ARTIFICIAL INTELLIGENCE COMPETENCY FRAMEWORKS

A success pipeline from college to university & beyond

NEEDS ASSESSMENT SUMMARY REPORT

EXECUTIVE SUMMARY

As part of a grant funded by PIA (Pôle montréalais d'enseignement supérieur en intelligence artificielle), Concordia University and Dawson College have undertaken a project to co-construct a comprehensive AI competency framework in order to pilot a success pipeline for learners from college to university to life-long learning. To collectively address evolving AI talent needs, the framework will serve as a base for curriculum development with the goal of balancing technical, ethical and human skills in training and programs, validation of competencies, and ultimately drive instructors to voraciously experiment and innovate in this emerging field. This Needs Assessment, set within the Montreal ecosystem, synthesizes critical insights from 23 stakeholder consultations, government reports and other secondary research, and informs the next stage of this work.

This report contains the following:

- **An introduction and contextualization of the Needs Assessment (NA)**

- **An overview of the methodology utilized to conduct the NA including how:**

  - Consultants were identified

  - The questionnaire was developed

  - An Advisory Committee was formed

  - The results were analyzed

- **Key findings of the NA**

  - The AI landscape and its trends

  - The skills and competencies required to work in AI

- **Recommendations**

  - Pedagogical recommendations

  - Institutional recommendations

  - Recommendations for ecosystem awareness & autonomous learning

The report concludes with high-level recommendations to address talent needs within the AI industry. A perspective on the planning required for adaptive, innovative solutions to the needs indicated by clear trends as well as an unforeseen emergence of new trends is provided, setting the context for desired outcomes of this PIA project as a contribution to the larger work of all stakeholders.

The findings and recommendations outlined in this Needs Assessment are illustrated by the dramatic growth in recent years in demand for AI talent and for training capacity. Within the scope of this project, it represents a picture of the Montreal AI ecosystem in 2019-2020.

Main Findings & Recommendations

- The AI ecosystem is evolving from an exploratory one to a stable one poised for exponential growth in industry to complement research.

- An integrated approach to the acquisition of technical and transversal skills is required. Incorporating human skills and competencies will allow for the adaptability and resilience required to keep pace with rapid change and needs of the workplace.

- Knowing how to continuously and efficiently learn, staying abreast in the field, is a skill that can and should be taught — especially in AI related programs due to rapid evolution in the field.

- Workers will need to develop extensive awareness regarding the ethical implications of the AI tools they design and the data they use to train such tools.

- The graduate's ability to fit in and to situate themselves within the business context is crucial to their employability. All AI solutions in the workplace will need to be aligned to objectives and success will be measured against Key Performance Indicators (KPIs); the solutions cannot simply remain in a vacuum but must succeed within real-world applications.

ACKNOWLEDGMENTS

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PIA (Pôle montréalais d'enseignement supérieur en intelligence artificielle) was created to ensure that college and university programs remain aligned with industry needs and to shed light on the social and ethical considerations related to the rise of AI. PIA supports post-secondary institutions to effectively create and update academic programs in order to reflect current and future AI needs.

Concordia Continuing Education (CCE) offers distinctive opportunities in the market to better answer the personal, professional and organizational growth needs of our society. One day at a time, we invite people from different backgrounds and stages of life to take part in trendsetting trainings that generate concrete results.

Dawson College is the largest college in Quebec's CEGEP network, home to 10,000 students in 50+ fields of study. We provide a welcoming and stimulating environment in which to learn and work, and where students are prepared to assume their role as productive and responsible citizens of the world.

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INTRODUCTION

Today's workplace is in the throes of a metamorphosis that presents interesting technological transformations and socio-demographic changes. The Canadian Chamber of Commerce ("Skills for an automated future", 2018) reports that 42% of current Canadian jobs are at risk because of automation and 35% to 60% of occupations will be impacted by technological changes. RBC ("Humans wanted - How Canadians youth can thrive in the age of disruption", 2018) states, "more than 25% of Canadian jobs will be heavily disrupted by technology in the coming decade." The impact of AI automation on the Montreal workforce will be overbalanced. The need is immediate for just-in-time training for those workers who are currently affected by the emergence of AI on the workforce and for the workers of tomorrow. The educational sector, in hand with industry must identify and develop technical and transversal skills, human and ethical skills in particular, to support the structure of an agile workforce for today and tomorrow.

In the field of Artificial Intelligence, Montreal is ranked #1 among 20 cities in Canada and internationally recognized for the quality of its artificial intelligence ecosystem (Montreal International, 2019). With investments totaling in more than $2 billion in the past three years from the provincial, federal governments and major players in the field, Montreal has exploded into a dynamic AI ecosystem, booming with start-ups and requiring an augmented workforce (Montreal International, 2019). This requires the reskilling and upskilling for a vast majority of Montrealers through courses and programs at different levels of knowledge and covering a range of different skills across disciplines. Canada is often celebrated as a world leader in cutting-edge artificial intelligence research, especially in Montreal and Toronto, but lags behind many other ranked countries when it comes to actually adopting AI (Ticoll, TECHNATION). A recent report, titled Skilling Canadians for Leadership in the AI Economy, provides a cogent analysis of the contrast between AI research and innovation, where Canada is a force, and a lagging

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demand for AI skills and adoption of AI technologies across the economy where it is shown to be uneven in a few of the leading sectors but alarmingly deficient in most, and especially among subject-matter experts (SMEs). The need for a higher adoption rate in our major industries brings a sharper focus for training talent here in Montreal, in Quebec and across Canada.

