BQA NCQF QUALIFICATION TEMPLATE

SECTION A:	QUALIFICATION DETAILS																
QUALIFICATION DEVELOPER (S)	University of Botswana																
TITLE	Bachelor of Science in Intelligent Systems												**NCQF LEVEL**	7			
STRANDS (where applicable)	N/A																
FIELD	Information and Communications Technology												**CREDIT VALUE**	480			
SUB FIELD	Information Technology																
New Qualification	✓	Legacy Qualification		Renewal Qualification													
				Registration Code													
SUB-FRAMEWORK	General Education		TVET		Higher Education	✓											
QUALIFICATION TYPE	Certificate	I		II		III		IV		V		Diploma		Bachelor	✓		
	Bachelor Honours			Post Graduate Certificate				Post Graduate Diploma									
	Masters				Doctorate/ PhD												

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE:

The term Intelligent Systems is defined by the ACM as broadly looking at Artificial Intelligence in the context of real-world systems. The qualification emphasizes the technical aspects of computing and their application to Artificial Intelligence. Computer systems are evolving at a high rate. All sectors of the economy are continually deploying ever-changing complex computer systems in their day-to-day operations. This has resulted in a huge demand for people who can understand, analyse, design and develop computing solutions to various complex problems. A mandatory goal of a university should

be that it is not left behind in the fourth industrial revolution. Artificial Intelligence skills are critical to meet this goal. These are taught as part of bachelor's degrees in Intelligent Systems, Computer Science, and related fields.

In response to this huge demand, there exist global trends in curricula developments in the field of Computer Science (ACM/IEEE/AAAI model curricula 2023), which are continually adapting to the ever-changing technological advancements in the field (this standard is used in the development of the developed qualification). There is need, therefore, for strategic curriculum developments within Botswana to align to these developments. This is endorsed in the country's Vision 2036 pillar 1 and 2 which aims at achieving sustainable economic and human social development in the country.

In addition, the country has seen the need to move towards a knowledge-based economy in order to realize economic growth that is globally competitive. This includes improvements in the quality of education, which should hasten the country's move from a natural resource driven as articulated in the National Development Plan (NDP 11). In addition, the Human Resource Development Council (HRDC, 2023) calls for a need to have advanced computing knowledge and skills required for the country's development and employability of human capital.

Some of these are Artificial Intelligence Engineers, Machine Learning Engineers, Software Engineers, Computer Network Professionals, Database Designers and Administrators and Applications Programmers. In particular, Artificial Intelligence is also listed amongst the future skills and jobs that are envisaged to be in high demand.

The feedback of the departmental national skills survey gives strong justification for having a qualification in Intelligent Systems, with numerous respondents indicating the need for Artificial Intelligence and Data Driven software development in Botswana, as well as internationally. Therefore, the purpose of this qualification is to produce graduates with competencies in problem solving, technical understanding of broad applicability of computing and applying theory in practical applications, with an emphasis on Artificial Intelligence and Machine Learning.

The Human Resource Development Council (HRDC) Priority Skills Report of Botswana 2023/2024 consolidated list of priority occupations and skills, under the Information and Communication Technology sector has listed the following technical skills as being a priority, among others: Application and Web Development, Data Analytics and Cyber Security, Programming, Software Development, Data Analytics and Cybersecurity, Algorithms, Artificial Intelligence, Machine Learning, User Interface Design, Data Visualization, Operating Systems, Cloud Services and Security. The developed qualification will ensure that graduates of the programme have these critical skills as well as the associated soft skills such as critical thinking, time management and professionalism. This therefore justifies the offering of the qualification.

PURPOSE:

The purpose of this qualification is to equip graduates with knowledge, skills, and competences to:

1. Design and implement intelligent, scalable software systems that solve complex real-world problems across diverse domains.

2. Apply advanced computing theories and state-of-the-art artificial intelligence techniques to develop innovative, data-driven solutions.
3. Uphold ethical standards and promote responsible, fair, and transparent use of intelligent technologies in society.
4. Identify and pursue entrepreneurial opportunities by developing creative intelligent system solutions for emerging industries.
5. Engage in lifelong, self-directed learning to remain current with advancements in intelligent systems, AI, and related technologies.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

For entry to the BSc Intelligent Systems, the following entry requirements shall apply.

(i) Certificate IV, NCQF level 4 or equivalent.
(ii) Entry through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) is accessible to all candidates through institutional policies in line with the national RPL and CAT policies.

