COMPUTING CAREERS & DISCIPLINES

UPDATED FOR 2025

A QUICK GUIDE FOR PROSPECTIVE STUDENTS AND CAREER ADVISORS

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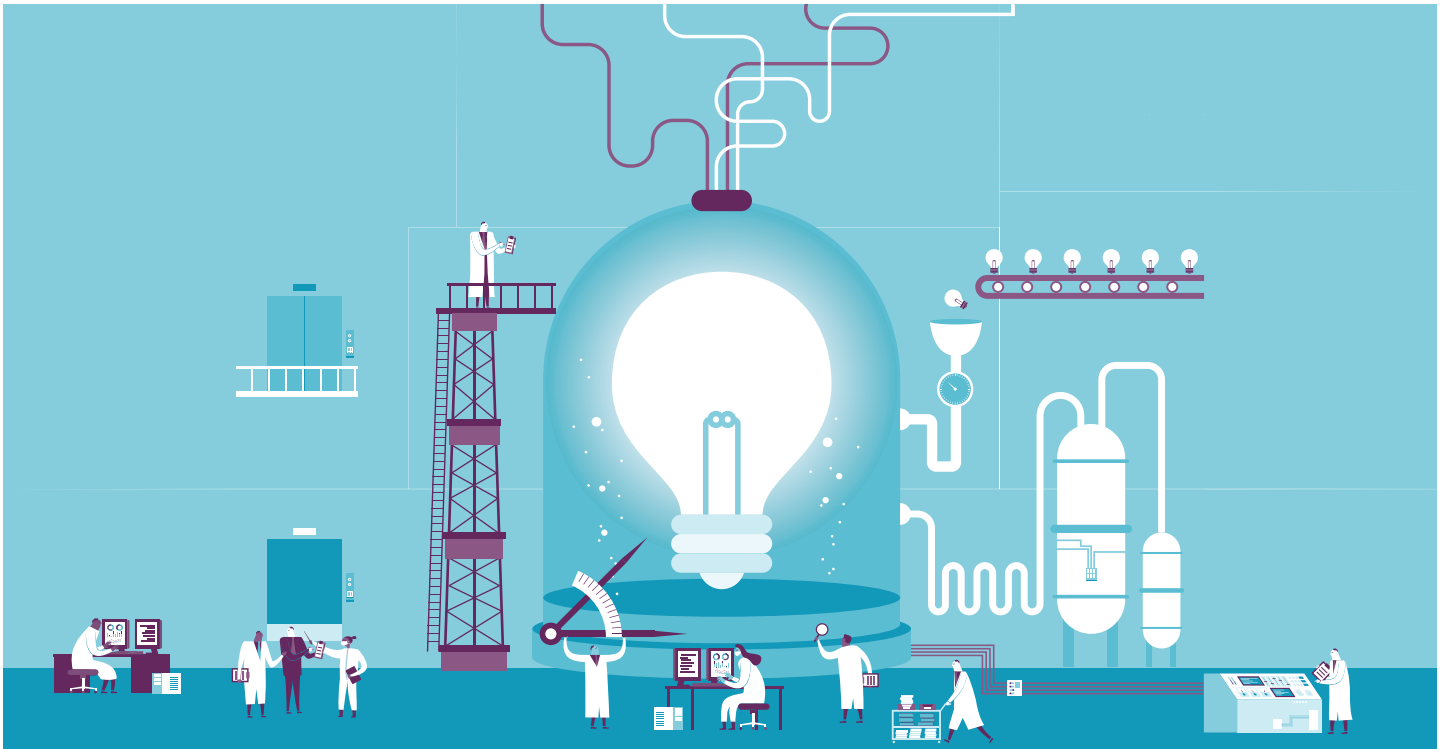

This guide provides our answers to three questions.

- **Why should you consider computing when choosing a career?**
- **What kind of computing jobs are out there?**
- **How do you get there? That is, what kind of education pathways will guide you to the computing career you desire?**

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This guide provides an overview of different types of computing careers and the academic pathways to arriving at those careers. It describes the seven main computing disciplines as defined by the ACM (Association of Computing Machinery), as well as four other popular computing specializations.

For each of the main disciplines, this guide provides information about sample programs and Canadian educational institutions for those disciplines and specializations.

More content can be found at: computingcareers.ca

ACKNOWLEDGMENTS

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Charts on pages 14, 18, 30, 34, and 38 are based on those that appear in the ACM Computing Curricula 2005 report.
Charts on pages 10, 22, and 26 are interpretations based on the ACM Computing Curricula 2020 report.

ILLUSTRATIONS + DESIGN

CERIC
Advancing Career Development in Canada
Promouvoir le développement de carrière au Canada
MOUNT ROYAL UNIVERSITY 1910

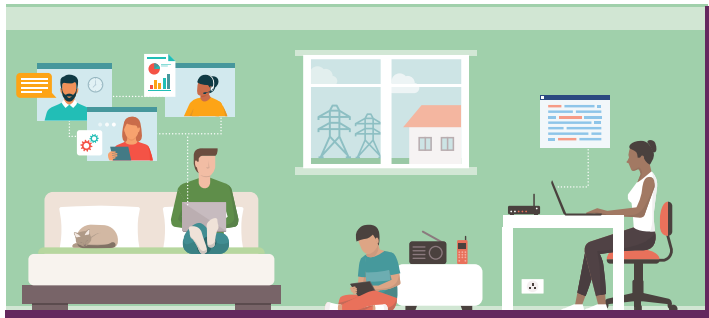
WHY COMPUTING?

JOBS

The job market for computing graduates is very strong and demand will continue to be high well into the future.

SOCIAL

Contrary to stereotypes, computing work is often highly social and rewards communication and social skills.



FLEXIBLE

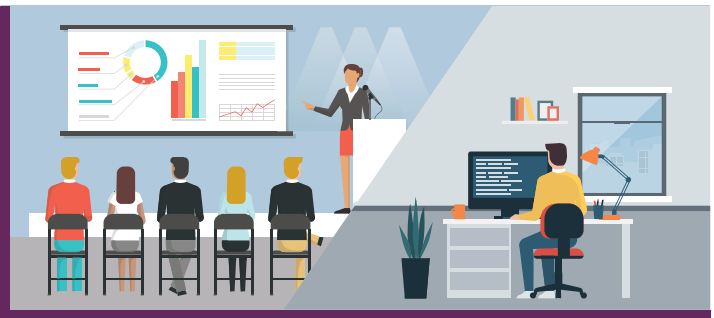
Computing work supports flexible and mobile lifestyles. You can work full-time or part-time at home, in an office, or abroad.

INNOVATIVE

Computing work can be innovative and creative. The world of tomorrow is being created by computing graduates today.

ETHICAL

Computing work can be focused on improving the social benefits of digital technology as well as mitigating its harms.



