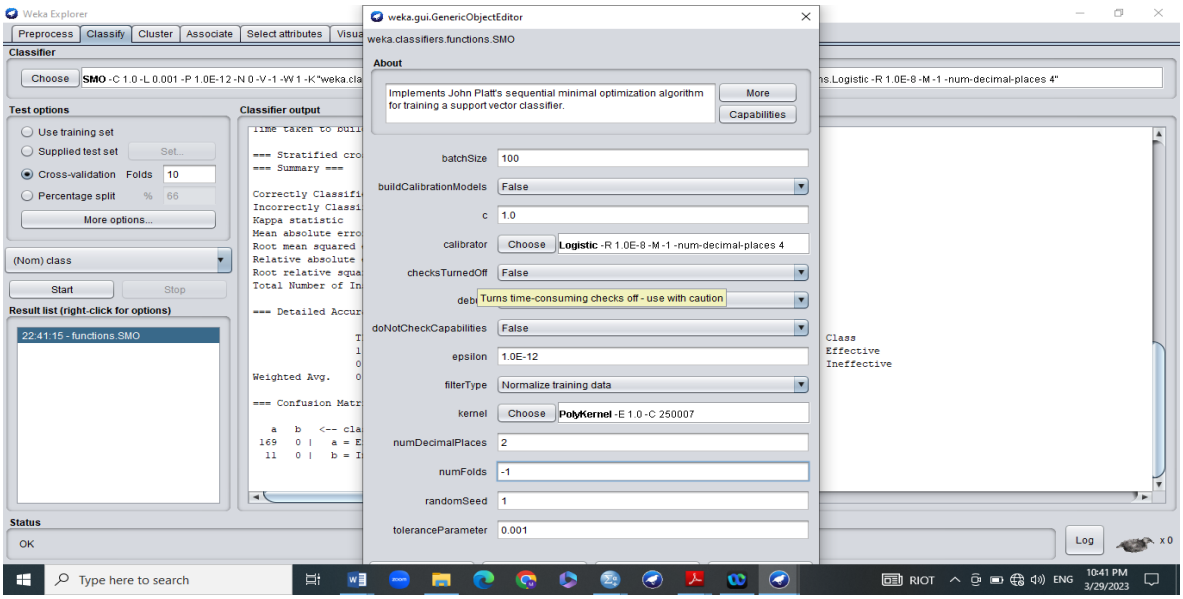
Appendix Q

Support Vector Machine Using WEKA Tool

This appendix provides the screenshots of Support Vector Machine (SVM) model generated using WEKA.