SECTION B	**QUALIFICATION SPECIFICATION**
GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
1. Design and develop intelligent systems and medium-to-large-scale software systems using appropriate software development lifecycles, principles, and modelling methodologies, such as Agile, Model-Driven Architecture, and Unified Process.	1.1. Select and apply appropriate software engineering methodologies for intelligent system development. 1.2. Design architectural models for scalable and maintainable intelligent systems. 1.3. Implement and test intelligent system components for domains such as healthcare, finance, and transportation. 1.4. Integrate data analysis, robotics, and IoT into cohesive system architectures. 1.5. Document system requirements, design decisions, and testing strategies using industry best practices.

2. Apply advanced computing theories, including Artificial Intelligence and Machine Learning to solve computing problems, in line with standards such as the ISO/IEC 23053 AI system lifecycle.	2.1. Select and justify the use of specific AI/ML algorithms for real-world problems. 2.2. Implement AI models for tasks such as natural language understanding, predictive analytics, and computer vision. 2.3. Evaluate model performance using appropriate statistical and computational metrics. 2.4. Tune and optimize models for accuracy, robustness, and scalability. 2.5. Compare alternative algorithmic Artificial Intelligence approaches to a given computational challenge in order to select the best ones based on suitable criteria.
3. Exhibit a strong professional work ethic while adhering to ethical standards in AI applications, as necessitated in organisations.	3.1. Identify ethical, legal, and professional responsibilities in developing AI systems. 3.2. Identify and address issues of fairness, bias, and discrimination in intelligent systems, as needed in organisations using Responsible AI frameworks. 3.3. Propose strategies to improve transparency and explainability in AI models used in organisations. 3.4. Apply professional codes of conduct when developing and deploying intelligent systems. 3.5. Critically evaluate the societal impact of intelligent systems in various application domains using frameworks such as Responsible AI frameworks, impact assessment models, and fairness, accountability, and transparency frameworks.
4. Leverage computing knowledge to identify and address entrepreneurial opportunities.	4.1 Identify real-world problems with potential for intelligent systems innovation. 4.2 Formulate business proposals that incorporate intelligent system solutions. 4.3 Design and prototype intelligent products targeting emerging industries.

	4.4 Perform feasibility studies and market analysis for AI-driven solutions. 4.5 Demonstrate creativity and innovation in conceptualizing new digital products and services.
5. Devise ways to apply Intelligent Systems to solve old problems in new ways and address new problems.	5.1 Identify conventional problems that can be transformed using AI and automation. 5.2 Design AI-powered workflows for adaptive and optimized solutions. 5.3 Integrate multiple AI disciplines to address novel domains. 5.4 Propose innovative intelligent solutions for emerging global challenges. 5.5 Evaluate the effectiveness and originality of intelligent solutions in disrupting traditional processes.
6. Apply self-directed learning to remain adept in emerging technologies and continuously enhance professional competencies.	6.1 Analyse recent advancements in AI and computing technologies, using approaches such as domain identification, benchmarks, analysis of opportunities and analysis of risks. 6.2 Reflect on personal learning goals and identify areas for professional growth. 6.3 Engage in self-directed learning through MOOCs, research papers, or online communities. 6.4 Critically evaluate new technologies for relevance and potential application.

SECTION C	QUALIFICATION STRUCTURE				
COMPONENT	TITLE	Credits Per Relevant NCQF Level			Total Credits
		Level [6]	Level [7]	Level [8]	
FUNDAMENTAL COMPONENT Subjects/ Courses/ Modules/Units	Introductory Mathematics I		**16**		**16**
	Discrete Structures I		**12**		**12**
	Introduction to Computing		**12**		**12**
	Communication and Academic Literacy Skills (Science)	**12**			**12**
	Academic and Professional Communication (Science)	**12**			**12**
	Introductory Mathematics II		**16**		**16**
	Discrete Structures II		**12**		**12**
	Discrete Structures III		**12**		**12**
	Calculus I		**12**		**12**
	Introductory Linear Algebra		**12**		**12**
CORE COMPONENT	Programming Principles		**12**		**12**