As adoption rates increase, the reported global shortage of AI talent (Gagné, "2019 Global AI Talent Report") will become even more pronounced without effective strategies to meet the increased demand. The AI talent scarcity problem in this context then has two main dimensions: the number of AI experts in the talent pool, and the capacity for training. The need for qualified trainers with AI expertise is therefore significant. Education stakeholders cannot rely on availability of expertise through hiring, for example, to meet training demands. An array of flexible and coherent strategies is needed to collectively address talent scarcity. Strong cross-institutional and industry partnerships need to be implemented. Innovative and effective use of online learning platforms is another. Most critically is the promotion of strategic local capacity-building exercises where expertise is deployed and developed within institutions.

This needs assessment report presents findings of the background research and consultations completed for the PIA grant project, and a set of curricular and pedagogical recommendations for institutions of higher education. Both the findings and recommendations are to be used to inform the next phase of the project, which focuses on the building of an AI competency framework, along with accompanying tools, for higher education in Montreal.

METHODOLOGY

As we explore the best way to prepare students for the Montreal AI workplace, the first thing to establish were the current gaps and needs within the industry. To accomplish this, the team began by performing secondary research to develop foundational knowledge and to determine what broader trends and needs have already been documented. With AI placed at the forefront of emerging 21st century technologies, there is no shortage of private, academic, and government reports (see Appendix A) . This project is focused on providing a framework and tools geared specifically for the Montreal context, yet the vast majority of the research is aimed at the national level or localized elsewhere than Montreal. Therefore, the orientation of the Needs Assessment shifted towards conducting primary research to ensure that the findings reflect the Montreal context. It was determined consultation with stakeholders from the Montreal AI ecosystem would add value to the research.

Identifying Consultants

The process began by conferring with a number of academics within the AI community, who helped identify key industries in the Montreal AI ecosystem, as well as AI professionals in relevant job roles to provide a range of perspectives and insights on the needs of the AI talent pool. From there we utilized a snowball approach where early consultations led to the development of further connections within the greater AI network, providing an opportunity for the research to conduct a deeper and wider investigation. In total, more than 20 hours of consultations were held with more than 23 members of the AI community.

Questionnaire Development

Using secondary data, several broad areas were identified to discuss with consults, including: hiring processes, technical, human/soft, and business skills, ethical competencies, and the Montreal landscape. In addition, some consultation within the AI academic sector assisted in honing into a set of questions for each area. This resulted in an Interview Guide (See Appendix C), used throughout the consultation process. The questions in the guide served as a foundation in a semi-structured interview approach.

Establishing an Advisory Committee

To ensure the continued focus and validity of this project, the team assembled an Advisory Committee, comprised of members of the Montreal AI community. Throughout the Needs Assessment phase of the project, the team identified and invited potential members with the mandate of providing feedback on the findings, recommendations, and other deliverables. These efforts have resulted in an Advisory Committee that makes up a cross section of AI community representatives as follows:

Name	Organization	TItle
Tamara Vandersluis	R2i	VP Innovation
Iulian Serban	Korbit Technologies	Co-Founder, CEO/CTO
Philip Mitsopoulos	Stradigi AI	Customer Success
Brandiff Caron	Concordia University	Assistant Professor and Associate Chair, Centre for Engineering in Society
Benoit Desgroseillers	Finance Montreal	Senior Director
Mike Deutsch	Kids Code Jeunesse	Educator and Product Manager
Michel Charest	Ville de Montreal	Architecte d'entreprise Direction - Technologies, architecture, innovation et sécurité

Analysis & Results

After the data collection phase, recurring themes were identified under the same headings used in the Interview Guide. An executive summary of our findings was written and presented to the Concordia Dawson PIA Advisory Committee to initiate a feedback process to aid in the completion of this Needs Assessment.

KEY FINDINGS

AI Industry Evolution and Trends

Over the last decade, Montreal has emerged as one of the preeminent leaders in AI research. Led by increasing amounts of federal and provincial funding and the renowned research leadership of Yoshua Bengio, Montreal has developed the core infrastructure to push the limits of the field. The ecosystem has always been based in its university system which includes over 150,000 students and top research institutes. Government funding has helped to build upon this base, with investments that have led to the expansion of Mila, an AI research institute which brings together over 500 researchers specializing in the field of Deep Learning and Neural Networks, and IVADO (Institut de valorisation des données) which has over 1000 affiliated scientists and researchers, working to bridge the gap between academics and industry in ML and AI. This has enticed many notable companies and organizations, such as Facebook, Microsoft, Google, and Ericsson, to open offices in the city and to forge partnerships with these organizations and universities. Yet, for all of the investment and talent centered in the Montreal AI ecosystem, it remains known mostly as a research center, rather than a hub for AI startups or industry innovators. This is an identified issue, with academia, industry, and government aligning to change this narrative.

In the last five years, the AI ecosystem has become more integrated into Montreal as a whole.

The increased need to specialize, work in large diverse teams, and utilize business knowledge to drive product value is thus altering how academic programs should prepare students for this field.

This move has seen the use of AI go from being centered in research labs and in the hands of tech companies to permeating virtually every field. In Montreal, AI adoption is more common in industries such as gaming, banking, transportation and government. In addition to its reach, the core roles in the field have changed. Previously, Data Scientists were expected to fulfill most of the needs in the field, now there are many emerging and specialized roles as needs expand and become more complex. Data Scientists, Data Engineers, AI and Deep Learning Specialists, Data Architects, which are filling the ever evolving technical needs in the field, and Data Analysts, Business Intelligence, Data Translators, who bridge the gap between technical needs and the

business needs of organizations. These roles merge with Domain Experts, Product and Project Managers, and UX designers to form holistic teams and units that interface with clients, other departments, and C level management, in addition to overseeing product development. The increased need to specialize, work in large diverse teams, and utilize business knowledge to drive product value is thus altering how academic programs will prepare students for this field.