Select SMO as a SVM in WEKA tool

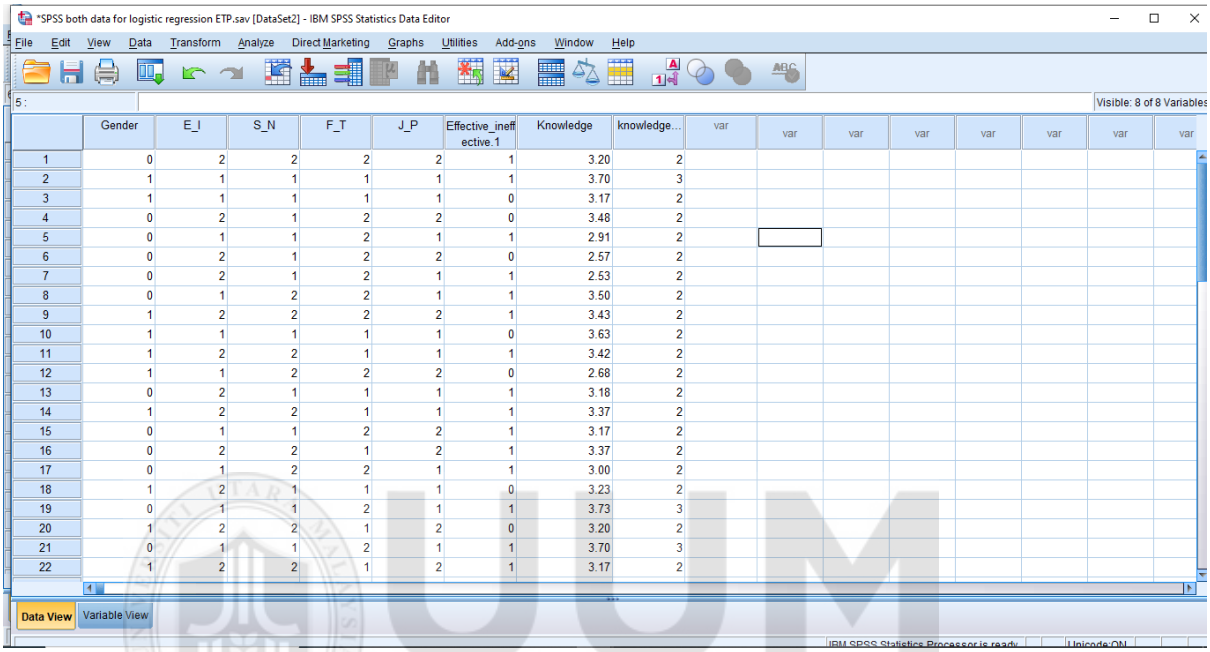


Select kernel polynomial

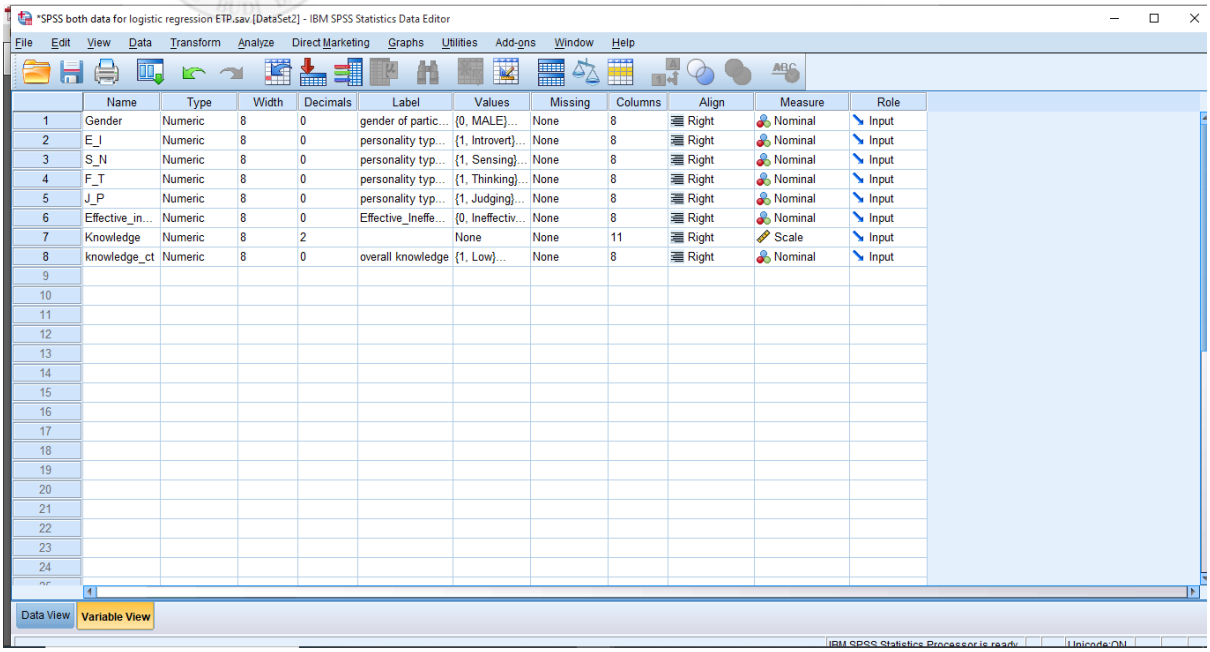
Appendix R

Logistic Regression Using SPSS

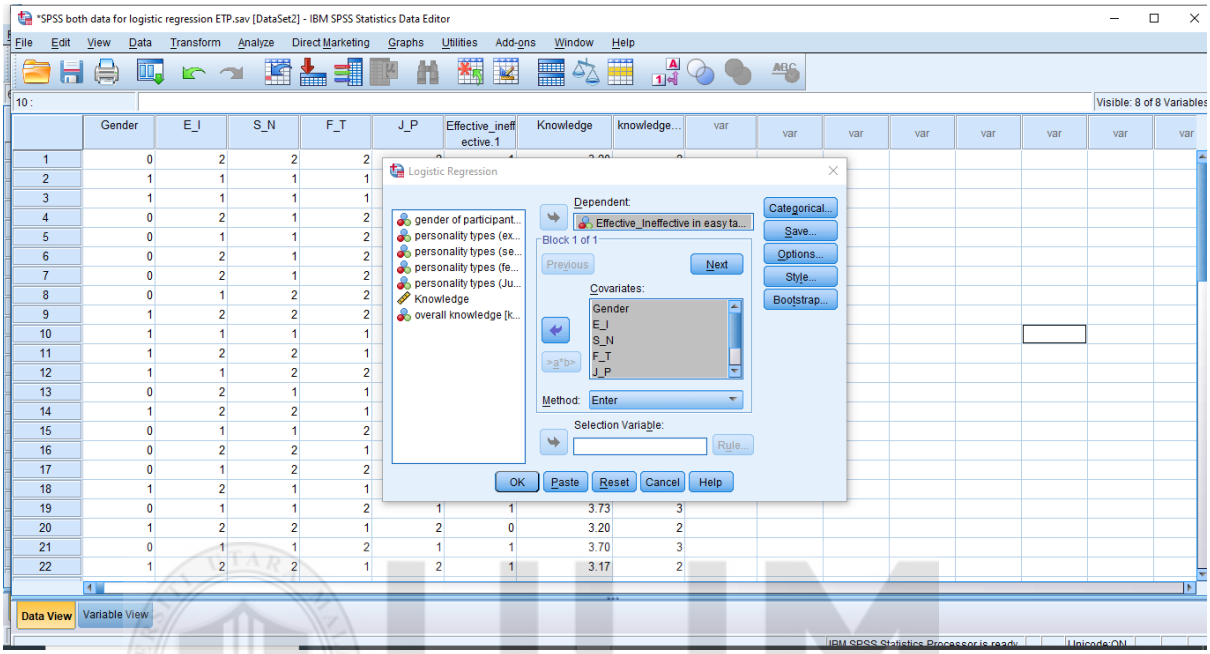
This appendix contains the screenshots of logistic regression analysis conducted using SPSS.



Sample of dataset



List of Variables



Select binary logistic regression

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Appendix S

Sample of Logistic Regression (SPSS Output)

This appendix showcases a sample output from the logistic regression analysis in SPSS. It includes the coefficients, odds ratios, and significance levels, which help explain the relationship between independent variables and performance.

1. This block presents the results with only the constant included before any coefficients (predictor variables) are entered in the equation.

Classification Table[a,b]					
			Predicted		
			Performance		
	Observed		**Ineffective**	**Effective**	**Percentage Correct**
Step 0	Performance	Ineffective	0	50	.0
		Effective	0	130	100.0
	Overall Percentage				72.0
a. Constant is included in the model.					
b. The cut value is .500					

2. The variables not in the equation show whether each predictor variables used improves the model. When the Sig. < .05, this shows that the variables are significant and would add the predictive power of the model. In this case only S_I Personality types was not contribute significantly to the model.

Variables not in the Equation					
			Score	df	Sig.
Step 0	Variables	Gender(1)	.825	1	.364
		E_I(1)	.297	1	.586
		S_N(1)	1.833	1	.176
		F_T(1)	4.131	1	.042
		J_P(1)	3.006	1	.083
		Knowledge	84.536	1	.000
		TP(1)	22.073	1	.000
		TC	63.764	1	.000
	Overall Statistics		186.221	8	.000

3. This block presents the results when the predictor variables are included; the model achieved 87% accuracy.

Classification Table[a]

Observed			Predicted Performance		
			Ineffective	Effective	Percentage Correct
Step 1	Performance	Ineffective	35(TN)	15(FP)	70.0
		Effective	11(FN)	119(TP)	91.5
	Overall Percentage				85.0

a. The cut value is .500

4. The variables in the equation determine which predictor variables contribute significantly to the model using Wald statistic. If the significant value less than .05, the variables do make a significant contribution. In this case, only S_I Personality types was not contributed significantly to the model.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Gender(1)	.646	.259	6.236	1	.013	1.907	1.149	3.166
	E_I(1)	-.676	.259	6.792	1	.009	.509	.306	.846
	S_N(1)	.477	.254	3.511	1	.061	1.611	.978	2.653
	F_T(1)	.634	.264	5.771	1	.016	1.885	1.124	3.163
	J_P(1)	.598	.255	5.489	1	.019	1.818	1.103	2.996
	Knowledge	3.668	.404	82.574	1	.000	39.185	17.763	86.445
	TP(1)	1.461	.263	30.844	1	.000	4.311	2.574	7.220
	TC	-1.529	.182	70.296	1	.000	.217	.152	.310
	Constant	-8.890	1.250	50.556	1	.000	.000		

a. Variable(s) entered on step 1: Gender, E_I, S_N, F_T, J_P, Knowledge, TP, TC.

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Appendix T

Sample of Decision Tree (WEKA Outputs)

This appendix includes a sample decision tree generated using the WEKA tool. It illustrates how the decision tree model was applied to classify the participants' performance.

This is a sample output of WEKA tool for decision tree prediction accuracy using 10-fold cross-validation.

- **Easy NTP**

```
=== Run information ===

Scheme:       weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     easyNTP
Instances:    180
Attributes:   7
              Gender
              Knowledge
              IE
              SN
              FT
              JP
              class
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

J48 pruned tree
------------------
Gender = Male
|      EI = Introvert: Effective (4.0/2.0)
|            EI = Extrovert
|      |   SN = Sensing
|      |   |   Knowledge <=2.8
|      |   |   |           |   JP=perceiving: Effective (2.0)
|      |   |   |           |   JP=Judging: Ineffective (3.0/1.0)
|      |   |   |          Knowledge > 2.8: Effective (141.0/1.0)
|      |   SN = Intuiting:    Ineffective (4.0/2.0)
Gender = Female
|      SN = Sensing
|      |   Knowledge <=2.72: Ineffective (3.0)
|      |   Knowledge > 2.72: effective (21.0)
|      SN = Intuiting: Ineffective (2.0/1.0)

Number of Leaves  : 8

Size of the tree : 15
```

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Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	169	93.8889 %
Incorrectly Classified Instances	11	6.1111 %
Kappa statistic	0	
Mean absolute error	0.1148	
Root mean squared error	0.2397	
Relative absolute error	96.0695 %	
Root relative squared error	99.9758 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	1.000	0.939	1.000	0.968	0.6323	0.456	0.934	Effective
	1.000	1.000	0.939	1.000	0.968	0.6323	0.456	0.057	Ineffective
Weighted Avg.	1.000	0.939	0.939	1.000	0.968	0.6323	0.456	0.881	

=== Confusion Matrix ===

a	b	<-- classified as
166	0	a = Effective
11	3	b = Ineffective

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- **EASY TP**

=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2
Relation: easyTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

J48 pruned tree

Gender = Male
| SN = Sensing
| | TF = Thinking: Effective (63.0/1.0)
| | TF = Feeling: Ineffective (16.0)
| SN = Intuiting: Effective (3.0)
Gender = Female
| EI = Extrovert
| | Knowledge > 2.62: Effective (18.0)
| | Knowledge <=2.62: Ineffective (6.0)
| EI = Introvert: Ineffective (4.0)

Number of Leaves: 6

Size of the tree: 11

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	156	86.6667 %
Incorrectly Classified Instances	24	13.3333 %
Kappa statistic	0.3284	
Mean absolute error	0.1876	
Root mean squared error	0.3417	
Relative absolute error	79.9897 %	
Root relative squared error	100.4294 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.949	0.667	0.902	0.949	0.925	0.337	0.642	0.892	Effective
	0.333	0.051	0.500	0.333	0.400	0.337	0.642	0.333	Ineffective
Weighted Avg.	0.867	0.585	0.849	0.867	0.855	0.337	0.642	0.818	

=== Confusion Matrix ===

a	b	<-- classified as
148	8	a = Effective
16	8	b = Ineffective

- **MEDIUM TP**

=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2
Relation: mediumTP

Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

J48 pruned tree

Gender = Male
| TF = Thinking: Effective (20.0/3.0)
| TF = Feeling
| | JP= Judging: Ineffective (24.0/3.0)
| | JP= Perceiving
| | | Knowledge: >3.55 Effective (23.0/4.0)
| | | Knowledge: <=3.55 Ineffective (7.0/2.0)
Gender = Female
| EI = Extrovert: Effective (30.0)
| EI = Introvert
| | JP= Perceiving: Ineffective (24.0/3.0)
| | JP= Judging
| | | Knowledge: >3.29 Effective (43.0/8.0)
| | | Knowledge: <=3.29 Ineffective (15.0/1.0)

Number of Leaves: 8

Size of the tree: 15

Time taken to build model: 0.02 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	123	68.3333 %
Incorrectly Classified Instances	57	31.6667 %
Kappa statistic	0.3081	
Mean absolute error	0.4165	
Root mean squared error	0.4769	
Relative absolute error	85.3143 %	
Root relative squared error	96.5197 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.894	0.605	0.669	0.894	0.765	0.340	0.616	0.630	Effective
	0.395	0.106	0.732	0.395	0.513	0.340	0.616	0.568	Ineffective
Weighted Avg.	0.683	0.394	0.696	0.683	0.659	0.340	0.616	0.604	

=== Confusion Matrix ===

```
 a  b   <-- classified as
93 11 |  a = Effective
46 30 |  b = Ineffective
```

- **MEDIUM NTP**

=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2
Relation: mediumNTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