VARIETY

Computing work is extremely varied (and thus less boring across a career) and encompasses both technical and management work.

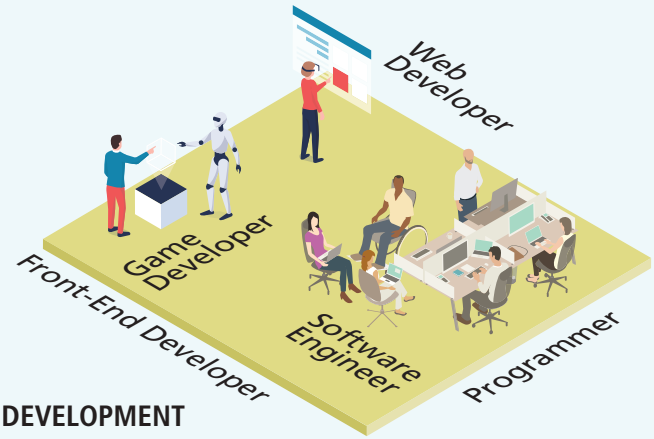
WHAT WORK CAN I DO?

MOST COMPUTING JOBS FALL INTO ONE OF THE GENERAL CATEGORIES SHOWN BELOW AND WHICH ARE EXPLAINED IN MORE DETAIL ON THE NEXT PAGE.

NOTICE THE PEOPLE ON THE STAIRS: THEY REPRESENT THE FACT THAT PEOPLE WORKING IN COMPUTING CAN OFTEN FIND THEMSELVES MOVING TO OTHER TYPES OF JOBS.

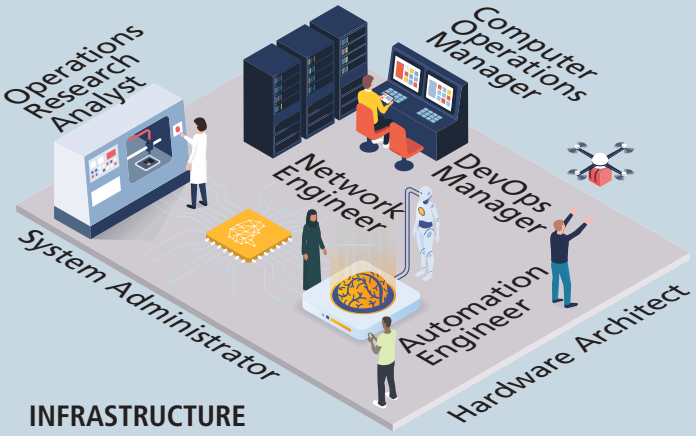
THERE ARE MANY, MANY, MANY DIFFERENT TYPES OF COMPUTING JOBS. COMPUTING IS MUCH MORE THAN JUST PROGRAMMING!

THIS PAGE ILLUSTRATES SOME SAMPLE COMPUTING JOB TITLES, ORGANIZED BY THE CATEGORIES SHOWN ON THE PREVIOUS PAGE.



DEVELOPMENT

These are the jobs most often identified with computing. The focus here is on software development, often referred to simply as programming. As you can see, there are many different labels for developers, each with a different focus.



INFRASTRUCTURE

Contemporary computing is dependent upon a sophisticated systems infrastructure. The jobs in this area span a very wide range of tasks, from configuration and support, to designing and creating the devices themselves.

DATA

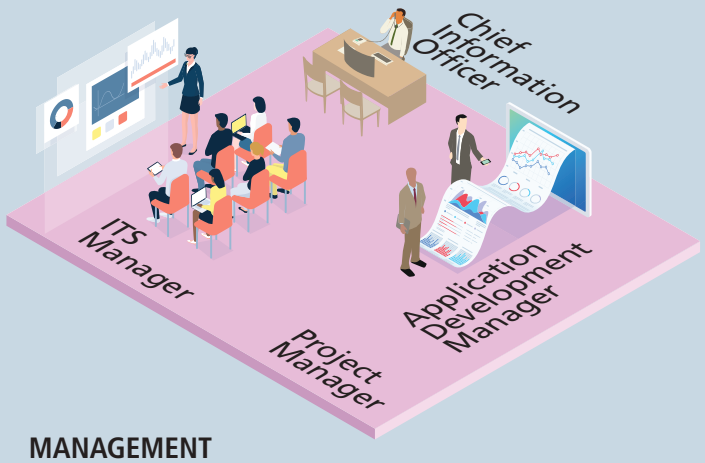
We live in a world that is over-flowing with digital data. Experts in this area help organize, analyze, and secure the data needs of organizations.

DESIGN

Most computing systems are used by humans, and as a result, specialists are needed to make these systems attractive and usable as well as efficient and bug-free.

BUSINESS

Ultimately, computing systems are used by businesses and organizations. Specialists are needed to help optimize computing systems for business needs, as well as adopt business processes to new innovations.



MANAGEMENT

Like other business activities, computing requires managers. A manager might oversee a project, a development team, a computing department, or the information needs of an entire corporation.

HOW DO I GET THERE?

The best way to acquire a computing career is to obtain the necessary educational credential.

But there are many potential computing education options to choose between.

This booklet guides you through the maze of options, by providing an overview of the different computing disciplines as defined by the ACM.

COMPUTER DISCIPLINES

There is not a single computing credential because there isn't a single computing discipline.

The ACM (Association of Computing Machinery) and the IEEE (Institute of Electrical and Electronics Engineers) have identified seven different computing disciplines. Additional speciality programs are offered by different educational institutes.

The remainder of this guide describes these ACM disciplines, which may help you to decide which computing education pathway is most appropriate for you.

These discipline descriptions are designed to help support prospective students and their supporters: parents, guardians, career practitioners, academic advisors, and career counsellors.

DISCIPLINE ROADMAP

TO HELP EXPLAIN THE DIFFERENCES IN THE COMPUTING DISCIPLINES, THIS GUIDE USES A CITY METAPHOR. EACH DISCIPLINE HAS ITS OWN CITY DISTRICT THAT PROVIDES AN OVERVIEW OF THE DISCIPLINE AND THEN STEPS INSIDE THAT DISCIPLINE TO DESCRIBE TYPICAL JOB TASKS.

COMPUTER ENGINEERING (CE)

is concerned with the design and construction of computers and computer-based systems.

CYBER SECURITY (CY)

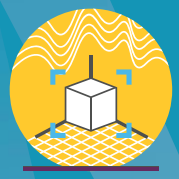
is focused on the creation, operation, analysis, and testing of secure computer systems.

INFORMATION SYSTEMS (IS)

is focused on building and then integrating computing solutions into business processes.

SOFTWARE ENGINEERING (SE)

is the discipline of developing and maintaining large software systems.