Developments in the Hiring Process

As AI units have evolved within organizations, the process of identifying and hiring new employees has also become more involved and complex. Data revealed early organizational hiring processes as being simplistic and their metrics undefined. But as organizations have hired more, identified what competencies and attitudes are necessary in their context, the number of steps in the process have increased. At least two screening calls and even an online coding test is typical before bringing someone in for their first interview. In person interviews often consist of multiple rounds of live coding, verbally working through business problems, and discussions with a panel of evaluators.

Consults related to the hiring process conveyed the importance of the demonstration of human skills like communication, willingness to collaborate, and signs of lifelong learning and efficiency of acquiring new knowledge. "Team-fit" was also brought up often and connected back to communication and collaborative capabilities. Many reported choosing less technically sound applicants who demonstrated strong team working tendencies over those with more technical skills and experience. This aligned with discussions with hiring firms working in the AI sector, who reported that many clients ask that they screen out candidates who do not exhibit communication abilities, regardless of background. It must be noted that there are certain positions in the AI field that have lower expectations in regard to human-skills, particularly in the roles of Data Engineer and Architecture. Depending on the organization, new hires face varying expectations regarding acquiring and applying domain knowledge.

> *It is important for those entering the AI field to reflect on their own workplace expectations and to ensure that their personal needs align with the organizational culture.*

Some organizations take time training new hires in these skills, where others have much steeper learning curves. Some organizations, especially those in applied research, have extremely high expectations and are unwilling to train on the job. It is important for those entering the AI field to reflect on their own workplace expectations and to ensure that their personal needs align with the organizational culture.

Masters and PhDs Increasingly Not Required

Up until recently, those working in the AI field were expected to follow a rather defined academic pathway. Beginning with Computer Science or Software Engineering undergraduate degrees and moving on to Masters and PhDs in Data Science and Machine Learning (ML). Although many positions in the AI field are and will continue to be filled by those with Masters and PhDs, the data reports that increasingly these degrees are not a hiring requirement; if a candidate can demonstrate they can do the work, employers increasingly will not judge where those skills were acquired.

Data Preparation

Data is what fuels AI and recent advances in the field have brought an ever-increasing volume of data as well as a change in the types of data being utilized. Yet this important resource must first be cleaned, labeled, and prepared, which can be both labour intensive and time consuming. These facts have led to several important demands. First, is the need to greatly grow the capacity of those capable of preparing data. Second, working with non-tabular data types like video, audio, sensor data, etc., is more complex and requires additional expertise. Third, domain knowledge about the data source and how the data will be used is also increasingly necessary. These needs must be considered in the design of educational programs.

Cloud Computing

The use of AI and ML, driven by the necessity for more data and computing power, has led to the rise of cloud computing in the field. Cloud computing offers those utilizing AI the ability to store the massive amounts of data on which to train algorithms, as well as the computing power needed to perform the training. In the past it was more feasible for organizations to purchase the storage and computing power infrastructure on site but, especially with the increasing use of audio and video data to train, utilizing data centers and super computers hosted by providers

and Microsoft (Azure), combining for well over 50% of market share, are the most used. Despite the increasing competition and investment, price remains a barrier for many organizations and computing power is not keeping up with the needs of Deep Learning. That said, overwhelmingly the data suggests that students preparing to enter the AI field must be familiar with cloud computing solutions. Having experience with at least one of the Big Three (AWS, Azure, Google Cloud) services is required, along with at least a high-level understanding of cloud architecture and engineering.

Required Skills and Competencies

Human Skills

As discussed in the Key Findings, of all the industry needs identified in our data, the need for AI workers to improve their human/soft skills was at the forefront. Integrating rapidly changing AI technologies more deeply into organizations poses many challenges. Human skills and competencies will allow workers to face these challenges with the adaptability and resilience required to work effectively in an organization and keep pace with what lies ahead.

> *The AI field is evolving rapidly, especially in regard to the tools, libraries, languages, and knowledge required to be effective. This means that workers who wish to stay relevant must constantly be learning.*

Communication

It is increasingly apparent that 21st century solutions cannot be devised in a silo. In the case of AI, employees must leverage the expertise of a team, convey findings, and adjust delivery to stakeholders with a range of technical knowledge, ask better questions and listen more attentively to the answers. Communication is one of the competencies that allow us to accomplish these tasks and to thrive in teams, units, and agile organizations.

Collaboration

As AI units grow and segment into teams with different roles, efficiency will rely more heavily on the cohesion of these parts. Collaboration assists development of

the skill of identifying the strengths and deficits in ourselves and others to leverage this knowledge to better ideate, plan, and develop. Collaboration provides apt and timely feedback to others and helps to receive and integrate their feedback into an employee's process. Collaboration is a willingness to accept and adjust to the needs of others in order to ensure the success of a project.

Design Thinking

The output of an AI worker will in some way have an effect on end-users. For this reason, higher education institutions must prepare students to incorporate the perspective of those who will use their product, to utilize customer journey mapping to gain insights, to step back and ask the questions "who am I developing this solution for and how will they use it?". Essentially, students should take a human-centered approach to their work. Doing so will allow them to create products that are more likely to meet business outcomes and the needs of their users.