J48 pruned tree

```
Gender = Male
|     EI = Extrovert: Effective (38.0/11.0)
|     EI = Introvert
|           |   TF = Thinking: Effective (33.0/2.0)
|           |   TF = Feeling
|           |         |       JP= Judging: Ineffective (15.0/7.0)
|           |         |       JP= Perceiving
|           |         |           Knowledge: >3.35 Effective (20.0)
|           |         |     Knowledge: <=3.35 Ineffective (10.0/5.0)
Gender = Female
|     EI = Extrovert: Effective (35.0/9.0)
|     EI = Introvert
```

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| | TF = Thinking: Effective (18.0/2.0)
| | TF = Feeling: Ineffective (11.0/7.0)

Number of Leaves : 8

Size of the tree : 15

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	147	81.6667 %
Incorrectly Classified Instances	33	18.3333 %
Kappa statistic	0.4743	
Mean absolute error	0.2434	
Root mean squared error	0.3885	
Relative absolute error	68.8204 %	
Root relative squared error	92.621 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.885	0.415	0.879	0.885	0.882	0.474	0.691	0.835	Effective
	0.585	0.115	0.600	0.585	0.593	0.474	0.691	0.436	Ineffective
Weighted Avg.	0.817	0.346	0.815	0.817	0.816	0.474	0.691	0.744	

=== Confusion Matrix ===

a	b	<-- classified as
123	16	a = Effective
17	24	b = Ineffective

- **HARD NTP**

=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2
Relation: hardNTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT

JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

J48 pruned tree

Gender = Male
| SN = Sensing: Effective (42.0/8.0)
| SN = Intuiting
| | TF = Feeling: Ineffective (4.0/2.0)
| | TF = Thinking
| | | JP= Judging: Ineffective (16.0/9.0)
| | | JP= Perceiving
| | | Knowledge >3.17 : Effective (27.0/4.0)
| | | Knowledge <=3.17: Ineffective (18.0/14.0)
Gender = Female
| TF = Feeling: Ineffective (19.0/3.0)
| TF = Thinking
| | JP= Perceiving: Effective (20.0/7.0)
| | JP = Judging
| | | Knowledge >3.15 : Effective (26.0/11.0)
| | | Knowledge <=3.15: Ineffective (8.0/3.0)

Number of Leaves : 9

Size of the tree : 17

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	146	81.1111 %
Incorrectly Classified Instances	34	18.8889 %
Kappa statistic	0.5759	
Mean absolute error	0.2319	
Root mean squared error	0.3877	
Relative absolute error	50.5239 %	
Root relative squared error	80.9541 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class

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	0.888	0.328	0.831	0.888	0.858	0.579	0.794	0.810
Effective								
	0.672	0.112	0.768	0.672	0.717	0.579	0.794	0.675
Ineffective								
Weighted Avg.	0.811	0.251	0.808	0.811	0.808	0.579	0.794	0.762

=== Confusion Matrix ===

```
  a   b   <-- classified as
 103  13 |   a = Effective
  21  43 |   b = Ineffective
```

- **HARD TP**

=== Run information ===

Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2
Relation: hardTP-weka.filters.unsupervised.attribute.Remove-R7
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

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=== Classifier model (full training set) ===

J48 pruned tree

```
Gender = Male
|   EI = Extrovert: Effective (15.0/8.0)
|   EI = Introvert
|       |   TF = Feeling: Ineffective (9.0/2.0)
|       |   TF = Thinking
|       |       |       JP= Judging: Ineffective (28.0/8.0)
|       |       |       JP= Perceiving
|       |       |           Knowledge >3.65 :  Effective (20.0/4.0)
|       |       |   Knowledge <=3.65: Ineffective (22.0/1.0)
Gender = Female
|   EI = Extrovert: Ineffective (27.0/6.0)
|   EI = Introvert
|       |       SN= Intuiting: Ineffective (21.0/6.0)
|       |       SN = Sensing
|       |       |           Knowledge >3.45 :  Effective (21.0/4.0)
|       |       |   Knowledge <=3.45: Ineffective (17.0/5.0)
```

Number of Leaves : 9

Size of the tree : 17

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	109	60.5556 %
Incorrectly Classified Instances	71	39.4444 %
Kappa statistic	0.1822	
Mean absolute error	0.4113	
Root mean squared error	0.5108	
Relative absolute error	87.4088 %	
Root relative squared error	105.3258 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.544	0.357	0.481	0.544	0.510	0.183	0.623	0.457	Effective
	0.643	0.456	0.699	0.643	0.670	0.183	0.623	0.725	Ineffective
Weighted Avg.	0.606	0.419	0.616	0.606	0.610	0.183	0.623	0.624	

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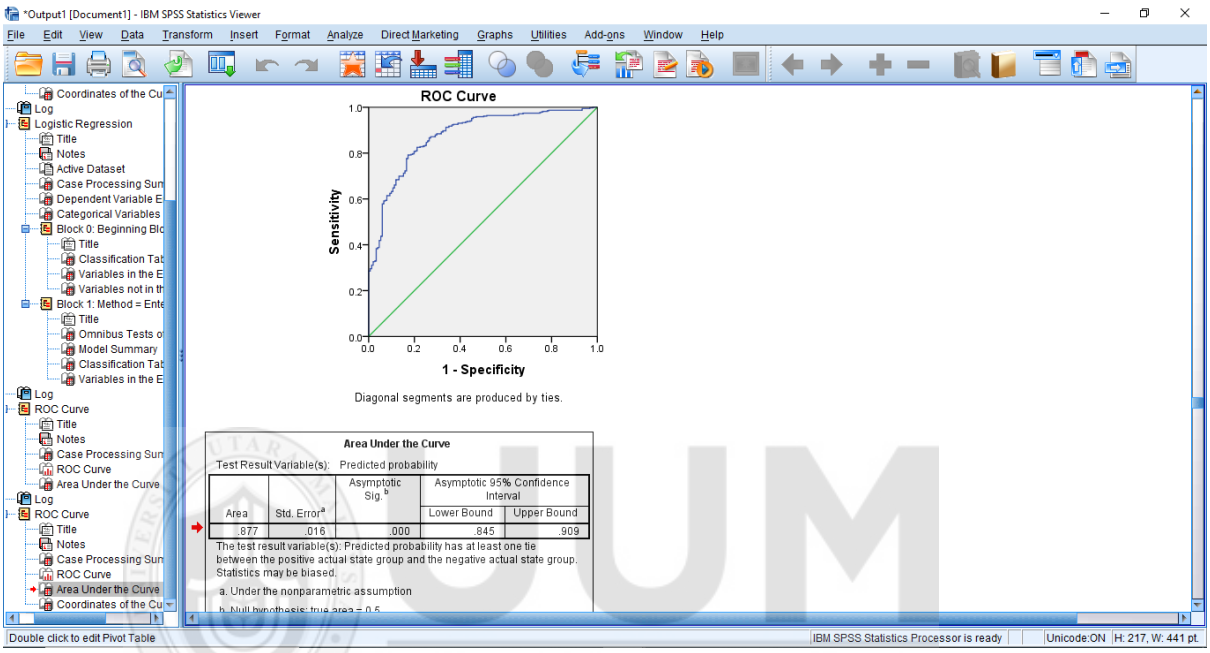
=== Confusion Matrix ===

a	b	<-- classified as
37	31	a = Effective
40	72	b = Ineffective

Appendix U

Sample of ROC Value Output Using SPSS Tool

This appendix presents the Receiver Operating Characteristic (ROC) curve and value output from SPSS. The ROC curve was used to assess the performance of the predictive models, particularly their ability to distinguish between different performance classes.



This is a sample of logistic regression area under ROC value output using SPSS tool.

- **Area Under the Curve**

Area Under the Curve

Test Result Variable(s): Predicted probability

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.877	.016	.000	.845	.909

The test result variable(s): Predicted probability has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

- **Table of the coordinated of the curves**

Coordinates of the Curve

Test Result Variable(s): Predicted probability

Positive if Greater Than or Equal To[a]	Sensitivity	1 - Specificity

.0000000	1.000	1.000
.0202824	1.000	.986
.0287332	1.000	.971
.0329347	1.000	.957
.0371233	.980	.957
.0389613	.980	.942
.0452935	.980	.928
.0584207	.980	.913
.0677662	.980	.899
.0703781	.980	.884
.0764225	.980	.870
.0871294	.961	.870
.0957128	.941	.870
.0991184	.922	.870
.1017506	.922	.855
.1049373	.922	.841
.1068945	.922	.826
.1086095	.922	.812
.1099426	.922	.797
.1116574	.922	.783
.1133949	.922	.768
.1163641	.922	.754
.1221460	.922	.739
.1320608	.922	.725
.1406226	.922	.710
.1449859	.922	.696
.1495618	.922	.681
.1547303	.922	.667
.1670099	.922	.652
.1855494	.922	.638
.1980402	.922	.623
.2166509	.922	.609
.2354080	.902	.609
.2387813	.902	.594
.2431642	.902	.580
.2565761	.902	.565
.2691558	.902	.551
.2800787	.902	.536
.2911487	.892	.536
.2991329	.892	.522