COMPUTER SCIENCE (CS)

covers the widest range of computing topics from its theoretical foundations to the development of new computing technologies and techniques.

DATA SCIENCE (DS)

brings together domain data, computer science, and statistics to interrogate data and extract useful information.

INFORMATION TECHNOLOGY (IT)

programs prepare students to meet the computer technology needs of business and other organizations.

OTHER SPECIALITIES

programs that expand some aspect of these disciplines or that closely integrates knowledge from other non-computing disciplines.

SO WHAT DO YOU LEARN IN COMPUTING?

The *ACM Computing Curricula* report describes six general areas of knowledge within computing (which are shown here, along with word clouds indicating common topics).

These **knowledge areas** are covered in differing amounts within each computing discipline.

As well, each individual computing program in any university or college will contain different proportions of each of these knowledge areas.

Programming Foundations

Abstraction, Algorithms, Debugging, Graphics, Semantics, Data Structures, Languages, Operating Systems, Performance Evaluation, Complexity

Hardware

Circuits, Engineering, Deployment, Digital Design, Architecture, Signal Processing, Configuration, Device Management, Support, Communication, Networks

Designing Software

Reliability, Tools, Safety, Analysis, Requirements, Platform, Development, Processes, Testing, Design, Best Practices, Quality Assurance, Modeling

Systems and Networks

Networking, Distributed Computing, Virtualization, Platforms, Internet of Things, Infrastructure, Embedded Systems, Artificial Intelligence, Security

Users and Organizations

Strategy, Business Intelligence, Security, Enterprise Architecture, Leadership, Project Management, User Experience, Digital Transformation, Ethics, Social Issues, Governance

Data and Analysis

Visualization, Security Issues, Information, Modeling, Design, Principles, Analysis, Data, Databases, Data Governance, Architecture, Requirements

CONTINUE TO SEE HOW THESE KNOWLEDGE AREAS CONNECT TO THE DIFFERENT COMPUTING DISCIPINES

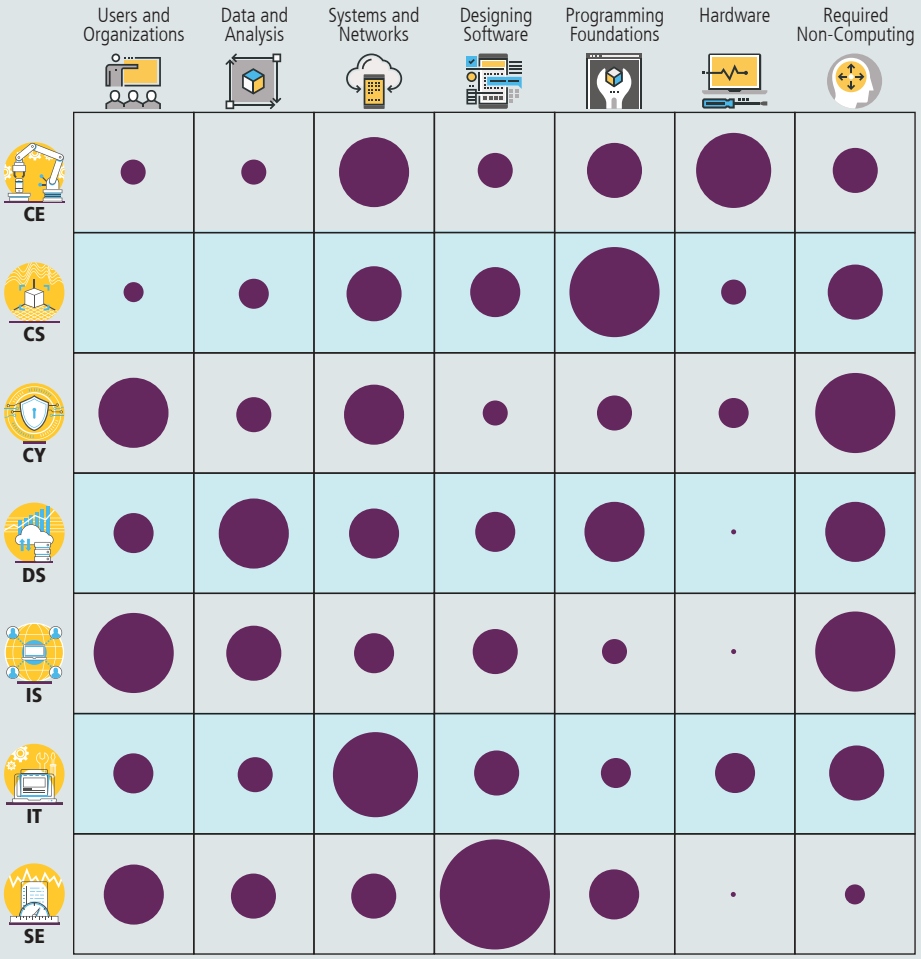
WHAT IS THE BIG PICTURE?

THE NEXT 28 PAGES FOCUS IN MORE DEPTH ON EACH OF THE SEVEN ACM COMPUTER DISCIPLINES. THIS PAGE PROVIDES A BIG PICTURE OVERVIEW OF THOSE SEVEN DISCIPLINES.

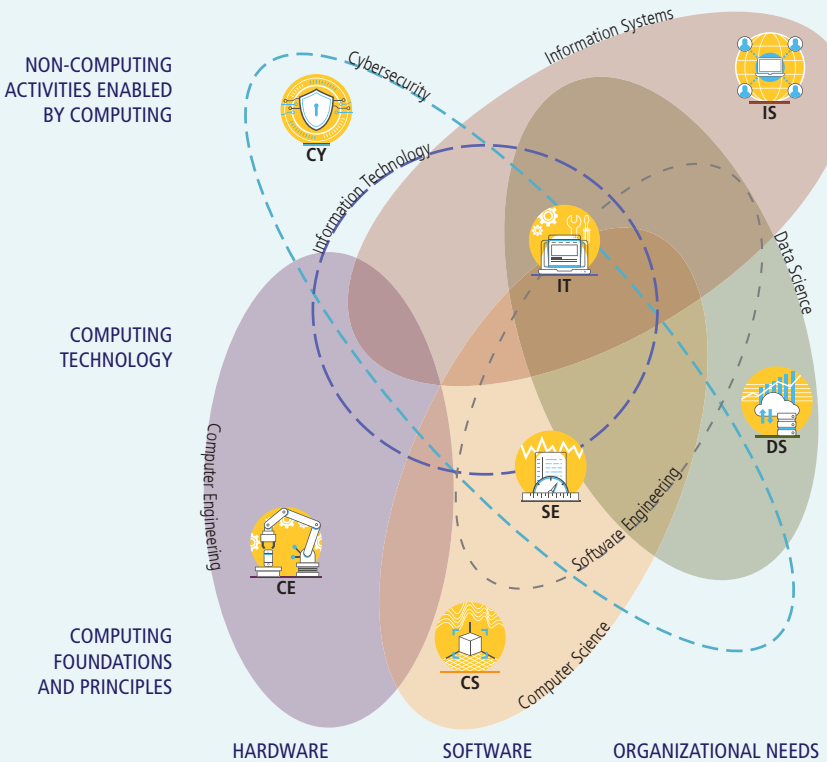
The previous page presented the seven main knowledge area categories for computing. This chart illustrates the mapping between those knowledge areas and the seven different academic computing disciplines.