Knowing How to Learn/Lifelong Learning

The AI field is evolving rapidly, especially in regard to the tools, libraries, languages, and knowledge required to be effective. This means that workers who wish to stay relevant must constantly be learning. Self-directed learning and commitment to professional development need to be continually be communicated to students, especially in AI-related programs. This competency includes creating a personal sustainable process for identifying and acquiring new knowledge, evaluating the effectiveness and reliability of that process, and seeking out new opportunities on which to practice acquired skills..

Ethical Awareness

The use of personal data to train AI models and the potential for the resulting products to affect individuals and society, requires workers in the AI field to develop an ethical awareness. Increasingly this is a necessity put forward by employers, governments, and the public. This includes the ability to evaluate data and its use through lenses of fairness, equity, accountability, and transparency. Finally, ethical awareness includes the ability to utilize frameworks and protocols to ensure these considerations are followed through on and that data is collected and stored securely.

Problem Solving

AI technologies are used for problem solving which makes this a required skill. But problem solving speaks not only to the ability to find a solution but also includes identifying the existence of problems, through asking the right questions and analyzing data, in addition to assessing the value of solutions. This set of tools is critical for overcoming technical hurdles but also meeting business objectives and KPIs.

Critical Thinking

Critical thinking emerged frequently in the consultations because it lies at the crux of many other human skills. Synthesizing different sets of knowledge, in the case of AI, domain and business knowledge with that of technical expertise, in addition to evaluating the validity and usefulness of information and guiding one's decision making process. Critical thinking is what assists in working through complex and unforeseen challenges, a necessity in the field, objectively assessing various factors at play in terms of their relevance, truthfulness, importance, etc. and determining the best course action to achieve the most favorable outcome.

Those working in the field must have a strong emphasis on keeping up to date with new tools, learning, practicing, implementing, and finally evaluating which tools, libraries, frameworks are best given the context.

Creativity

Many of the human skills mentioned in both the primary and secondary research share an underlying correlation - they all represent skills that artificial intelligence currently does not do well. Creativity is at the top of this list. When it comes to memorization and working within clearly defined sets of rules and procedures, AI will exceed human capabilities. When the goal is thinking outside the box and developing novel ideas, connecting seemingly disparate data, and creating human-centered solutions, all of which are at the core of being effective in the AI field, humans will come out on top.

Technical Skills

Technical skills are at the core of an AI worker. Without a depth of knowledge and ability in programming languages, mathematics, and the ever-evolving set of tools, a career in AI will likely be out of reach. That said, the consults reported the skill gaps in employees are primarily in business and human skills. Technical skills were identified as adequate overall but must be extended in the following areas.

> *Our consults have repeatedly identified the gap in recent graduates' ability to fit in and to be effective in the business context. In a field defined by speed and efficiency, being able to hit the ground running is a must, making the need to better align these two worlds, a necessity.*

Mathematics and Statistics

Mathematics, particularly in the area of Statistics, were identified as a key foundational skill. Understanding the mathematics behind algorithms, linear regression, etc. was reported to be "unchanging", unlike many of the other technical tools which change rapidly.

Programming

Another foundational skill is fluency in several programming languages. At the top of the list were Python, followed by Java, and C. It was mentioned that students should stay ahead of new and emerging languages, as this is one of the most important keys to staying relevant in the field. Programming fluency is a foundational requirement for getting a job, as most hiring processes in the field include asynchronous and live coding tests. Several consults also reported the importance of being comfortable and transparent with their coding. With team coding and coding reviews becoming common practice, the idea that your code will only be seen by you is a thing of the past. Having a public GIT and working on Open Source coding projects can help develop comfort in this area. Lastly, moving forward, there are projects currently in the works for AI and ML assisted coding. As these technologies develop it will be imperative for one to adopt these tools to increase productivity and accuracy.

Deep Learning Basics

At the forefront of AI research and industry use is Deep Learning. For this reason, the basic concepts, frequently used algorithms, and APIs are a must for anyone entering the field. Many of our consults suggested that a Deep Learning Basics course should be added to all AI related programs, certainly for PhDs and Masters, but also for those completing Computer Science and Software Engineering degrees. It must also be noted that Montreal has some of the best Deep Learning research institutions and researchers in the world. Anyone living in Montreal and hoping to enter this field should take advantage of the many opportunities to take part in this research work and conversation.

Frameworks, Libraries, APIs

The foundational competencies of Mathematics and Programming skills, will always be at the core of AI but there are many other skills and tools that make this technology function and that one must be able to utilize, but also needs to stay abreast on the evolution of these tools. For this reason, those working in the field must have a strong emphasis on keeping up to date with new tools, learning, practicing, implementing, and finally evaluating which tools, libraries, frameworks are best given the context (a critical skill in itself).

Frameworks and libraries offer data scientists and engineers, a way to avoid developing from scratch, saving massive amounts of time and money. Working from pre-existing tools and redesigning for project needs, is one of the driving forces behind the speed at which the field is evolving. Thus, it is important for those going into the field to know both how to work from scratch but also how to build upon the open-source work of others. The following libraries were mentioned most often in our consultations:

- Tensorflow
- PyTorch
- ApacheSpark
- Hadoop

Business Skills

Those who have gone through the university system (especially an extended academic experience acquiring a masters or PhD), and then transitioned from academia to industry, know misalignments exist. The two differ greatly in terms of expectations, efficiency, bureaucracy, hierarchy, teams, and the list goes on. Navigating these differences requires one to obtain knowledge, ways of thinking, and organizational awareness, that are currently unique to each environment. Our consults have repeatedly identified the gap in recent graduates' ability to fit in and to be effective in the business context. In a field defined by speed and efficiency, being able to hit the ground running is a must, making the need to better align these two worlds, a necessity. The following business knowledge/skills were conveyed most often in our consultations:

Business Objectives and KPIs

There is a great difference between creating a solution in a vacuum and doing so in context and with parameters. All AI solutions in the workplace will need to be aligned to objectives and success will be measured against KPIs. The ability to design solutions with these elements in mind is critical to success in the field.