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.3099393	.891	.522
.3183179	.889	.522
.3215377	.886	.507
.3256601	.882	.493
.3322520	.882	.478
.3365980	.822	.464
.3377421	.880	.449
.3405317	.880	.435
.3436240	.879	.420
.3450636	.878	.406
.3490349	.879	.398
.3537606	.879	.291
.3560362	.877	.291
.3587788	.874	.291
.3628548	.871	.291
.3712444	.871	.285
.3826762	.845	.281
.4018615	.824	.279
.4199693	.824	.278
.4278312	.824	.275
.4376323	.804	.275
.4466397	.804	.261
.4528386	.804	.246
.4860710	.804	.232
.5185848	.804	.217
.5226381	.804	.203
.5442137	.784	.203
.5673362	.765	.203
.5758607	.765	.188
.5856884	.745	.188
.5927218	.745	.174
.5979844	.745	.159
.6033616	.745	.145
.6071771	.725	.145
.6200465	.706	.145
.6321110	.686	.145
.6358551	.686	.130
.6414809	.667	.130
.6614873	.647	.130
.6814723	.627	.130

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.6864132	.608	.130
.6904506	.608	.116
.6951263	.608	.101
.6995159	.608	.087
.7029652	.608	.072
.7058353	.588	.072
.7099360	.569	.072
.7136396	.569	.058
.7141547	.549	.058
.7171876	.529	.058
.7222509	.529	.043
.7301039	.529	.029
.7434881	.510	.029
.7555885	.490	.029
.7606433	.451	.029
.7627721	.431	.029
.7693733	.412	.029
.7753777	.392	.029
.7805204	.373	.029
.7939784	.373	.014
.8180041	.353	.014
.8395441	.353	.000
.8495498	.333	.000
.8607180	.314	.000
.8697731	.294	.000
.8767519	.275	.000
.8847038	.255	.000
.8872856	.235	.000
.8888837	.216	.000
.8975608	.196	.000
.9080958	.176	.000
.9130525	.157	.000
.9147383	.137	.000
.9237325	.118	.000
.9383277	.098	.000
.9494956	.078	.000
.9572649	.059	.000
.9606474	.039	.000
.9648778	.020	.000
1.0000000	.000	.000

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a. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

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Appendix V

Sample of ANN (WEKA outputs)

This appendix contains the output from the ANN model generated using WEKA. It shows how the ANN model performed in predicting developers' performance, providing key metrics.

- **Easy NTP**

```
=== Run information ===

Scheme:       weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
Relation:     easyNTP
Instances:    180
Attributes:   7
              Gender
              Knowledge
              IE
              SN
              FT
              JP
              class
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0
    Inputs    Weights
    Threshold    -1.612323991080546
    Node 2    4.079162368936238
    Node 3    4.104727445668504
    Node 4    5.247351573734934
    Node 5    3.1777362869507515
Sigmoid Node 1
    Inputs    Weights
    Threshold    1.6123450792869298
    Node 2    -4.1076454996743745
    Node 3    -4.075942931252122
    Node 4    -5.247319954365999
    Node 5    -3.177646115985696
Sigmoid Node 2
    Inputs    Weights
    Threshold    1.6319834284718058
    Attrib Gender=MALE    1.1844660639065632
    Attrib Knowledge    9.026732310349168
    Attrib IE=Introvert    0.5314094885708147
    Attrib SN=Inituiting    0.09204460600113731
    Attrib FT=Feeling    3.0948677179438286
    Attrib JP=Judging    -0.37823219952998555
Sigmoid Node 3
    Inputs    Weights
    Threshold    1.5964033464805456
    Attrib Gender=MALE    1.019012189844543
```

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Attrib Knowledge 8.88492206004524
Attrib IE=Introvert 0.8588663459270639
Attrib SN=Inituiting 0.050506935843821384
Attrib FT=Feeling 3.265965524741468
Attrib JP=Judging -0.4711669934442308
Sigmoid Node 4
Inputs Weights
Threshold -1.6705827346063178
Attrib Gender=MALE 2.2929243066465634
Attrib Knowledge 5.058311374612433
Attrib IE=Introvert 1.172909852667952
Attrib SN=Inituiting -2.9535195628683235
Attrib FT=Feeling -3.31154274000043
Attrib JP=Judging -5.329264347834518
Sigmoid Node 5
Inputs Weights
Threshold 2.182455439077911
Attrib Gender=MALE 2.8294468797991916
Attrib Knowledge 3.8237876476374724
Attrib IE=Introvert 2.4295701586303284
Attrib SN=Inituiting 3.561823936269066
Attrib FT=Feeling -0.9728854021178202
Attrib JP=Judging 0.8795926486385012
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

Time taken to build model: 0.24 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	166	92.2222 %
Incorrectly Classified Instances	14	7.7778 %
Kappa statistic	0.1834	
Mean absolute error	0.0965	
Root mean squared error	0.2707	
Relative absolute error	80.7291 %	
Root relative squared error	112.9339 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.970	0.818	0.948	0.970	0.959	0.189	0.806	0.984	Effective
	0.182	0.030	0.286	0.182	0.222	0.189	0.806	0.196	Ineffective
Weighted Avg.	0.922	0.770	0.908	0.922	0.914	0.189	0.806	0.936	

=== Confusion Matrix ===

a	b	<-- classified as

164 5 | a = Effective
 9 2 | b = Ineffective

- **Easy TP**

=== Run information ===

Scheme: weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
Relation: easyTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0
Inputs Weights
Threshold -7.22168273048237
Node 2 7.333868135387107
Node 3 4.562277510401897
Node 4 3.797147805782776
Node 5 3.453582937255274
Sigmoid Node 1
Inputs Weights
Threshold 7.222307991067093
Node 2 -7.334629072986696
Node 3 -4.5626594554813895
Node 4 -3.7974248993198745
Node 5 -3.453847221245762
Sigmoid Node 2
Inputs Weights
Threshold 0.5226748837965672
Attrib Gender=MALE 5.146757419581444
Attrib Knowledge 5.999725607573578
Attrib IE=Introvert -3.2667817370684906
Attrib SN=Inituiting 4.268784523490736
Attrib FT=Feeling 3.8644008532666367
Attrib JP=Judging -3.9616957991438526
Sigmoid Node 3
Inputs Weights
Threshold 7.302698585129874
Attrib Gender=MALE 2.3656979259129978
Attrib Knowledge 8.948062681036513
Attrib IE=Introvert 2.9376912177422803
Attrib SN=Inituiting -2.107777387157654
Attrib FT=Feeling -0.9624181933347362
Attrib JP=Judging -0.1365005990787547
Sigmoid Node 4
Inputs Weights

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Threshold 4.969538916384451
Attrib Gender=MALE -1.8808851521312042
Attrib Knowledge 9.972278549828708
Attrib IE=Introvert -1.2675324582671317
Attrib SN=Inituiting -1.2643120674751522
Attrib FT=Feeling 0.16899828294881278
Attrib JP=Judging 1.3656926864663814
Sigmoid Node 5
Inputs Weights
Threshold 0.06478190927587092
Attrib Gender=MALE 3.6909988879126376
Attrib Knowledge 3.4395861992450745
Attrib IE=Introvert -3.2186829000064963
Attrib SN=Inituiting 1.2640601708427424
Attrib FT=Feeling -5.66595331919958
Attrib JP=Judging 1.3997385073246207
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

Time taken to build model: 0.1 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	155	86.1111 %
Incorrectly Classified Instances	25	13.8889 %
Kappa statistic	0.2545	
Mean absolute error	0.1559	
Root mean squared error	0.3516	
Relative absolute error	66.474 %	
Root relative squared error	103.3485 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.955	0.750	0.892	0.955	0.923	0.269	0.731	0.933	Effective
	0.250	0.045	0.462	0.250	0.324	0.269	0.731	0.350	Ineffective
Weighted Avg.	0.861	0.656	0.835	0.861	0.843	0.269	0.731	0.855	

=== Confusion Matrix ===

a	b	<-- classified as
149	7	a = Effective
18	6	b = Ineffective

- **Medium NTP**

=== Run information ===

Scheme: weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a

Relation: mediumNTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0
Inputs Weights
Threshold -8.308990761461665
Node 2 7.082345751040713
Node 3 4.9429271389675415
Node 4 4.983408930490522
Node 5 8.353746079837427
Sigmoid Node 1
Inputs Weights
Threshold 8.309255160641099
Node 2 -7.082578553926097
Node 3 -4.9430688433524965
Node 4 -4.983546064557313
Node 5 -8.354010955402025
Sigmoid Node 2
Inputs Weights
Threshold 1.0682762291753949
Attrib Gender=MALE 1.7540606294167198
Attrib Knowledge 12.088343832505172
Attrib IE=Introvert -6.6308943415813415
Attrib SN=Inituiting 2.4992510789914255
Attrib FT=Feeling 4.76043748753173
Attrib JP=Judging -6.255527322652588
Sigmoid Node 3
Inputs Weights
Threshold 1.0217402331726657
Attrib Gender=MALE -1.0800195912550934
Attrib Knowledge 11.288263609867677
Attrib IE=Introvert -1.7480956032330501
Attrib SN=Inituiting -2.7326496916400815
Attrib FT=Feeling -2.4444863043685476
Attrib JP=Judging -0.6310326956320127
Sigmoid Node 4
Inputs Weights
Threshold -0.973075837212566
Attrib Gender=MALE -0.6632313401524159
Attrib Knowledge 10.283039276639531
Attrib IE=Introvert 1.3521304086695598
Attrib SN=Inituiting -0.3949393512713436
Attrib FT=Feeling 4.135536681904543
Attrib JP=Judging 3.1341233560419135
Sigmoid Node 5