Subjects/Courses/ Modules/Units	Object-Oriented Programming		**16**		**16**
	Data Structures		**12**		**12**
	Technical Writing		**12**		**12**
	Database Concepts		**12**		**12**
	Machine Learning		**12**		**12**
	Web Technology and Applications		**12**		**12**
	Operating Systems and Computer Architecture		**12**		**12**
	Algorithms		**12**		**12**
	Computer Networks		**12**		**12**
	Probabilistic Representation and Reasoning		**12**		**12**
	Introduction to Software Engineering		**12**		**12**
	Industrial Attachment		**60**		**60**
	Intelligent Systems		**12**		**12**
	Society, Ethics, and the Profession		**12**		**12**
	Introduction to Artificial Intelligence		**12**		**12**
	Natural Language Processing		**12**		**12**

	Computer Vision		**12**		**12**
	Intelligent Systems Project I			**8**	**8**
	Intelligent Systems Project II			**16**	**16**
	Agents and Cognitive Systems		**12**		**12**
	Emerging Topics in Artificial Intelligence		**12**		**12**
STRANDS/ SPECIALIZATION	Subjects/ Courses/ Modules/Units	**Credits Per Relevant NCQF Level**			**Total Credits**
		Level [ ]	**Level [ ]**	**Level [ ]**	
1.					
2.					
Electives	Software Design		**12**		**12**

(Select 3 out of 8 modules)	Fundamentals of Entrepreneurship		**12**		**12**
	Logical Representation and Reasoning		**12**		**12**
	Small Business Management		**12**		**12**
	Parallel and Distributed Artificial Intelligence		**12**		**12**
	Integrative Programming		**12**		**12**
	Human-Computer Interaction		**12**		**12**
	Mobile Computing and Applications		**12**		**12**

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	**Credit Value**
6	**24**
7	**432**
8	**24**
TOTAL CREDITS	**480**
Rules of Combination: **(Please Indicate combinations for the different constituent components of the qualification)**	
The qualification requires **128** credits of fundamental courses, **316** credits of core courses, and **36** credits of elective courses. The total credit a learner must achieve is **480.**	

ASSESSMENT ARRANGEMENTS

Assessment will consist of both formative and summative assessments and should be aligned with learning outcomes and sub-outcomes. Assessment will be conducted by registered and accredited assessors by a recognized regulatory body.

1. **Formative assessment**

The Formative assessment shall contribute 50% of the final grade.

2. **Summative assessment**

Summative assessment shall contribute 50% of the final grade.

Assessment will be carried out by BQA-registered and accredited assessors. Assessors should hold at least a Master of Science in Artificial Intelligence, Computer Science, or related area.

MODERATION ARRANGEMENTS

In accordance with the university policies and regulations, internal and external moderations shall be conducted by BQA registered and accredited moderators or by a recognized regulatory body. Moderators should hold at least a Master of Science in Artificial Intelligence, Computer Science, or related area.

1. **Internal moderation requirements**

Internal moderation is carried out by registered and accredited moderators whose area of expertise is in with the courses to be moderated.

2. **External moderation requirements**

External moderation is carried out by accredited moderators from other institutions recruited for this purpose.

RECOGNITION OF PRIOR LEARNING

There is a provision for an award of this qualification through RPL in line with institutional and national policies.

Candidates may submit evidence of prior learning and current competence and/or undergo appropriate forms of RPL assessment for the award of credits towards the qualification in accordance with applicable university RPL policies and relevant national-level policy and legislative framework. Implementation of RPL shall also be consistent with requirements, if any, prescribed for the field or sub-field of study by relevant national, regional, or international professional bodies. There is a limit to the number of credits that can be used as RPL, as per institutional policy.

CREDIT ACCUMULATION AND TRANSFER

There is a provision for award of this qualification through credit accumulation in line with institutional and national CAT policies. There is a limit to the number of credits that can be used as CAT, as per institutional policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Horizontal Articulation

- Bachelor of Science in Computer Science.
- Bachelor of Science in Computer Information Systems.
- Bachelor of Science in Mathematics.

Vertical Articulation

Graduates of this qualification will have the following options for postgraduate education:

- Master of Science in Data Science and Artificial Intelligence.
- Master of Science in Computer Science.
- Master of Science in Computer Information Systems.
- Master of Science in Statistics.

Employment Pathways

Graduates of this qualification will be able to take up the following jobs

- AI/Machine Learning Developer
- Data Scientist / Data Analyst
- Robotics Scientist
- Software Developer (AI/IoT Focus)
- Computer Vision Scientist
- Natural Language Processing (NLP) Scientist
- Embedded Systems Developer / IoT Scientist

QUALIFICATION AWARD AND CERTIFICATION

1. **Minimum standards of achievement for the award of the qualification**

   To be awarded a BSc Intelligent Systems qualification, a candidate must satisfy the appropriate provisions of the university. A candidate is expected to complete a minimum of 480 credits as prescribed for the qualification.