Agile Approach

Supporting the movement to more diverse teams and speedier, iterative solution development is Agile. This approach has changed the design process for software development and the project management that drives it. Utilizing strategies like Scrum and Sprints, workers are asked to be highly communicative, collaborative, and flexible. Having experience in such an environment and developing the associated competencies are valuable within the industry.

DevOps/DevSecOps

As Agile works to improve communication and flow between developers, other departments and customers, DevOps works similarly to improve communication and integration specifically for developers and IT. DevSecOps are practices that work to ensure this process also includes protocols to secure and protect the solutions that are being developed. These approaches are becoming workplace norms, so knowledge of them is a plus for AI workers.

Teaching and Programs (Pedagogical Recommendations)

Data Preparation

Data is what drives Machine Learning (ML) and AI, thus a strong respect for and understanding of data preparation are critical. Our findings identify several issues with current education programs and fresh-from- university-hires' attitudes towards data preparation.

- Data sets used in higher education programs are often "Toy Data Sets" that are exciting (think Airbnb and Facebook) but are not representative of the vast majority of Enterprise data, which is much less engaging. When students get their first jobs in the field this realization leads to a lack of motivation.

- The data used in higher education programs is often clean, which does not reflect the reality of the workplace. Thus, students come out of ML/AI programs without the data preparation skills and experience required on the job.

- In the past, much of the data used in ML/AI projects was tabular, however this has changed. Increasingly data is being collected in a wide range of types, such as video, sound, seismic, sensor, etc. Experience in working with a range of data types is becoming a necessity:

The following recommendations address these data-related gaps:

Competencies related to data cleaning and knowledge of the data production pipeline were suggested to be added to program outcomes.

- Add courses that focus their learning outcomes on data preparation, where students are introduced to the needs of this process, strategies for meeting these needs and practice in applying these strategies. In addition to courses, data preparation learning outcomes and practice should be woven throughout program courses. Students should regularly be required to work with "dirty data", as this reflects the workplace context.

- Universities need to develop more industry partnerships to access real world data on which to use for practice and applied student projects. Students must also get involved in data cleaning projects, such as DirtyData project.

> *Outcomes should be added to programs regarding use of various data types. By the end of ML/AI programs, students should have been exposed to the challenges of several data types and strategies for overcoming them. Students might even be urged to specialize in types, depending on their workplace goals.*

- Outcomes should be added to programs regarding use of various data types. By the end of ML/AI programs, students should have been exposed to the challenges of several data types and strategies for overcoming them. Students might even be urged to specialize in types, depending on their workplace goals.

- Open data is an important emerging source of data for ML/AI that curriculum should leverage more effectively. Exposing students to the effective use of these resources is important (see e.g., Open Data Goverment of Canada).

Practical Curriculum

AI organizations are starving for talent who can hit the ground running from day one. Unfortunately, many organizations find that those hired directly out of higher education programs do not have the applied experience to fill this need. Programs should consider framing learning experiences in more workplace reflective terms by doing the following:

- Professors and instructional designers should discuss and define a working definition of a "practical project" for the program or stack. Once defined, they may choose to develop guidelines for creating practical projects that fit the context of their definition and can help instructors to consistently implement such projects throughout the program.

> *Capstone projects provide an invaluable assessment tool for determining if students can meet and integrate the program outcomes. The scope of these types of projects allow them to incorporate technical, human, and business-related competencies.*

- Many consults described the issue that the first inclination of recently graduated new hires is to build solutions from scratch, as this is how they are often trained in university. The reality is that this process can be much too slow and that, often, workplace products are developed using existing libraries and/or algorithms. To reflect this reality, in-class assignments should offer students opportunities to use this approach. This does not mean doing away with building algorithms and coding from scratch, as there is clear educational value in fully understanding these processes. Yet, integrating use of libraries will provide students additional tools to approach problems they will one day face in the workplace.

- All programs should consider incorporating a culminating or capstone project for several reasons. Capstone projects provide an invaluable assessment tool for determining if students can meet and integrate the program outcomes. The scope of these types of projects allow them to incorporate technical, human, and business-related competencies. Often these types of projects include a final presentation before a panel, which could include both academic and business community members, providing students a more real world experience and the ability to showcase their skills to and network with potential employers. There is also the potential in capstone projects to go beyond the theoretical and to focus on actual business problems through partnerships or a potential internship.

RECOMMENDATIONS

> *Higher education programs could add value for their students by providing them not only with the technical and human skills to be workplace-ready, but also developing a collection of artifacts to showcase their skills to potential employers.*

- Many of the libraries and tools that propel the AI community are developed in an open-source format. Programs should consider allowing students to obtain credit for making open-source contributions. Working in this medium brings students into contact with AI professionals and community members who can provide swift feedback on their code contributions and model a real and get them used to the workplace environment. In addition, this will also help to build students' collaborative skills.