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Inputs Weights
Threshold -1.0371385053461835
Attrib Gender=MALE 4.550485242557211
Attrib Knowledge 4.584979339481953
Attrib IE=Introvert 3.9938344458141963
Attrib SN=Inituiting 4.409500198516426
Attrib FT=Feeling -1.9596509054419995
Attrib JP=Judging -1.7911377321578088
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

Time taken to build model: 0.07 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	151	83.8889 %
Incorrectly Classified Instances	29	16.1111 %
Kappa statistic	0.5381	
Mean absolute error	0.1761	
Root mean squared error	0.3544	
Relative absolute error	49.7877 %	
Root relative squared error	84.4754 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.899	0.366	0.893	0.899	0.896	0.538	0.849	0.933	Effective
	0.634	0.101	0.650	0.634	0.642	0.538	0.849	0.715	Ineffective
Weighted Avg.	0.839	0.305	0.838	0.839	0.838	0.538	0.849	0.883	

=== Confusion Matrix ===

a	b	<-- classified as
125	14	a = Effective
15	26	b = Ineffective

- Medium TP

=== Run information ===

Scheme: weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
Relation: mediumTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN

FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0
Inputs Weights
Threshold -2.747814463835889
Node 2 2.675676674061201
Node 3 2.367000195416931
Node 4 2.77036049432141
Node 5 2.2527349422836687
Sigmoid Node 1
Inputs Weights
Threshold 2.747814463833765
Node 2 -2.675676674058894
Node 3 -2.3670001954153013
Node 4 -2.7703604943197457
Node 5 -2.252734942281631
Sigmoid Node 2
Inputs Weights
Threshold -8.28044612238649
Attrib Gender=MALE -1.9982507868510968
Attrib Knowledge 9.06411570924355
Attrib IE=Introvert -0.2616024964660808
Attrib SN=Inituiting -0.9992850432639037
Attrib FT=Feeling 4.538041884732333
Attrib JP=Judging 4.860527539396203
Sigmoid Node 3
Inputs Weights
Threshold -6.180477210730169
Attrib Gender=MALE 11.008644131822377
Attrib Knowledge 5.746034282035654
Attrib IE=Introvert -2.3054202879031847
Attrib SN=Inituiting 3.355508331343503
Attrib FT=Feeling 1.4565793977379453
Attrib JP=Judging -4.722796461675759
Sigmoid Node 4
Inputs Weights
Threshold -6.499403034610365
Attrib Gender=MALE 0.42648505651798974
Attrib Knowledge 14.424367329423161
Attrib IE=Introvert -2.6182749082380745
Attrib SN=Inituiting 1.2068771221576318
Attrib FT=Feeling -5.8368848340413
Attrib JP=Judging 0.9879813423522679
Sigmoid Node 5
Inputs Weights
Threshold -7.421029274386928
Attrib Gender=MALE -5.078691567410166
Attrib Knowledge 3.793183095559527
Attrib IE=Introvert 6.98982559567093
Attrib SN=Inituiting -4.69560378282179
Attrib FT=Feeling 3.478157325932317

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Attrib JP=Judging -5.026291284959339
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

Time taken to build model: 0.1 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	113	62.7778 %
Incorrectly Classified Instances	67	37.2222 %
Kappa statistic	0.2275	
Mean absolute error	0.4146	
Root mean squared error	0.5424	
Relative absolute error	84.9177 %	
Root relative squared error	109.7794 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.712	0.487	0.667	0.712	0.688	0.228	0.626	0.707	Effective
	0.513	0.288	0.565	0.513	0.538	0.228	0.626	0.517	Ineffective
Weighted Avg.	0.628	0.403	0.624	0.628	0.625	0.228	0.626	0.627	

=== Confusion Matrix ===

a	b	<-- classified as
74	30	a = Effective
37	39	b = Ineffective

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- Hard NTP

=== Run information ===

Scheme: weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
Relation: hard NTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0

Inputs Weights
Threshold -10.217541248679213
Node 2 4.647094885955859
Node 3 6.202629706150964
Node 4 6.623577461305876
Node 5 6.5178911602332334
Sigmoid Node 1
Inputs Weights
Threshold 10.217500395288742
Node 2 -4.6470804961408465
Node 3 -6.202604025428656
Node 4 -6.623552965281675
Node 5 -6.517863401273089
Sigmoid Node 2
Inputs Weights
Threshold -2.0356576356135623
Attrib Gender=MALE 6.2272580642629825
Attrib Knowledge 13.577551074252629
Attrib IE=Introvert -1.4099865874551059
Attrib SN=Inituiting 5.225396245134555
Attrib FT=Feeling 2.988598282838154
Attrib JP=Judging -0.042940751742980184
Sigmoid Node 3
Inputs Weights
Threshold -1.3518520568456518
Attrib Gender=MALE -1.8596118294147514
Attrib Knowledge 6.456161446393677
Attrib IE=Introvert -7.707807228829701
Attrib SN=Inituiting 4.921657865510223
Attrib FT=Feeling 1.7777401192795685
Attrib JP=Judging -3.276457638348229
Sigmoid Node 4
Inputs Weights
Threshold -1.3535244805541669
Attrib Gender=MALE -4.2815380665894
Attrib Knowledge 17.12174623844943
Attrib IE=Introvert 1.146227607473292
Attrib SN=Inituiting -1.6775641796273912
Attrib FT=Feeling 0.2594982298094743
Attrib JP=Judging -4.628070499944366
Sigmoid Node 5
Inputs Weights
Threshold -1.2857259631462126
Attrib Gender=MALE 2.6256636016308184
Attrib Knowledge 10.85448628883054
Attrib IE=Introvert 2.639042912070103
Attrib SN=Inituiting -1.6077392161628798
Attrib FT=Feeling 3.846591774591153
Attrib JP=Judging 6.687131032861244
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

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Time taken to build model: 0.12 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	153	85 %
Incorrectly Classified Instances	27	15 %
Kappa statistic	0.662	
Mean absolute error	0.1846	
Root mean squared error	0.3638	
Relative absolute error	40.2288 %	
Root relative squared error	75.9792 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.922	0.281	0.856	0.922	0.888	0.666	0.874	0.905	Effective
	0.719	0.078	0.836	0.719	0.773	0.666	0.874	0.834	Ineffective
Weighted Avg.	0.850	0.209	0.849	0.850	0.847	0.666	0.874	0.880	

=== Confusion Matrix ===

a	b	<-- classified as
107	9	a = Effective
18	46	b = Ineffective

- **Hard TP**

=== Run information ===

Scheme: weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2 -N 500 -V 0 -S 0 -E 20 -H a
Relation: hardTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

Sigmoid Node 0
Inputs Weights
Threshold 6.749454483898948
Node 2 -5.891968918232094
Node 3 -1.9431110314402587
Node 4 -5.941932241639852
Node 5 -5.605640441552534
Sigmoid Node 1
Inputs Weights

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Threshold -6.74945710251745
Node 2 5.89197137132199
Node 3 1.9431112183019503
Node 4 5.941934803239858
Node 5 5.605642912082491
Sigmoid Node 2
Inputs Weights
Threshold 3.7923355025233945
Attrib Gender=MALE -2.754960570670259
Attrib Knowledge -3.6537758551882233
Attrib IE=Introvert -10.191853420058983
Attrib SN=Inituiting 6.406966929060274
Attrib FT=Feeling 3.3751456067965697
Attrib JP=Judging -8.441706674597368
Sigmoid Node 3
Inputs Weights
Threshold 9.67122823469385
Attrib Gender=MALE -5.868995538609118
Attrib Knowledge -10.174776639899621
Attrib IE=Introvert -2.5492162088030956
Attrib SN=Inituiting 0.3676612734120312
Attrib FT=Feeling 7.937850673599199
Attrib JP=Judging -0.5429045564379983
Sigmoid Node 4
Inputs Weights
Threshold -10.974570833535184
Attrib Gender=MALE 3.4103457217936923
Attrib Knowledge -7.735146406566782
Attrib IE=Introvert -0.6282057153681436
Attrib SN=Inituiting -5.435086974770956
Attrib FT=Feeling -4.989358659368399
Attrib JP=Judging 5.513238001430623
Sigmoid Node 5
Inputs Weights
Threshold 0.7672781382156343
Attrib Gender=MALE -1.9008896623159002
Attrib Knowledge -12.640560004902985
Attrib IE=Introvert 8.911869390538838
Attrib SN=Inituiting -2.343580264323733
Attrib FT=Feeling -4.5928840990501305
Attrib JP=Judging 4.376194875912708
Class Effective
Input
Node 0
Class Ineffective
Input
Node 1

Time taken to build model: 0.09 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	123	68.3333 %
Incorrectly Classified Instances	57	31.6667 %

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Kappa statistic	0.3284
Mean absolute error	0.3907
Root mean squared error	0.5115
Relative absolute error	83.0219 %
Root relative squared error	105.4715 %
Total Number of Instances	180

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.588	0.259	0.580	0.588	0.584	0.328	0.643	0.495	Effective
	0.741	0.412	0.748	0.741	0.744	0.328	0.643	0.720	Ineffective
Weighted Avg.	0.683	0.354	0.684	0.683	0.684	0.328	0.643	0.635	

=== Confusion Matrix ===

a	b	<-- classified as
40	28	a = Effective
29	83	b = Ineffective

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Appendix W

Sample of K-Nearest Neighbour Algorithm (WEKA outputs)

This appendix includes a sample output from the KNN algorithm in WEKA. It displays the classification results and performance metrics, helping to evaluate the algorithm's accuracy in predicting developer performance.