Each circle represents the relative coverage of the knowledge area within a typical program in that discipline.

Every higher education computing program contains a variety of required courses that are not part of the computing knowledge areas. Examples include mathematics courses in Computer Science, statistics courses in Data Science, and business courses in Information Systems.



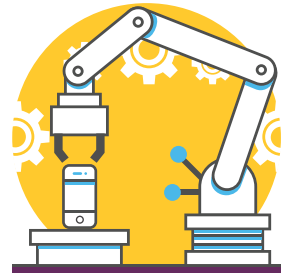
There is an overlap of educational content in all of the ACM computing disciplines. This chart illustrates the relative conceptual and practical coverage of the different disciplines and how they relate to each other.



COMPUTER ENGINEERING

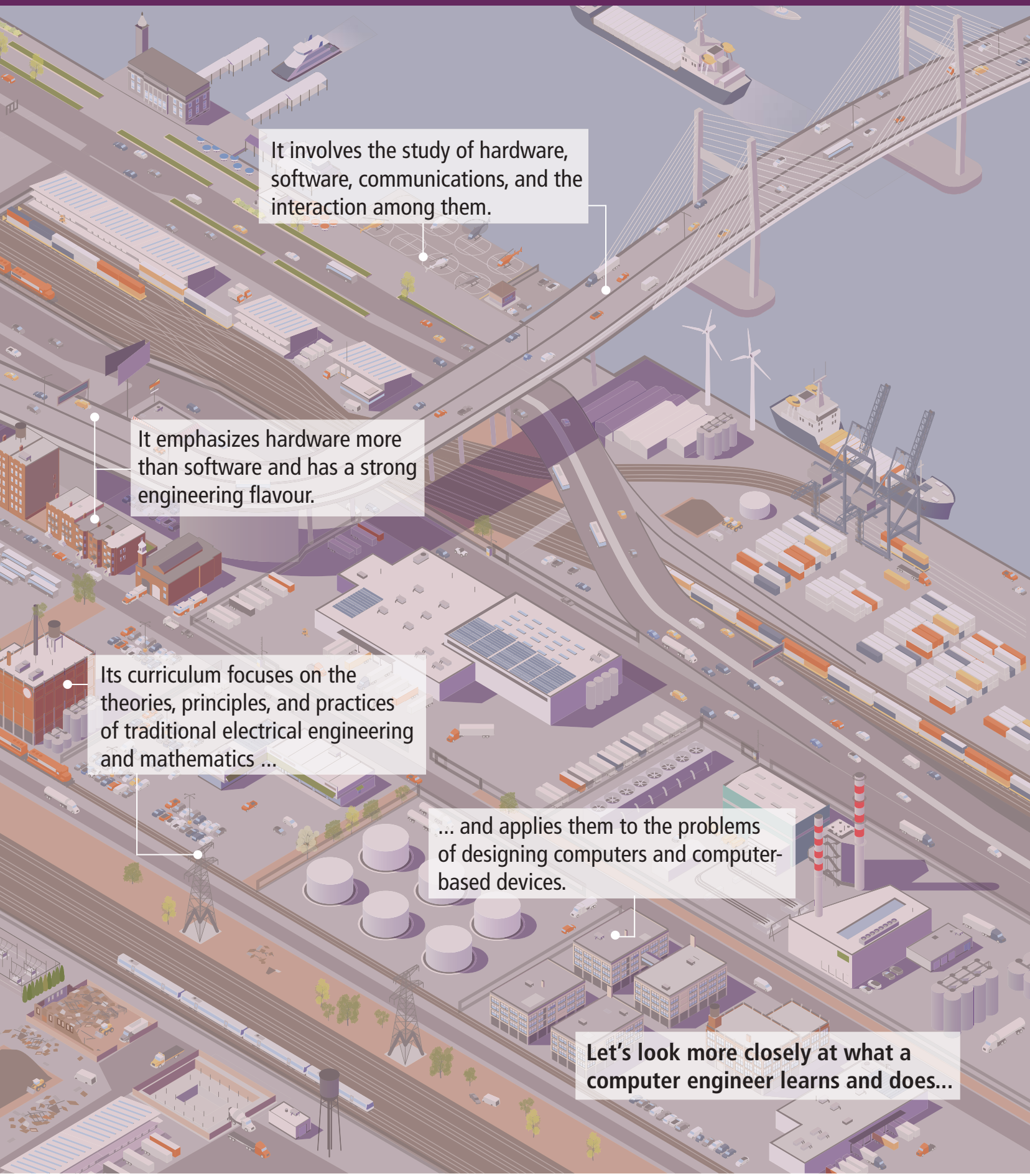
Computer Engineers are focused on the connection between hardware and software. A dominant area within computing engineering is embedded systems: the development of devices that have software and hardware embedded in them. Devices such as cell phones, digital audio players, digital video recorders, alarm systems, x-ray machines, and laser surgical tools all require integration of hardware and embedded software.

The emphasis here is more on hardware than on software, but CEs use both for integrated devices. CEs apply engineering theories to the problems of designing computers and computer-based devices. This is a theory-driven practice which incorporates traditional engineering and mathematics.