Increasing Marketability

Whether a student's post-education goal is in industry or academia, a key piece of taking that next step after graduation is to showcase their competencies and acquired experience. The data suggests that students coming out of Montreal higher education programs do not showcase their skills in a marketable portfolio of their work through GitHub and on LinkedIn. Higher education programs could add value for their students by providing them not only with the technical and human skills to be workplace-ready, but also developing a collection of art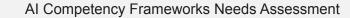ifacts to showcase their skills to potential employers. The following curricular recommendations aim to build upon the aforementioned items:

- Programs should be designed where at least several courses build towards a deliverable that is shared within a student's portfolio/GitHub. The importance of this type of project as a portfolio piece and its connection to obtaining a job should be emphasized by instructors. Instructors need to bridge the gap for the students in not only preparing their technical skills but also helping them prepare how to communicate their skills to future

employers. Explicit training on how to effectively add and display the piece should be part of the project.

- Programs might develop guides on how to reflect upon and chart one's acquired and relevant competencies, helping students to identify marketable skills and competencies obtained both through traditional education and experiential learning. These might include acquisition of both theoretical and applied experience, participation in outside events and projects, human skills development, and networking participation. As students complete these recommendations the guide would walk them through effectively adding them to their portfolio.

- Currently, LinkedIn plays an important role in helping recruiters and companies to identify new hires. Therefore, a student's LinkedIn profile is critical for ensuring job prospects. For this reason, institutions should provide field-related LinkedIn Profile Workshops. Many universities already offer such workshops, but they are broad and do not address the AI domain directly. It is recommended that AI related programs develop their own unique workshop offerings that address their students' specific needs and include guest speakers in technical recruiter and HR manager roles.

Preparing for the Business Environment

Along with needing applied technical skills, those working in the AI industry are asked to develop deliverables in a business context. By utilizing business terminology and frameworks and contextualizing technical assignments and projects with business cases, programs can support students' development of these much-needed competencies.

- Effective transfer of knowledge occurs when students apply their knowledge on real-world business cases. These cases can be developed, for instance using Kaggle data, or, ideally, could be put forward by Montreal based business partners. Allowing students to work on real world problems in class will increase engagement, provide a service to the community, and help students to develop skills related to a business mindset.

- Many consults described interns and hires freshly out of programs as having the ability to carry out technical tasks but struggle to recognize how those tasks fit into business outcomes. Two terms that often emerged were Business Objectives and KPIs. When

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students are provided instructions on performing a technical task/activity/assignment in the classroom, they should be situated in a business context that includes objectives. The deliverable they provide should be thus aligned to these objectives and they might be asked to come up with ways to measure the performance of the deliverable.

- Both potential AI hires and workers will be asked not only to demonstrate technical competencies but also to communicate their approach and reasoning to different stakeholders. This is key to ensuring efficiency within business units. To develop these communication skills, programs should ensure that students are asked to not only deliver the code for projects but also to present in front of peers and panels on their work. Students should also be expected to field questions and defend their designs. Marks should also be given for presentation performance and convey the importance of developing the skill.

- A common practice in the workplace is the use of frameworks. There are many types of frameworks used, whether for project development (Agile/Waterfall), explaining the value of an AI project (AI Canvas Model), or checking the ethical blind spots of your algorithm (Ethical Framework). These types of frameworks/models should be used in classes, especially on final and capstone projects, in order to help students increase awareness of the various contexts and considerations they will face in the workplace and to help develop critical thinking and problem solving skills.

- Our data regarding hiring suggests that many students exiting AI related programs and

applying for jobs, are not fully aware of the roles they are applying for. For instance, many mistakenly view Data Analytics positions as an intro-level position on the way to becoming a Data Scientist. With new roles emerging in Data Science and AI, this problem will only increase. Programs should consider introducing students to the roles they will be qualified to fill when exiting the program. These roles can be introduced and discussed in classes. Programs could also set up and promote speaker series that invite industry members, (ideally alumni) to speak of their experience. Role awareness will help students have a better understanding of the field, how it's developing, and will help them to align their experience in the program with their post-graduation goals.

An Ethical Approach

Preparing students to ethically collect data, build models with a low risk of bias, and protect data from breaches is imperative for employment, for the bottom line of companies, for the longevity of the industry, and for the wellbeing of society in the 21st century. With such high stakes higher education programs must address the development of these competencies head on. To accomplish this, we recommend the following:

- Ethical competencies should be added to program learning outcomes.

- Developing ethical competencies cannot be approached through a one off, compliance course. These competencies must be woven into courses throughout the program, to ensure that ethics are a regular part of the learning process and that students cultivate an ethical practice.

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- Protecting data and cyber security should be taught as keys to an ethical practice.

- Students should be made aware of and discuss landmark governmental privacy and security regulations like the Canada Directive on ADS and GDPR.

- Projects throughout programs should consider requiring students utilize ethical AI frameworks such as the AI-RFX Procurement Framework and Google Model Cards.

Preparing to Work in Teams

As AI adoption has increased and becomes more established in organizations, the makeup of AI related units and teams have also become more complex. In order to ensure collaboration and communication, that design of products is aligned to users and KPIs are met, AI teams bring on members beyond the traditional Data Scientist and AI Specialist roles. Units might include Business Intelligence, Business Analyst, Data Engineer, Project and Product Manager, Data Translator roles, amongst others. This adds new perspectives, values, workflows, and goals, making team dynamics more challenging and critical to address. For these reasons, integrating team working skills into AI related programs will better prepare students for the real world and add value to their offering. To achieve this:

- Teamwork and teamwork-related competencies (such as communication and collaboration) should be incorporated into program outcomes.