The results of KNN when K value is 13

- **Easy NTP**

```
=== Run information ===

Scheme:       weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A
\"weka.core.EuclideanDistance -R first-last\""
Relation:     easyNTP
Instances:    180
Attributes:   7
              Gender
              Knowledge
              IE
              SN
              FT
              JP
              class
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification


Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances         169               93.8889 %
Incorrectly Classified Instances        11                6.1111 %
Kappa statistic                          0
Mean absolute error                      0.0916
Root mean squared error                  0.2249
Relative absolute error                 76.6376 %
Root relative squared error             93.8053 %
Total Number of Instances              180

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure  MCC      ROC Area  PRC Area  Class
               1.000    1.000        0.939      1.000      0.968      ?        0.857     0.985     Effective
               0.000    0.000            0      0.000          0      ?        0.857     0.239     Ineffective
Weighted Avg.  0.939    0.939            0      0.939          0      ?        0.857     0.939
```

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=== Confusion Matrix ===

```
  a   b   <-- classified as
169   0 |   a = Effective
 11   0 |   b = Ineffective
```

- **Easy TP**

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""
Relation: easyTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	156	86.6667 %
Incorrectly Classified Instances	24	13.3333 %
Kappa statistic	0	
Mean absolute error	0.2053	
Root mean squared error	0.3399	
Relative absolute error	87.5438 %	
Root relative squared error	99.897 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	1.000	0.867	1.000	0.929	?	0.633	0.898	Effective
	0.000	0.000	?	0.000	?	?	0.633	0.207	Ineffective
Weighted Avg.	0.867	0.867	?	0.867	?	?	0.633	0.806	

=== Confusion Matrix ===

```
  a   b   <-- classified as
156   0 |   a = Effective
 24   0 |   b = Ineffective
```

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➢ **Medium NTP**

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""
Relation: mediumNTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	142	78.8889 %
Incorrectly Classified Instances	38	21.1111 %
Kappa statistic	0.1913	
Mean absolute error	0.2769	
Root mean squared error	0.3708	
Relative absolute error	78.2821 %	
Root relative squared error	88.3921 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.971	0.829	0.799	0.971	0.877	0.249	0.800	0.905	Effective
	0.171	0.029	0.636	0.171	0.269	0.249	0.800	0.548	Ineffective
Weighted Avg.	0.789	0.647	0.762	0.789	0.738	0.249	0.800	0.824	

=== Confusion Matrix ===

a	b	<-- classified as
135	4	a = Effective
34	7	b = Ineffective

➢ **Medium TP**

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A

\"weka.core.EuclideanDistance -R first-last\""
Relation: mediumTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	115	63.8889 %
Incorrectly Classified Instances	65	36.1111 %
Kappa statistic	0.2313	
Mean absolute error	0.4427	
Root mean squared error	0.4758	
Relative absolute error	90.6707 %	
Root relative squared error	96.2946 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.788	0.566	0.656	0.788	0.716	0.239	0.660	0.694	Effective
	0.434	0.212	0.600	0.434	0.504	0.239	0.660	0.564	Ineffective
Weighted Avg.	0.639	0.416	0.632	0.639	0.627	0.239	0.660	0.639	

=== Confusion Matrix ===

a	b	<-- classified as
82	22	a = Effective
43	33	b = Ineffective

- **Hard NTP**

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A
\"weka.core.EuclideanDistance -R first-last\""
Relation: hardNTP
Instances: 180
Attributes: 7
Gender

Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	144	80 %
Incorrectly Classified Instances	36	20 %
Kappa statistic	0.5199	
Mean absolute error	0.3372	
Root mean squared error	0.3986	
Relative absolute error	73.4745 %	
Root relative squared error	83.2342 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.957	0.484	0.782	0.957	0.860	0.554	0.833	0.861	Effective
	0.516	0.043	0.868	0.516	0.647	0.554	0.833	0.740	Ineffective
Weighted Avg.	0.800	0.327	0.813	0.800	0.785	0.554	0.833	0.818	

=== Confusion Matrix ===

a	b	<-- classified as
111	5	a = Effective
31	33	b = Ineffective

- **Hard TP**

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 13 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""
Relation: hardTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP

class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 13 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	117	65 %
Incorrectly Classified Instances	63	35 %
Kappa statistic	0.1925	
Mean absolute error	0.4422	
Root mean squared error	0.4756	
Relative absolute error	93.9554 %	
Root relative squared error	98.0794 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.338	0.161	0.561	0.338	0.422	0.205	0.636	0.475	Effective
	0.839	0.662	0.676	0.839	0.749	0.205	0.636	0.734	Ineffective
Weighted Avg.	0.650	0.472	0.633	0.650	0.625	0.205	0.636	0.636	

=== Confusion Matrix ===

a	b	<-- classified as
23	45	a = Effective
18	94	b = Ineffective

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Appendix X

Sample of Support Vector Machine (WEKA output)

This appendix contains the output from the SVM model in WEKA, providing classification results and metrics used to evaluate the model's performance in predicting the outcomes.

- **Easy NTP**

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     easyNTP
Instances:    180
Attributes:   7
              Gender
              Knowledge
              IE
              SN
              FT
              JP
              class
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
  Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

        -0.004  * (normalized) Gender=MALE
 +      -0.018  * (normalized) Knowledge
 +      -0.0014 * (normalized) IE=Introvert
 +      -0.0004 * (normalized) SN=Inituiting
 +      -0.0005 * (normalized) FT=Feeling
 +       0.0019 * (normalized) JP=Judging
 -       0.9942

Number of kernel evaluations: 2289 (82.396% cached)

Time taken to build model: 0.2 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances         169               93.8889 %
Incorrectly Classified Instances        11                6.1111 %
Kappa statistic                          0
```

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Mean absolute error 0.0611
Root mean squared error 0.2472
Relative absolute error 51.1338 %
Root relative squared error 103.1196 %
Total Number of Instances 180

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	1.000	0.939	1.000	0.968	?	0.500	0.939	Effective
	0.000	0.000	?	0.000	?	?	0.500	0.061	Ineffective
Weighted Avg.	0.939	0.939	?	0.939	?	?	0.500	0.885	

=== Confusion Matrix ===

```
  a   b   <-- classified as
 169   0 |   a = Effective
  11   0 |   b = Ineffective
```

- **Easy TP**

=== Run information ===

Scheme: weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K "weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation: easyTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