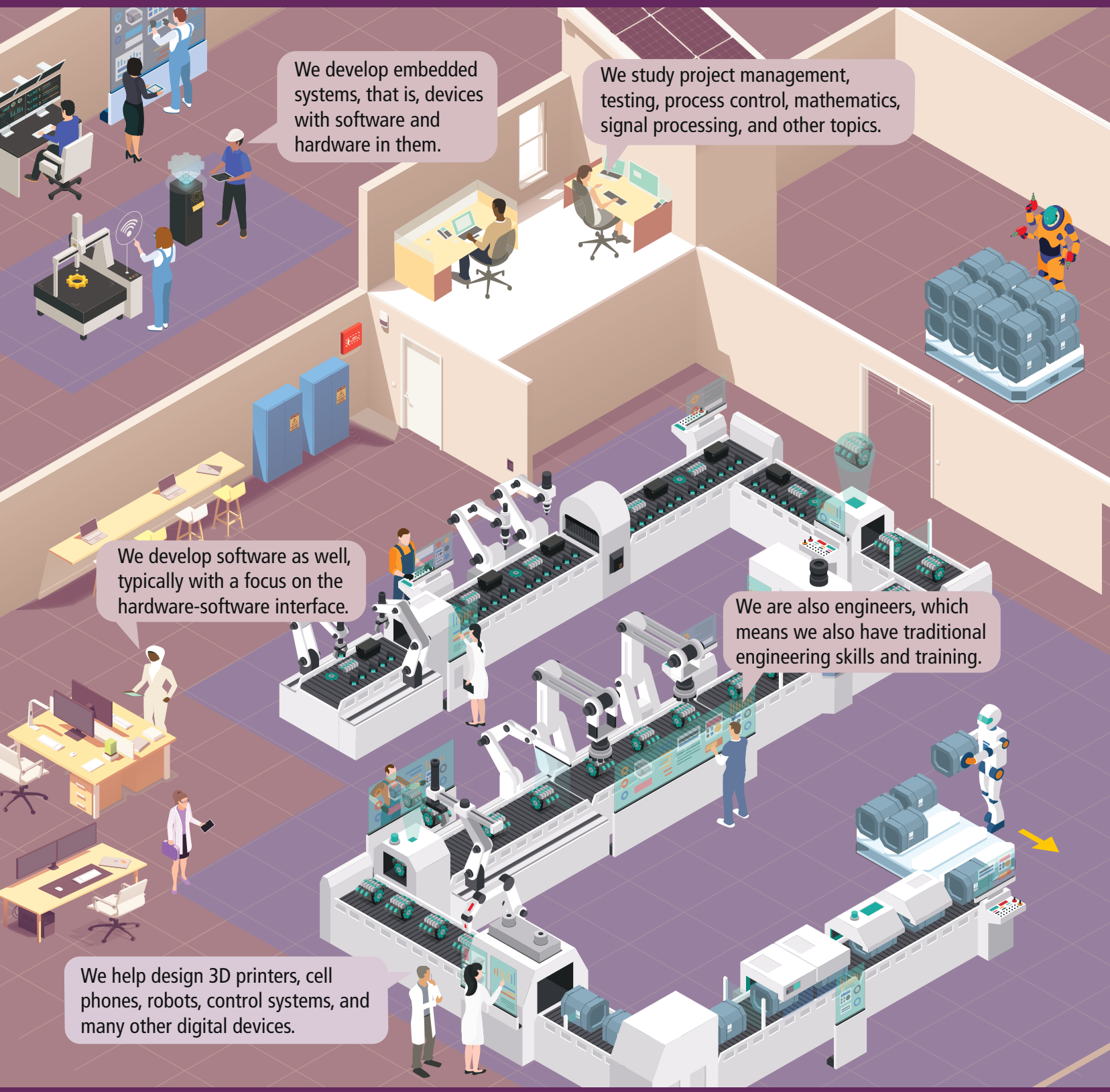
COMPUTER ENGINEERING

Computer Engineering (CE) is concerned with the design and construction of computers and computer-based systems.



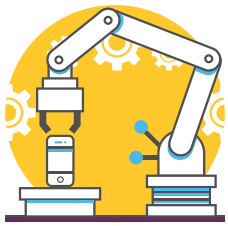
COMPUTER ENGINEERING

In Computer Engineering (CE), we are especially interested in the interaction between hardware and software.



Interesting ... we do some of these same tasks over in Computer Science but are more focused on the software aspects.

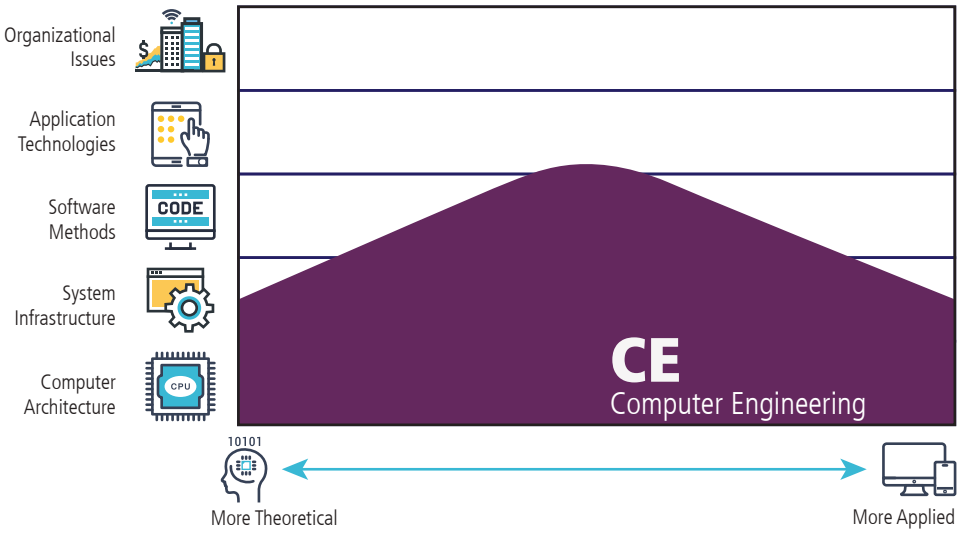
In Information Technology, we are also interested in hardware but in a more applied way.



COMPUTER ENGINEERING

Summary

Computer Engineering is focused on computer architecture and infrastructure, from the applied to the theoretical aspects. It also has an interest in software methods (programming) insofar as it applies to the hardware side of computing.



On the Job

Designs hardware to implement communication systems.

Develops hardware devices that are software-controlled, such as iPods, smart phones, and gaming devices.

Focuses exclusively on hardware design, including digital electronics, with less involvement in software design.

Evaluates and improves the usability (user experience) of computing systems.

Core Courses

Circuits and Electronics

Computer Architecture and Organization

Computer Networks

Control Systems

Data and Systems Communications

Data Structure and Algorithms

Digital Design

Embedded Systems

Information Security

Internet of Things

Signal Processing

Software Design

Sample Degrees

University of Western Ontario, Bachelor of Engineering Science in Computer Engineering

Thompson Rivers University, Bachelor of Engineering in Computer Engineering

University of Alberta, Bachelor of Engineering in Computer Engineering

McGill University, Bachelor of Engineering in Computer Engineering

University of New Brunswick, Bachelor of Science in Computer Engineering

Université Laval, Baccalauréat en ingénierie en génie informatique

University of Saskatchewan, Bachelor of Science in Engineering – Computer Engineering

St. Mary's University, Bachelor of Engineering – Electronic Systems Engineering

Toronto Metropolitan University, Bachelor of Engineering in Computer Engineering

Other Pathways

Vanier College, Computer Engineering Technology (DCS – 3 years)

Saskatchewan Polytechnic, Computer Engineering Technology (Advanced Diploma – 3 years)

Seneca Polytechnic, Computer Engineering Technology (Advanced Diploma – 3 years)

George Brown College, Computer Systems Technology, (Advanced Diploma – 3 years)

Okanagan College, Electronics Engineering Technology (Diploma plus Co-op – 2.5 years)

Northern Alberta Institute of Technology, Computer Engineering Technology (Diploma – 2 years)

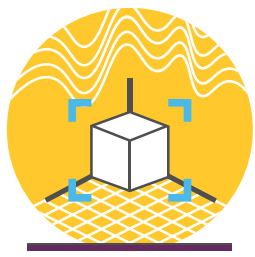
College of the North Atlantic, Computing Systems Engineering Technology (Diploma – 2 years)

Northern College, Computer Engineering Technician (Diploma – 2 years)

COMPUTER SCIENCE

Computer Scientists develop a strong foundation based on mathematics and algorithms. They are trained to discover the best solutions for new problems, generate new technologies and come up with innovative cutting-edge ideas. They design and test software that applies theory to practice, creating innovations in fields like robotics, computer vision, intelligent systems and bioinformatics.