2. **Certification**

   Candidates meeting prescribed requirements will be awarded the qualification Bachelor of Science in Intelligent Systems. A certificate will be awarded.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

A comparison was made for the developed qualification both regionally and internationally. The qualifications benchmarked against are the

Title of Qualification, NQF Level & Credit Value or Duration

Similarities: Bachelor of Science in Data Science (Botswana International University of Science and Technology, Botswana) (same NQF Level) and the Bachelor of Science in Artificial Intelligence (Illinois Institute of Technology, USA) also have a four-year duration. Bachelor of Science in Artificial Intelligence (University of Cape Town, South Africa) and Bachelor of Science in Computer Science and Informatics Specialising in AI (University of Johannesburg, South Africa) are both at South Africa NQF Level 7, equivalent to the developed qualification.

Differences:

The titles of the benchmark qualifications are different, reflecting a choice to lean more towards Data Science, for example, Bachelor of Science in Data Science (Botswana International University of Science and Technology, Botswana), or Artificial Intelligence, for example, Bachelor of Science in Artificial Intelligence (University of Cape Town, South Africa). The Bachelor of Science in Data Science qualification has 495 credits different from the developed qualification 480. The South African ones are of shorter duration (three years), and less credits. The US qualification has a different credit system, with 127 credits. The developed qualification uses the name Intelligent Systems in place of Artificial Intelligence, as has been used by the ACM/IEEE-CS/AAAI curricula guides.

Main Exit Outcome(s)

Similarities: Most of the main exit outcomes are similar.

Differences: The Bachelor of Science in Data Science (Botswana International University of Science and Technology, Botswana) exit outcomes are more focused on Data Science, while the developed qualification focuses on Artificial Intelligence knowledge and application, which include data-driven approaches. The developed qualification is in Artificial Intelligence, which includes data-driven approaches.

Domains/Modules/Courses/Subjects covered (Fundamental, core & electives)

Similarities: The other qualifications offer a number of data-centric courses, such as Data Analytics, Data Mining, and Artificial Intelligence, which the developed qualification does as well, in addition to Mathematics and Statistics courses also, as does the developed qualification.

Differences: The developed qualification has more Artificial Intelligence courses as core (8 dedicated courses, while there are only 2 in the Bachelor of Science in Data Science. The developed qualification has more Artificial Intelligence courses than all of the above qualifications, closely following the recommendations of the ACM/IEEE-CS/AAAI curricula 2023 recommendations

Assessment strategies and Weightings

Similarities: The Bachelor of Science in Data Science qualification has a similar weighting of 50:50 (Continuous Assessment:Exam). Also, the Bachelor of Science in Artificial Intelligence (University of Cape Town, South Africa. All the benchmark qualifications have similar assessment strategies, being quizzes, exams, projects, presentations, etc.

Differences: The summative assessments weigh less than the formative ones (60:40) for some of the benchmark qualifications but are equal in the developed qualification (50:50).

Qualification rules and minimum Standards for the award of the qualification

Similarities: These are similar for all the benchmark qualifications.

Differences: There are no major differences.

Education and Employment Pathways

Similarities: There are many similarities with the employment pathways for the benchmark qualifications.

Differences: The learning pathways and career options are more diverse in the developed qualification, capturing the areas of Computer Science, Artificial Intelligence, and Data Science. The developed qualification is primarily targeted at the Botswana job market, based on government documents, survey data, and experience on the ground. It offers graduate pathways to careers as

Artificial Intelligence Specialists, Software Developers, and studies for Master of Science qualifications in Computer Science and Artificial Intelligence.

The developed qualification compares well with the two international qualifications above in terms of exit outcomes, breadth and depth of coverage of Artificial Intelligence, Industrial Attachment experience, and career and education pathways.

REVIEW PERIOD

The qualification will be reviewed every 5 years.

For Official Use Only:

CODE (ID)			
REGISTRATION STATUS	**BQA DECISION NO.**	**REGISTRATION START DATE**	**REGISTRATION END DATE**
LAST DATE FOR ENROLMENT		**LAST DATE FOR ACHIEVEMENT**	