```
      -0.0012 * (normalized) Gender=MALE
+     -0.0051 * (normalized) Knowledge
+      0.0007 * (normalized) IE=Introvert
+      0.0004 * (normalized) SN=Inituiting
+     -0.0003 * (normalized) FT=Feeling
+      0.0002 * (normalized) JP=Judging
```

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- 0.9978

Number of kernel evaluations: 5228 (81.418% cached)

Time taken to build model: 0.01 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	156	86.6667 %
Incorrectly Classified Instances	24	13.3333 %
Kappa statistic	0	
Mean absolute error	0.1333	
Root mean squared error	0.3651	
Relative absolute error	56.8458 %	
Root relative squared error	107.3283 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	1.000	1.000	0.867	1.000	0.929	?	0.500	0.867	Effective
	0.000	0.000	?	0.000	?	?	0.500	0.133	Ineffective
Weighted Avg.	0.867	0.867	?	0.867	?	?	0.500	0.769	

=== Confusion Matrix ===

a	b	<-- classified as
156	0	a = Effective
24	0	b = Ineffective

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- **Medium NTP**

=== Run information ===

Scheme: weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K "weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation: mediumNTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
  Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

       -0.6142 * (normalized) Gender=MALE
 +   -3.7482 * (normalized) Knowledge
 +   0.1089 * (normalized) IE=Introvert
 +   -0.095 * (normalized) SN=Inituiting
 +   -0.0398 * (normalized) FT=Feeling
 +   0.5802 * (normalized) JP=Judging
 +   1.1749

Number of kernel evaluations: 4569 (75.082% cached)

Time taken to build model: 0.04 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	155	86.1111 %
Incorrectly Classified Instances	25	13.8889 %
Kappa statistic	0.5799	
Mean absolute error	0.1389	
Root mean squared error	0.3727	
Relative absolute error	39.272 %	
Root relative squared error	88.8411 %	
Total Number of Instances	180	

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=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.935	0.390	0.890	0.935	0.912	0.584	0.773	0.883	Effective
	0.610	0.065	0.735	0.610	0.667	0.584	0.773	0.537	Ineffective
Weighted Avg.	0.861	0.316	0.855	0.861	0.856	0.584	0.773	0.804	

=== Confusion Matrix ===

   a   b   <-- classified as
 130   9 | a = Effective
  16 25 | b = Ineffective

- **Medium TP**

=== Run information ===

Scheme: weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K "weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation: mediumTP
Instances: 180
Attributes: 7

Gender
Knowledge
IE
SN
FT
JP
class

Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

-0.4416 * (normalized) Gender=MALE
+ -3.0824 * (normalized) Knowledge
+ -0.0853 * (normalized) IE=Introvert
+ 0.0504 * (normalized) SN=Inituiting
+ 0.2821 * (normalized) FT=Feeling
+ 0.0285 * (normalized) JP=Judging
+ 1.6227

Number of kernel evaluations: 5828 (76.486% cached)

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Time taken to build model: 0.03 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	126	70 %
Incorrectly Classified Instances	54	30 %
Kappa statistic	0.3649	
Mean absolute error	0.3	
Root mean squared error	0.5477	
Relative absolute error	61.4488 %	
Root relative squared error	110.8552 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.827	0.474	0.705	0.827	0.761	0.373	0.677	0.683	Effective
	0.526	0.173	0.690	0.526	0.597	0.373	0.677	0.563	Ineffective
Weighted Avg.	0.700	0.347	0.698	0.700	0.692	0.373	0.677	0.632	

=== Confusion Matrix ===

```
 a  b   <-- classified as
86 18 |  a = Effective
36 40 |  b = Ineffective
```

- **Hard NTP**

```
=== Run information ===

Scheme:       weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K
"weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator
"weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation:     hardNTP
Instances:    180
Attributes:   7
              Gender
              Knowledge
              IE
              SN
              FT
              JP
              class
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
  Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

        -0.114  * (normalized) Gender=MALE
 +      -4.4003 * (normalized) Knowledge
 +       0.4335 * (normalized) IE=Introvert
 +      -0.3197 * (normalized) SN=Inituiting
 +      -0.2605 * (normalized) FT=Feeling
 +      -0.0261 * (normalized) JP=Judging
 +       2.1269

Number of kernel evaluations: 5468 (79.383% cached)