Computer Scientists think up new ways to use computers, explore applications and develop effective ways to solve complex computing problems. They are involved in computer programming, and may supervise programmer teams. Computer Scientists may also develop encryption and other data protection schemes. They are involved in large software development projects.



COMPUTER SCIENCE

Computer Science (CS) covers the widest range of computing topics, from its theoretical foundations to the development of new computing techniques.

The work of computer scientists falls into three categories:

They devise new ways to use computers.

They design software architectures and implement them efficiently.

They develop effective algorithmic solutions to computing problems.

Their theoretical and mathematical background allows them to create, analyze, and improve algorithms.

Let's take a closer look at what computer scientists do ...

COMPUTER SCIENCE

Computer Science (CS) professionals can perform many different tasks, but we focus on software development and improving algorithmic solutions.

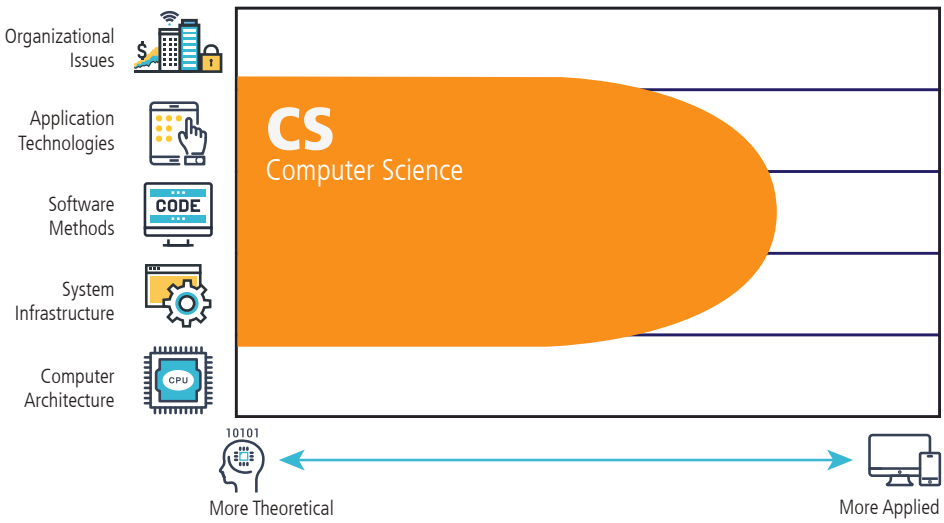
In Software Engineering, we do some of these things, but are more focused on the process of improving how software is created.

In Data Science, we are also involved in machine learning, artificial intelligence, and visualization, but with a focus on data collection and analysis.

COMPUTER SCIENCE

Summary

Computer science has the widest range of computing topics. It focuses especially on the theoretical aspects of computing, leaving the more applied topics (and organizational and architecture issues) to other disciplines.



On the Job

Use new theories to create cutting edge software.

Focus on the theoretical aspects of technology.

Utilize theory to research and design software solutions.

Use a wide range of foundational knowledge to adapt to new technologies and ideas.

Apply mathematical and theoretical knowledge in order to compare and produce computational solutions.

Core Courses

Artificial Intelligence

Computer Organizations and Systems

Data Structures and Algorithms

Discrete Mathematics

Formal Languages and Automata

Graphics and Visualization

Human-Computer Interaction

Linear Algebra

Networking and Communications

Numeric Computation

Operating Systems

Parallel and Distributed computing

Programming Languages

Software Development Fundamentals

Theory of Computation

Sample Degrees

University of Saskatchewan, Bachelor of Science in Computer Science

University of Northern British Columbia, Bachelor of Computer Science

Dalhousie University, Bachelor of Computer Science

Memorial University of Newfoundland, Bachelor of Arts in Computer Science

University of Prince Edward Island, Bachelor of Science in Computer Science

University of Guelph, Bachelor of Science in Computer Science

Université de Montréal, Baccalaureat en informatique

Mount Allison University, Bachelor of Computer Science

Algoma University and Northern College, Bachelor of Computer Science

Université de Sherbrooke, Baccalauréat en informatique

Other Pathways

Collège LaSalle Montréal, Technique de l'informatique (DEC – 3 years)

John Abbott College, Computer Science Technology (DEC – 3 years)

Collège de Maisonneuve, Électronique Programmable (Certificate - 2 years)

Confederation College, Computer Programmer (Diploma – 2 years)

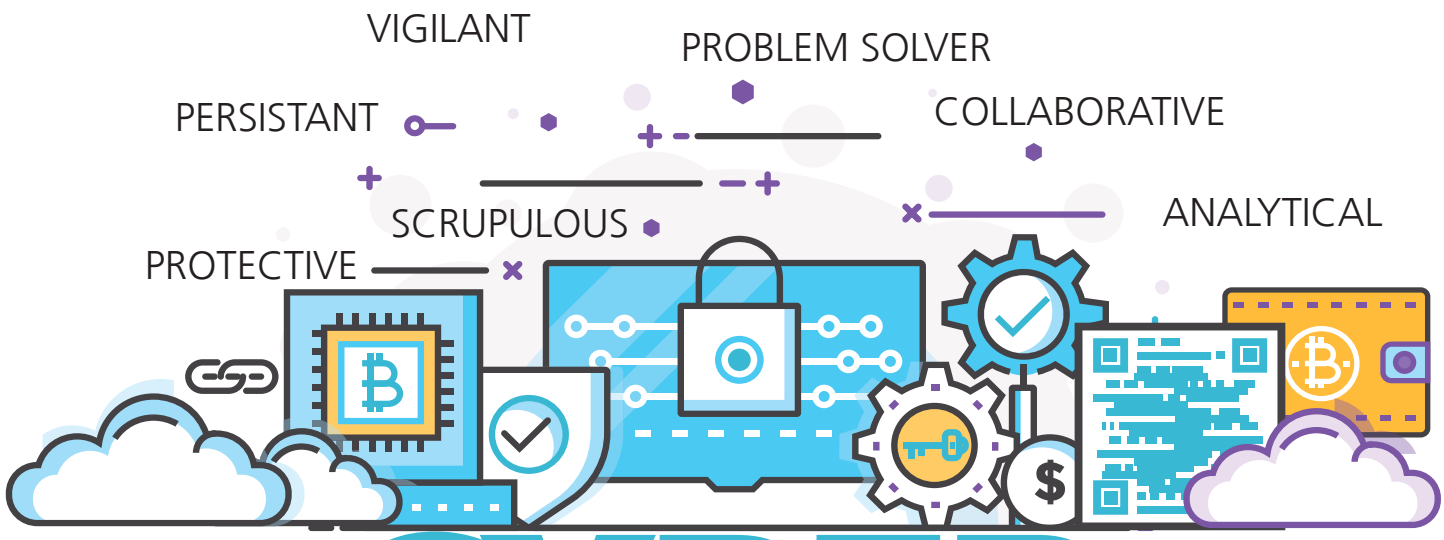
Algonquin College, Computer Programmer (Online Diploma – 2 years)

