Bioinformatics Degree Curriculum Development: The African Challenge and Lessons Learned

UB, Gaborone, Botswana

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Future University, Sudan

WHERE WE STAND IN FU?

Faculty of
Computer
Science

Faculty of
Engineering

Faculty of
Telecommunication

Faculty of
Information
Technology

Faculty of
Geoinformatics
<table>
<thead>
<tr>
<th>Designation</th>
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<tbody>
<tr>
<td>Professors</td>
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<tr>
<td>Associate Professors</td>
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<tr>
<td>Assistant Professors</td>
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<td>Lecturers</td>
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<tr>
<td>Assistant Lecturers</td>
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</table>
OFFERED PROGRAMMES

- Bachelor of Computer Science
- Bachelor of Artificial Intelligence
- Bachelor of Bioinformatics
- Bachelor of Software Engineering
- Master of Computer Science
  - Specializations:
    - Artificial Intelligence
    - Computer Graphics
    - Software Engineering
    - Bioinformatics
PROGRAM PHILOSOPHY

- Provides the students with an opportunity to enhance their knowledge, skills, and experience to become successful practitioners and leaders in the field of Bioinformatics.
- The Program is designed to prepare the students to pursue their careers as Bioinformatics professionals. It is suitable for students with a background in computing, medicine and/or biology.
- The Program is organized to enhance students' understanding of the theories, concepts and practices of Bioinformatics, enabling them to develop new skills and competencies.
AIMS OF THE PROGRAM

- To develop an understanding of the theoretical concepts and principles, underlying the science of bioinformatics.

- Application of the theories to the practices of genomic computing as well as other evolving “Omics.

- Assume responsible positions and apply skills in industry and government at the research, planning, and development levels,

- To develop a strong foundation and enthusiasm in students for the growth of their skills and knowledge in Bioinformatics through independent research and study.
LEARNING OUTCOMES

- The emphasis of the program is on both theoretical and practical techniques for the design and development of bioinformatics applications;

- Enabling graduates to apply their knowledge and skills in a variety of bioinformatics software development processes.
CAREER PROSPECTS

- Bioinformatics System Analyst
- Bioinformatics Analyst/Programmer
- Bioinformatics Analyst/Scientist
- Bioinformatics Research Specialist
- Bioinformatics System Design Analyst/Programmer
- Bioinformatics Research Analyst
- Bioinformatics Information System Developer
- Bioinformatics Service Analyst/Programmer
- Bioinformatics Quality Assurance Supervisor
- Bioinformatics Analyst/Programmer
- Bioinformatics Information System Administrator
- Biotechnologist
- Academician
Course Structure

- The Master of Science in Bioinformatics is composed of three semesters of course work and one semester of project for a total of 39 credit hours.

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Unit</th>
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<tbody>
<tr>
<td>Core</td>
<td>15</td>
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<tr>
<td>Specialization</td>
<td>18</td>
</tr>
<tr>
<td>Project</td>
<td>6</td>
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</table>
# Course Structure

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses</td>
<td>Credit Hours</td>
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<tr>
<td>Core I</td>
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<tr>
<td>Core II</td>
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<td>Core III</td>
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<td>Specialization I</td>
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<table>
<thead>
<tr>
<th>Semester 3</th>
<th>Semester 4</th>
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<tbody>
<tr>
<td>Courses</td>
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<td>Specialization IV</td>
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<td>Specialization V</td>
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<td>Specialization VI</td>
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<td></td>
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</table>
**Bioinformatics Core Courses:**
These courses are required for the students enrolled in MSc Bioinformatics program. These are common to the three tracks.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSCS01</td>
<td>Theory of Computing</td>
<td>3</td>
</tr>
<tr>
<td>MSCS02</td>
<td>Advanced Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>MSCS03</td>
<td>Advanced Algorithm Design and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>MSCS04</td>
<td>Advanced Operating Systems</td>
<td>3</td>
</tr>
<tr>
<td>MSCS05</td>
<td>Principles of Programming Languages</td>
<td>3</td>
</tr>
</tbody>
</table>
# Course Structure