Time taken to build model: 0.02 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances         150               83.3333 %
Incorrectly Classified Instances        30               16.6667 %
Kappa statistic                          0.6204
```

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Mean absolute error 0.1667
Root mean squared error 0.4082
Relative absolute error 36.3153 %
Root relative squared error 85.2535 %
Total Number of Instances 180

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.922	0.328	0.836	0.922	0.877	0.628	0.797	0.821	Effective
	0.672	0.078	0.827	0.672	0.741	0.628	0.797	0.672	Ineffective
Weighted Avg.	0.833	0.239	0.833	0.833	0.829	0.628	0.797	0.768	

=== Confusion Matrix ===

a	b	<-- classified as
107	9	a = Effective
21	43	b = Ineffective

- **Hard TP**

=== Run information ===

Scheme: weka.classifiers.functions.SMO -C 1.0 -L 0.001 -P 1.0E-12 -N 0 -V -1 -W 1 -K "weka.classifiers.functions.supportVector.PolyKernel -E 1.0 -C 250007" -calibrator "weka.classifiers.functions.Logistic -R 1.0E-8 -M -1 -num-decimal-places 4"
Relation: hardTP
Instances: 180
Attributes: 7
Gender
Knowledge
IE
SN
FT
JP
class
Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

SMO

Kernel used:
Linear Kernel: K(x,y) = <x,y>

Classifier for classes: Effective, Ineffective

BinarySMO

Machine linear: showing attribute weights, not support vectors.

-0.7429 * (normalized) Gender=MALE
+ -2.3056 * (normalized) Knowledge
+ 0.3795 * (normalized) IE=Introvert
+ 0.4815 * (normalized) SN=Inituiting
+ 0.3004 * (normalized) FT=Feeling

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+ -0.3786 * (normalized) JP=Judging
+ 1.8975

Number of kernel evaluations: 6197 (77.3% cached)

Time taken to build model: 0.03 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances	115	63.8889 %
Incorrectly Classified Instances	65	36.1111 %
Kappa statistic	0.1873	
Mean absolute error	0.3611	
Root mean squared error	0.6009	
Relative absolute error	76.7348 %	
Root relative squared error	123.9144 %	
Total Number of Instances	180	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.382	0.205	0.531	0.382	0.444	0.193	0.588	0.436	Effective
	0.795	0.618	0.679	0.795	0.733	0.193	0.588	0.668	Ineffective
Weighted Avg.	0.639	0.462	0.623	0.639	0.624	0.193	0.588	0.580	

=== Confusion Matrix ===

a	b	<-- classified as
26	42	a = Effective
23	89	b = Ineffective

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Appendix Y

Experimental Session Script

This appendix provides the detailed script used during experimental sessions to communicate with participants about the task's duration. The script includes time duration announcements made throughout the tasks to ensure participants are aware of the total time available and how much time remains. This helped induce the desired level of time pressure (TP), particularly for the TP tasks.

No-Time-Pressure (NTP) – Instructions

****ROUND 1:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have a series of programming tasks in C++ lined up for you. Please pay close attention to the instructions provided for each task.

Before we move forward, could each of you please confirm that you've completed the consent form and the questionnaire?

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****10:20 AM:****

Once everyone is ready,

Let's begin with **Task 1**:

****Time Context:** No Time Pressure (NTP)**

****Task Complexity:** Easy**

****Estimated Time:** 45 minutes**

You have a total of 45 minutes for this task. We'll remind you of the remaining time only once, so please focus on completing the task efficiently.

****10:30 AM:****

Take the next 5 minutes to review the task. If you have any questions or uncertainties, don't hesitate to ask for clarification. And don't forget to include your student ID on the sheet.

****10:40 AM:****

You now have 45 minutes to complete the task. If you finish early, raise your hand to indicate you're done.

If someone finishes the task, timestamp their sheet, and they can choose to continue if they wish.

Remember, this is an individual task, so please refrain from discussing it with your peers. If you have any questions about the task, feel free to ask me. You can begin now.

Time is ticking...

If someone asks about the time, simply provide them with the current time. If they have questions about the task, encourage them to do what they understand from the instructions.

****11:25 AM:****

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. On these sheets, you'll find various sources of workload demands, each with a rating scale ranging from 0 to 100 in increments of 5. Your task is to rate each workload source by marking the appropriate point on the scale. Feel free to ask if you have any questions.

****11:40 AM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

****Experimental Session Script****

Time-Pressure (TP) – Instructions

****ROUND 2:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have another series of programming tasks in C++. Please make sure to carefully follow the instructions provided for each task.

Before we continue, may I please confirm with each of you whether you've signed the consent form and completed the questionnaire?

****10:20 AM:****

Once everyone is ready,

Let's move on to **Task 2:**

****Time Context:** Time Pressure (TP)**

****Task Complexity:** Easy**

****Estimated Time:** 15 minutes**

For this task, you have 15 minutes. We'll give you reminders at the 8-minute mark and every 2 minutes after that. Please focus on completing the task efficiently within this time frame.

****10:30 AM:****

Take the next 5 minutes to quickly review the task. If there's anything you don't understand, please feel free to ask. Also, don't forget to write your student ID on the sheet.

****10:40 AM:****

You have 15 minutes to complete the entire task. If you finish before the time is up, please let me know by raising your hand.

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When someone finishes the task, I'll timestamp the sheet against the latest easy task under TP they've completed, and they can choose to continue if they wish.

This is an individual task, so please refrain from discussing it with your peers. If you have any questions about the task, direct them to me.

You may begin now.

Time is ticking...

You have Only 8 minutes left to complete the Task.

Tick, tick, tick…

You have Only 5 minutes left now for the Task.

Tick, tick, tick…

Only 2 minutes left

If someone asks about the time, I'll provide the current time. If there are questions about the task, encourage participants to proceed with what they understand.

10:55 AM:

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. These sheets list various sources of workload demands, each with a rating scale from 0 to 100 in increments of 5, covering a range from low to high. Your task is to rate each workload source by marking a tick on the scale. If you have any questions, please don't hesitate to ask.

****11:10 AM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

No-Time-Pressure (NTP) – Instructions

****ROUND 3:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have another set of programming tasks in C++. Please make sure to carefully follow the instructions provided for each task.

****10:20 AM:****

Once everyone is ready,

Let's proceed with **Task 3:**

****Time Context:** No Time Pressure (NTP)**

****Task Complexity:** Medium**

****Estimated Time:** 60 minutes**

For this task, you have a total of 60 minutes. We'll remind you about the remaining time only once, so please focus on completing the task efficiently.

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****10:30 AM:****

Take the next 5 minutes to review the task briefly. If you have any uncertainties or questions, please don't hesitate to ask for clarification. Also, don't forget to include your student ID on the sheet.

****10:40 AM:****

You have the full 60 minutes to complete this task. If you finish before the allotted time, kindly raise your hand to indicate your completion.

When someone finishes the task, I'll timestamp the sheet against the medium NTP task they've completed, and they can choose to continue if they wish.

Remember, this is an individual task, so please avoid discussing it with your peers. If you have any questions about the task, feel free to direct them to me.

You may begin now.

Time is ticking...

If someone asks about the time, I'll provide the current time. If there are questions about the task, encourage participants to proceed with what they understand.

****11:40 AM:****

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. These sheets list various sources of workload demands, each with a rating scale from 0 to 100 in increments of 5, covering a range from low to high. Your task is to rate each workload source by marking a tick on the scale. If you have any questions, please don't hesitate to ask.

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****12:00 PM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

Time-Pressure (TP) – Instructions

****ROUND 4:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have another set of programming tasks in C++. Please make sure to carefully follow the instructions provided for each task.

****10:20 AM:****

Once everyone is ready,

Let's proceed with **Task 4:**

****Time Context:** Time Pressure (TP)**

****Task Complexity:** Medium**

****Estimated Time:** 30 minutes**

For this task, you have 30 minutes. We'll provide the first reminder after fifteen minutes and subsequent reminders every five minutes. Please focus on efficiently completing the task within the given time frame.

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****10:30 AM:****

Take the next 5 minutes to quickly review the task. If there's anything you don't understand, please don't hesitate to ask for clarification. Also, don't forget to include your student ID on the sheet.

****10:40 AM:****

You have the full 30 minutes to complete this task. If you finish before the time is up, please let me know by raising your hand.

When someone finishes the task, I'll timestamp the sheet against the latest medium TP task they've completed, and they can choose to continue if they wish.

Remember, this is an individual task, so please refrain from discussing it with your peers. If you have any questions about the task, feel free to direct them to me.

You may begin now.

Time is ticking...

You have Only 15 minutes left to complete the Task.

Tick, tick, tick…

You have Only 10 minutes left now for the Task.

Tick, tick, tick…

You have Only 5 minutes left now for the Task

Tick, tick, tick…

Only 2 minutes left

If someone asks about the time, I'll provide the current time. If there are questions about the task, encourage participants to proceed with what they understand.

****11:10 AM:****

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. These sheets list various sources of workload demands, each with a rating scale from 0 to 100 in increments of 5, covering a range from low to high. Your task is to rate each workload source by marking a tick on the scale. If you have any questions, please don't hesitate to ask.

****11:25 AM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

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No-Time-Pressure (NTP) – Instructions

****ROUND 5:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have another set of programming tasks in C++. Please make sure to carefully follow the instructions provided for each task.

Before we proceed, may I please confirm with each of you whether you've signed the consent form and completed the questionnaire?

****10:20 AM:****

Once everyone is ready,

Let's start with **Task 1:**

****Time Context:** No Time Pressure (NTP)**

****Task Complexity:** Hard**

****Estimated Time:** 1 hour and 45 minutes**

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For this task, you have a total of 1 hour and 45 minutes. We'll remind you about the remaining time only once, so please focus on efficiently completing the task.

****10:30 AM:****

Take the next 5 minutes to briefly review the task. If there are any uncertainties or questions, please don't hesitate to ask for clarification. Also, ensure that you include your student ID on the sheet.

****10:40 AM:****

You have the full 1 hour and 45 minutes to complete this task. If you finish before the time is up, please let me know by raising your hand.

When someone finishes the task, I'll timestamp the sheet against the hard NTP task they've completed, and they can choose to continue if they wish.

Remember, this is an individual task, so please refrain from discussing it with your peers. If you have any questions about the task, feel free to direct them to me.

You may begin now.

Time is ticking...

If someone asks about the time, I'll provide the current time. If there are questions about the task, encourage participants to proceed with what they understand.

****12:25 PM:****

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. These sheets list various sources of workload demands, each with a rating scale from 0 to 100 in increments of 5, covering a range from low to high. Your task is to rate each workload source by marking a tick on the scale. If you have any questions, please don't hesitate to ask.

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****12:40 PM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

Time-Pressure (TP) – Instructions

****ROUND 6:****

[Instructions are in italics and bold, while regular text represents spoken content.]

****10:00 AM:****

Welcome to our experimental session! Today, we have another set of programming tasks in C++. Please make sure to carefully follow the instructions provided for each task.

****10:20 AM:****

Once everyone is ready,

Let's begin with **Task 6:**

****Time Context:** Time Pressure (TP)**

****Task Complexity:** Hard**

****Estimated Time:** 1 hour and 15 minutes**

For this task, you have 1 hour and 15 minutes. We'll provide the first reminder after fifteen minutes and subsequent reminders every five minutes. Please focus on efficiently completing the task within this time frame.

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****10:30 AM:****

Take the next 5 minutes to quickly review the task. If there's anything you don't understand, please don't hesitate to ask for clarification. Also, don't forget to include your student ID on the sheet.

****10:40 AM:****

You have the full 1 hour and 15 minutes to complete this task. If you finish before the time is up, please let me know by raising your hand.

When someone finishes the task, I'll timestamp the sheet against the latest medium TP task they've completed, and they can choose to continue if they wish.

Remember, this is an individual task, so please refrain from discussing it with your peers. If you have any questions about the task, feel free to direct them to me.

You may begin now.

Time is ticking...

You have Only 50 minutes left now for the Task.

Tick, tick, tick…

You have Only 40 minutes left now for the Task

Tick, tick, tick…

You have Only 30 minutes left now for the Task.

Tick, tick, tick…

You have Only 20 minutes left now for the Task

Tick, tick, tick…

You have Only 15 minutes left now for the Task.

Tick, tick, tick…

You have Only 10 minutes left now for the Task

Tick, tick, tick…

You have Only 5 minutes left now for the Task.

Tick, tick, tick…

Only 2 minutes left

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If someone asks about the time, I'll provide the current time. If there are questions about the task, encourage participants to proceed with what they understand.

****11:55 AM:****

Time's up! Please stop your work and pass your sheets to the person sitting next to you. We'll collect them from there.

Now, we'd like to gather your feedback on the perceived task load. NASA developed this technique to assess how individuals perceive the workload of a task.

We're handing out the Magnitude of Load (Ratings) sheets. These sheets list various sources of workload demands, each with a rating scale from 0 to 100 in increments of 5, covering a range from low to high. Your task is to rate each workload source by marking a tick on the scale. If you have any questions, please don't hesitate to ask.

****12:20 PM:****

We'll now collect all NASA-TLX materials, including your ratings sheets. Please ensure that you've placed your student ID on all the materials you're returning. Thank you!

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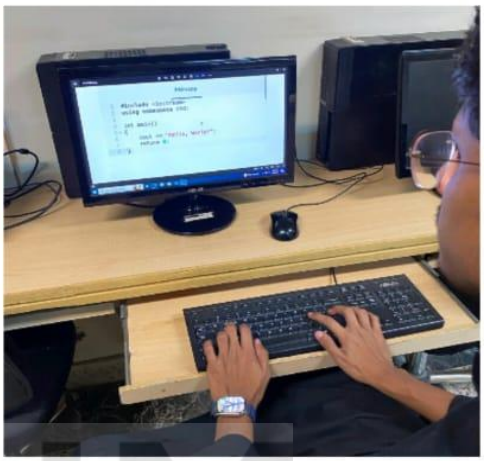
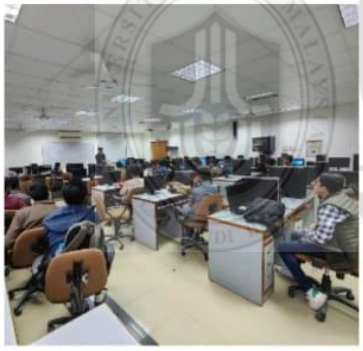
Appendix Z (A)

Photos of Experiments

This appendix contains photographs taken during the experimental sessions, capturing the setup and participants performing the tasks. These photos provide a visual representation of the experimental environment and demonstrate the conditions under which data were collected.

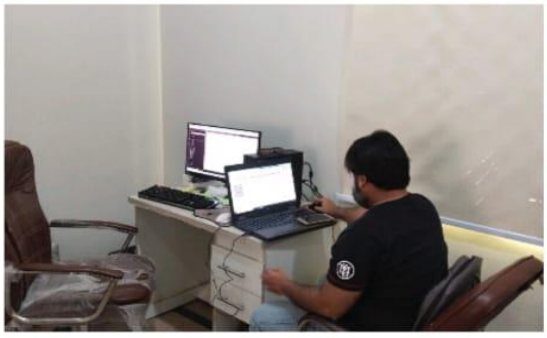




Appendix Z (B)

Photos of Case Studies

This appendix contains photographs taken during the ovbersavation of case studies in software houses, capturing the setup and participants performing the tasks. These photos provide a visual representation and demonstrate the conditions under which data were collected.



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