Douglas College, Computer Science (Certificate – 1 year)

Western Community College, Computer Science Fundamentals (Diploma – 1 year)

Acadia University, Computer Science (Certificate – 30 credit hours)

Cambrian College, Mobile Application Development (Graduate Certificate – 1 year)



CYBER SECURITY

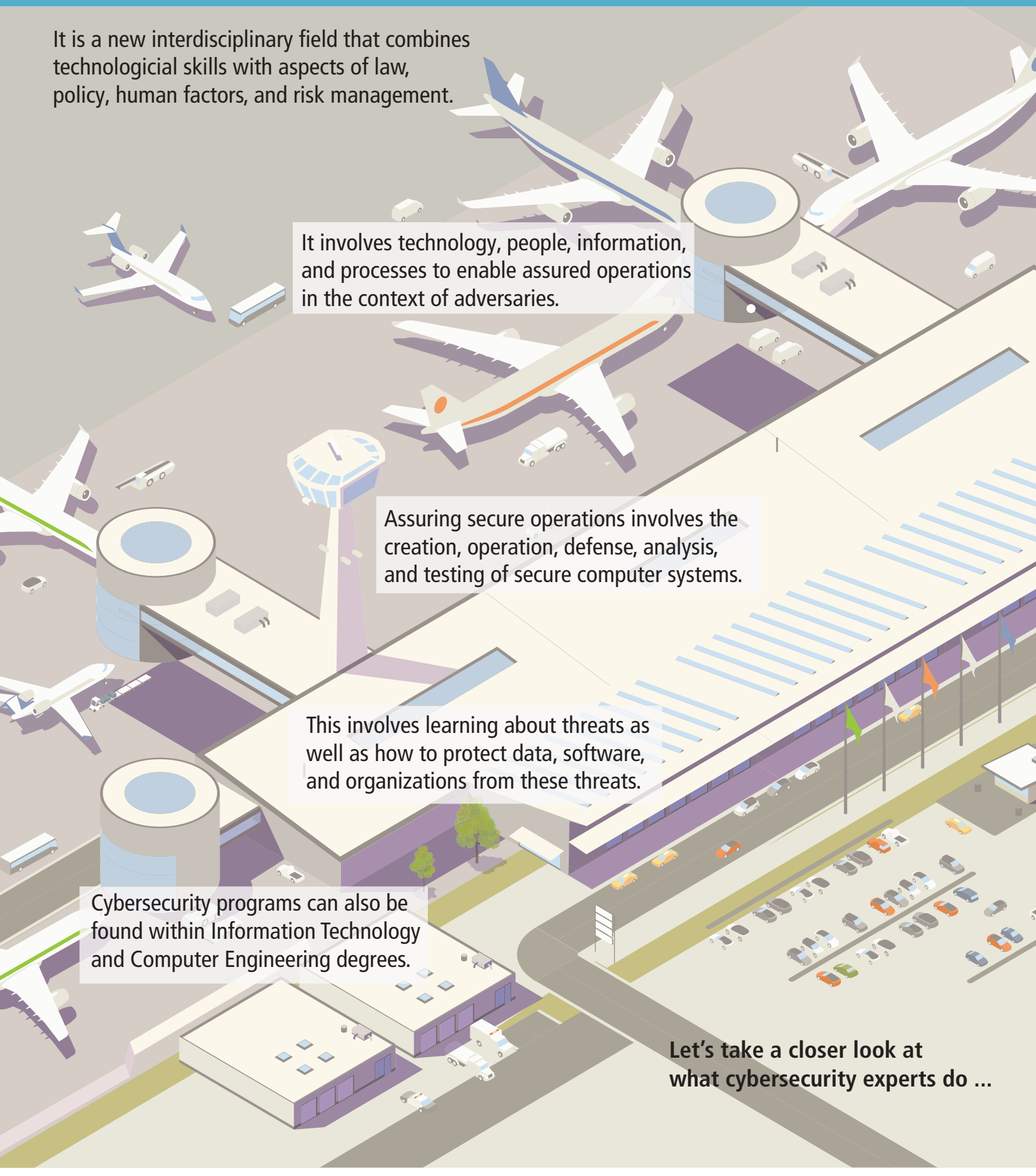
Cybersecurity professionals focus on protecting computer systems, networks, and data from cyber threats and attacks. They work to identify vulnerabilities, implement security measures, and respond to incidents to safeguard sensitive information.

Cybersecurity experts apply a combination of technical skills and knowledge of security protocols to develop strategies that defend against malware, phishing, and other cyber threats. Their work involves continuous monitoring, threat assessment, and risk management to ensure the integrity, confidentiality, and availability of information systems.

CYBER SECURITY

Cybersecurity (CY) is focused on the creation, operation, analysis, and testing of secure computer systems.

It is a new interdisciplinary field that combines technologicial skills with aspects of law, policy, human factors, and risk management.



It involves technology, people, information, and processes to enable assured operations in the context of adversaries.

Assuring secure operations involves the creation, operation, defense, analysis, and testing of secure computer systems.