- Teamwork skills should be developed explicitly. This includes: discussing group dynamics and best practices in the build up to group projects, utilizing basic project management strategies and tools to support students in dividing and tracking work and addressing issues that may arise, asking students to reflect on their group work experiences to develop metacognitive skills, and to include these elements into a teamwork rubric criterion that that sets expectations for learning outcomes that align with industry expectations.

- Promote teamwork experiences outside of the classroom such as hackathons, competitions, and work-integrated learning opportunities.

Updating Your AI Toolbox and Lifelong Learning

Being up to date on emerging software and tools is key to employability and sustaining a role in the AI industry. With tools changing so rapidly, programs ought to consider how they can prepare students to be autonomous learners who are able to keep their professional toolbox relevant long after leaving the classroom.

- Programs ought to avoid having courses that promote and/or emphasize specific platforms and focus more on fundamental skills that can be applied across platforms. Providing students options on the tools that they use in class or, at minimum, emphasizing how skills using one tool apply to other like-tools is critical. Instructors should name like-tools and provide links for those interested in exploring them on their own.

- Models of lifelong learning ought to be exemplified by faculty in the classroom, by sharing the ways they keep up with the newest research and tools and conveying the importance of doing so to their students. This idea of lifelong learning should also be promoted through professional development opportunities for educators. Providing spaces where educators can continuously learn from experts and share best practices with peers, which will better ensure these practices are passed along to students.

- Once in the workplace, students will find that their education in AI related methods and strategies will need to continue. Often what is needed are extremely specific skills, tools, and/or competencies and they need them in a short timeframe. The reality is that many AI workers turn to MOOCs (Massive Open Online Courses) to fill this need. Institutions of higher education should consider should consider building this reality into their programs. Weaving MOOCs into a class can allow for a blended approach, in which students are acquiring basic or supplemental content asynchronously, through MOOCs, and then applying and/or extending this knowledge in the classroom synchronously. On the program level, students might be provided with a choice of several MOOC options that they must complete during their program, offering a pathway to specialization. Another option is having students reflect on learning at certain points in their program and identify gaps or areas of struggle. They are then presented with a range of MOOCs that they are required to complete to fill those gaps. Not only will this provide a more flexible approach to student learning, but it will also help students prepare for life after graduation, where MOOCs will likely continue to support them in their day to day workplace needs.

Institutional Partnerships

The goal of better preparing students for the AI workforce is largely connected to immersing them in industry-based learning experiences. The most direct way for institutions to facilitate this is by developing partnerships. Virtually all of the consultants indicated that they would be interested in, or already are, partnering with universities. To establish and take advantage of such partnerships we recommend the following:

- Set more aggressive goals for developing AI related partnerships with existing business development units. Leverage Mitacs, NSERC, CCTT and other grant/funding opportunities to overcome financial barriers.

- Collaborate with startup accelerators like District3, CENTECH, and others to partner with startup companies. AI-focused programs can often offer less legal and bureaucratic hurdles to partnering than large, more established businesses.

- Create competitions or hackathons at your institution and invite businesses to submit real problems for students to work on during the event. Those that submit business problems might also be on the judges' panel for the event. This one-time event can offer businesses a glimpse of the value they might derive from a more involved partnership, and opportunity to spot suitable talents for employment while watching them in action.

Once established, Partners might be asked to provide:

- Business problems/data for students to use for course and capstone projects.

- Internships are one of the most important reasons for developing partnerships. This is where students have the opportunity to directly apply what they've learned in the

> *The goal of better preparing students for the AI workforce is largely connected to immersing them in industry-based learning experiences.*

program, where they can readily develop technical, human, and business skills, and they are put in an excellent position to obtain a job following graduation. To make internships more fruitful, the following is recommended:

▫ Students take one class, while in their internship, that provides a space to reflect on learning and problem-solve challenges they are facing at work with an instructor and their peers.

▫ Ensure that the host company is requiring those overseeing interns to provide feedback at regular intervals.

▫ Students must complete a reflective assignment in which they discuss the technical, human, and business skills they developed during the experience.

▫ Mentorships can also be set-up through industry partnerships. Mentorships can offer students guidance on their career path, help them to identify areas of their skillset they need to develop, emphasize business awareness, and expand their network.

Ecosystem Awareness and Participation

To effectively prepare students for careers in the Montreal AI ecosystem, a highly interconnected, ever evolving space, programs should consider helping students to integrate themselves in the community and instill the need to become lifelong learners.

To effectively prepare students for careers in the Montreal AI ecosystem, a highly interconnected, ever evolving space, programs should consider helping students to integrate themselves in the community and instill the need for them to be lifelong learners.

There are many events and opportunities for extended learning and networking that students can get involved in, but programs and instructors can support them in those first steps by helping to increase awareness and qualifying these offerings.

Curriculum

Adopt curriculum extension initiatives such as attending Meetups, online/in-person conferences, or other events. Students should be required to report on the event and how it extends to classroom learning. Students might also be asked to follow blogs, discussion boards, and RSS feeds on topics related to class, allowing students to set up their own processes for staying abreast of emerging trends and new tools and techniques in the field. Para curriculum: Require students to participate in coding competitions and hackathons to apply technical knowledge, human-skills, network and showcase their skills.

Project-based Learning

The Montreal ecosystem has a growing list of organizations that offer extended learning opportunities for students, in the form of regular discussion and classes as well as opportunities to apply their AI skills by consulting with the business community, for example, IVADO, D3, and FinML just to name a few. These are great ways for students to practice, connect, and increase the likelihood of landing a job.