## Bioinformatics Specialization Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSCBI01</td>
<td>Genomics &amp; Gene Expression</td>
<td>3</td>
</tr>
<tr>
<td>MSCBI02</td>
<td>Proteomic Informatics</td>
<td>3</td>
</tr>
<tr>
<td>MSCBI03</td>
<td>Simulating Biological Systems</td>
<td>3</td>
</tr>
<tr>
<td>MSCBI04</td>
<td>Informatics for Metabolomics</td>
<td>3</td>
</tr>
<tr>
<td>MSCBI05</td>
<td>Data Analysis &amp; Essential Statistics</td>
<td>3</td>
</tr>
<tr>
<td>MSCBI06</td>
<td>Data Integration and Interaction Networks</td>
<td>3</td>
</tr>
</tbody>
</table>
**Course Structure**

**Master’s Project:**
Students in the Master of Science in Bioinformatics (MSCBio) program are required to do a Master’s Research Project.

To opt for a Master’s Research Project, a student must have at least three B Grades in all core courses.

Students who have not completed their core course requirements or low grades, they will be not allowed to register for the research project or required to repeat the courses with low grades in order to satisfy these requirements.

To complete a research project student must have to follow these steps:

- **Step 1** - Find an Supervisor/Advisor
- **Step 2** - Form a Committee
- **Step 3** - Carry out the Work and Defend It
African Challenges

- **Degree approach**
  - Course-based vs. research-based degree

- **Faculty**
  - Qualification; Quantity; and Sustainability

- **Scholarships for M.Sc. students**
  - Few governments in Africa provide funding for graduate students

- **State-of-Art Bioinformatics laboratory**
- **Library and eBooks**
- **Subscription to international Journals**
Lessons Learned

Course-based degree

- In case of the availability of:
  - adequate and enough qualified Bioinformatics instructors;
  - the supporting computing infrastructure;
  - Fellowships

  Then, the course-based degree would be the correct option to be adopted by the concerned University/Faculty.

- Another option, will be to integrate the MSc degree as a tracking/specialization within existing computer master.
Lessons Learned

Research-based degree

- In case of the unavailability of:
  - adequate and enough qualified Bioinformatics instructors;
  - the supporting computing infrastructure;

- Then, the Research-based degree would be the correct option to be adopted by the concerned University/Faculty.
Lessons Learned

Scholarships for MSc students

- To secure more annual scholarships for postgraduate studies especially from the lower and middle income countries through support from the AU Science, Technology and Innovation grants or other relevant International funding.
- Encourage exchanging of Bioinformatics postgraduate students within African Universities/Research Centres.
Conclusion and Recommendation

- To replicate the experience of the African Institute for Mathematical Sciences (AIMS) that was founded in 2003 in Cape Town, South Africa.
- To establish the “African Institute for Bioinformatics (AIB)” with the support of the AU, EU, WHO, CIDA, SIDA grants for at least the first 5-10 years that could support establishing Bioinformatics Centres of Excellence within the African countries.
- AIB will be a pan-African network of centres of excellence for postgraduate education, research and outreach in Bioinformatics. The AIB will then call annually for 20-30 fellowships for postgraduate (MSc PhD) in Bioinformatics across Africa.
Conclusion and Recommendation

- AIB will offer an intensive one-year postgraduate course leading to a structural Master’s in Bioinformatics, formally accredited by the Universities in the hosting country, the programme is taught in association with the Faculty from the Regional and International Universities.
- AIB will plan to expand the concept to 15-20 centres by 2025.
- Each centre/station is managed by a Director/President with competent staff.
The model delivers top international and African lecturers who volunteer to teach three-week course in the host country.

In addition, AIB developed a unified B.Sc. in Bioinformatics due to the recent demands for mathematical modeling in Systems biology, Bioinformatics and genomics.

The AIB network if established will be training around 150 master students within the 5 years of its establishment.
Thank You!