Professional Development

All AI related departments should have a continuously updated repository of conferences, events, meetups, workshops, and opportunities that students should be urged to engage with. The repository could very easily be promoted in all courses and can be connected to the importance of having applied experience, networking, and building a resume. This repository can also be a tool for instructors to stay informed, which will in-turn be passed on to their students.
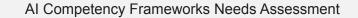
CONCLUSION

This needs assessment began in a pre-COVID world where a vigorous mobilization within the education sector to address talent and training needs brought on by the rapid proliferation of AI technologies and applications was already well underway. The pandemic conditions have resulted in a severe economic downturn and uncertainty across all sectors globally, adding further near-term challenges to meet these needs. Yet there is also immense opportunity. For example, educational institutions and partner organizations are investing heavily in the development of effective online resources to enhance teaching and learning. With so many stakeholders engaged, the potential for delivering adaptive and innovative solutions to address the talent and training needs in AI fields could also increase significantly. Given the extreme uncertainty of the present moment however, it is difficult to predict impacts and plan for outcomes. Indeed, what is the future of the AI labour market and for the training institutions that feed it?

While the findings of this needs assessment do not project future needs, they do point to recommendations that will allow for learners to adapt to the realities of digitalization as the driver of the 21st century economy and the AI labour market. The findings are based on 23 stakeholder consultations, government reports and other secondary research, and set within a snapshot of the Montreal ecosystem in 2019-2020. Thematic recommendations for pedagogy, for increasing the scope of partnerships across institutions and with industry, and for fostering greater overall awareness and engagement with the Montreal ecosystem figure prominently. This work informs the next phase of the PIA project undertaken by Concordia University and Dawson College where the focus shifts to the building of an AI competency framework, along with accompanying tools, targeting college, university and mid-career learners in Montreal. The main audience for the framework is program developers, RAC (Recognition of Acquired Competencies) coordinators, instructional designers and educators involved in AI curriculum development. The hope is that it will be relevant and useful for other higher education contexts.

The main recommendations from this needs assessment to be implemented into an AI competency framework are to:

- Take an integrated approach to the acquisition of technical and transversal skills. Incorporating human skills and competencies will better allow for the adaptability and resilience required for the changing needs of the workplace.

- Develop skills needed for lifelong learning. Knowing how to continuously and efficiently learn,

staying up to date, is a skill that can and should be taught -- especially in AI related programs since the field evolves so rapidly.

- Impart an extensive awareness in students of the ethical implications of existing and new AI tools, as well as the data used to train such tools.

- Include real-world AI applications, cases, and increased opportunities for extended or work in-tegrated learning in programs. For example, developing the graduate's ability to fit in and to be effective in the business context is crucial to their employability.
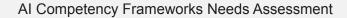
Coherently implementing AI competencies across programs for learners at different stages of education is a complex problem. The themes identified here, however consistently point back to the transferrable skills required for success in the 21st century. Beyond technical skills and formal qualifications, the findings also validate that employers are often equally concerned about the work-related practical and human skills needed to perform various job tasks successfully. See, for example, Harvard Business Review and WEF Future of Jobs report. In the future, for students to thrive they will need to be not only knowledgeable and dedicated, but curious and nu-anced learners. The curriculum will need to equip students to leverage human strengths, so that people and AI-enabled machines can solve problems together that would be impossible alone. Strong strategic partnerships between institutions and industry for collectively addressing current AI talent and training gaps that are robust but also adapt to dynamic future challenges such as the COVID-19 pandemic are needed now more than ever.

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APPENDICES

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Appendix C: Interview Guide

Degrees	1. What value do you place on a degree? 2. Are degrees required in your company? 3. Do you feel like students with a PHD/Master's degree are more prepared for work in AI? 4. Are there some programs that you feel prepare students better for work in AI? If so, which ones? 5. Do you have domain-specific hires? (Biology, psychology, neuroscience, physics, ecology, geology, business, etc.)
Preparedness of applicants	6. Is it typical to hire students right after school? 7. What skills do the new grads you hire possess? In what areas do they come prepared? 8. What are they lacking? Gaps? 9. What does the ideal candidate look like? 10. What areas might educational institutions emphasize more? 11. Are you willing to hire someone with basic core skills such as programming and statistics, knowing that they will need to be further trained on the job? 12. Is it common to hire people that are self-taught? 13. What types of experiences are required (internships, projects, report writing, etc.) beyond education and work experience?
Technical skills	14. What technical skills are essential to this field? 15. What are the programming needs when you're hiring? Which languages do you require applicants to know? 16. Do you care more about specific programming languages or about general programming expertise? 17. What operating systems do you want applicants to use? (Linux, Windows, Mac) 18. What specific requirements for machine learning do you have in terms of statistics, programming, infrastructure, data science? 19. What specific data types are utilized in your workplace? (such as text, audio, etc.) 20. What infrastructure knowledge is required for a typical hire?
Human skills	21. What are the soft/human skills that are necessary in this field? Communication? Presentation Skills? Collaboration? Writing? 22. How are soft/human skills assessed in the interview process? 23. Could you provide some scenarios where these skills are used in the workplace?
Ethics	24. What ethical considerations guide your employees on a day to day basis in your organization? (in terms of societal acceptance, validation, biases, privacy, surveillance) 25. What considerations are made for protecting data? 26. How do you reduce algorithm bias?
Hiring process	27. Walk us through your hiring process? 28. Is a performance test required in the hiring process? If so, can you elaborate? 29. Do you do coding interviews? Do you require interviewees to write pseudo-code?
Montreal AI landscape	30. What's the landscape like in Montreal in terms of AI professionals? Job opportunities, research vs technical, worker capacity, growth potential. 31. What do you project will be important to learn in the years to come in the realm of AI?