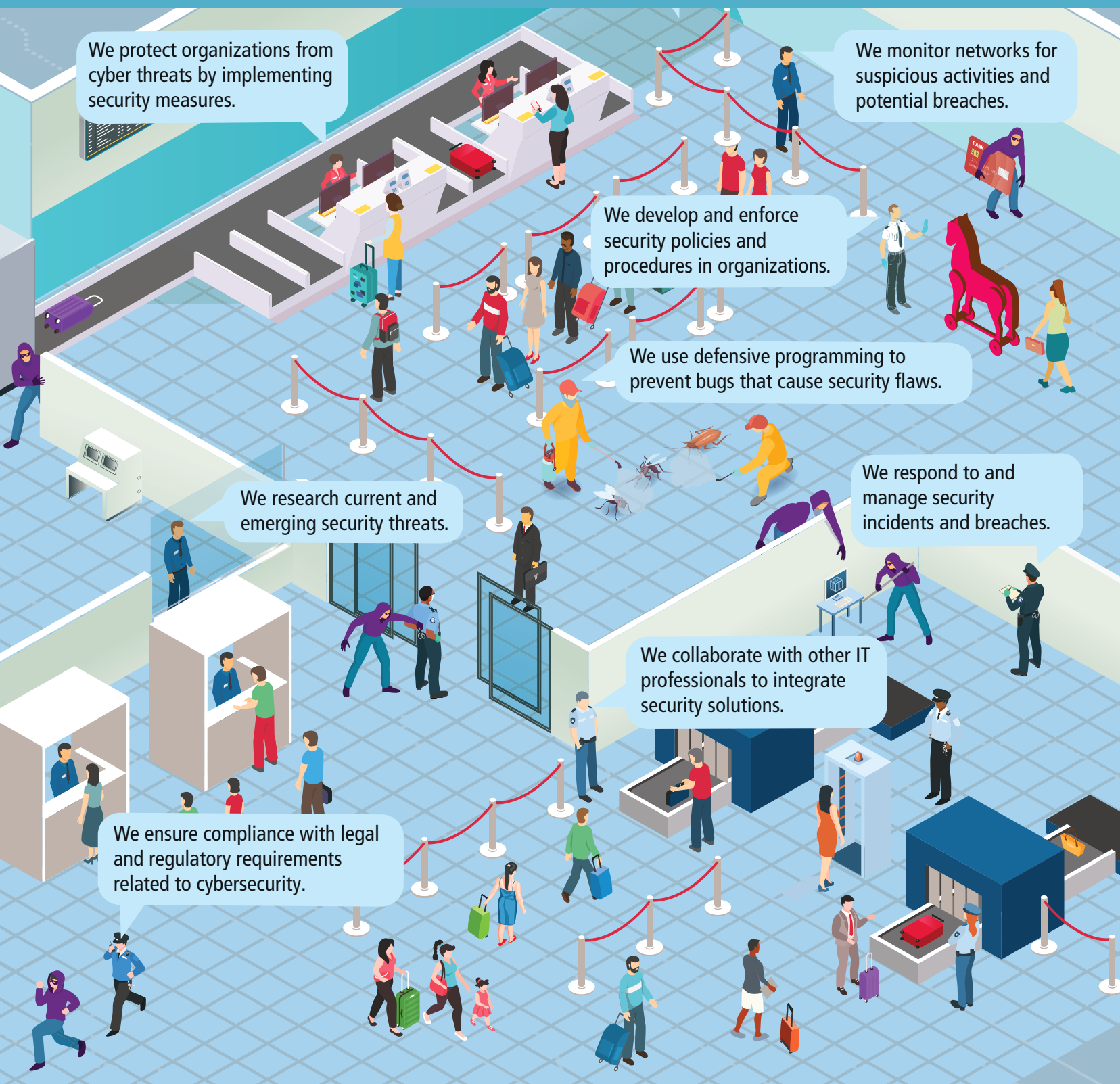
This involves learning about threats as well as how to protect data, software, and organizations from these threats.

Cybersecurity programs can also be found within Information Technology and Computer Engineering degrees.

Let's take a closer look at what cybersecurity experts do ...

CYBER SECURITY

Cybersecurity (CY) work is interdisciplinary and combines technical skills with organizational capabilities.



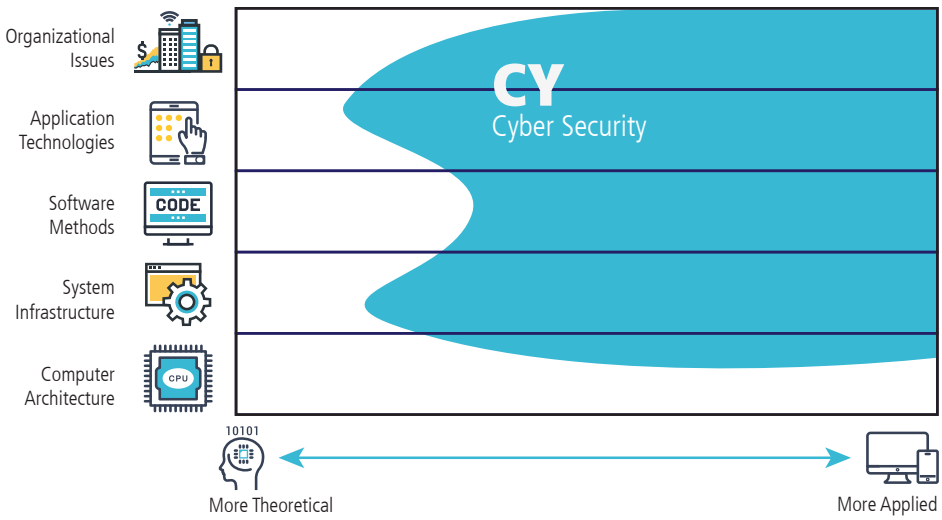
In Information Systems, we are also interested in security but from a organizational and business perspective.

In Information Technology, we are also interested in security, but focus more on the networking and technical aspects.

CYBER SECURITY

Summary

Cybersecurity professionals focus on protecting computer systems, networks, and data from cyber threats and attacks. They work to identify vulnerabilities, implement security measures, and respond to incidents to safeguard sensitive information.



On the Job

Evaluating potential security risks and vulnerabilities in systems and networks.

Responding to and investigating security breaches and incidents.

Identifying and mitigating vulnerabilities in software, hardware, and network configurations.

Educating employees on security best practices and protocols.

Creating and implementing security policies and procedures for the organization.

Core Courses

Introduction to Cybersecurity

Network Security

Operating System Security

Cryptography and Data Protection

Secure Software Development

Identity and Access Management

Digital Forensics

Introduction to Programming

Systems Administration

Incident Response and Management

Malware Analysis and Penetration Testing

Risk Management and Compliance

Privacy and Ethics

Law and Governance

Sample Degrees

University of Toronto, Bachelor of Science – Information Security

Carleton University, Bachelor of Computer Science – Cybersecurity Stream

Queen's University, Bachelor of Computing with Major in Security

University of Guelph, Masters of Cybersecurity and Threat Intelligence

Polytechnique Montréal, Baccalauréat par cumul avec appellation en cybersécurité

Sheridan College, Bachelor of Applied Information Sciences – Information Systems Security

University of New Brunswick, Bachelor of Computer Science – Cybersecurity specialization

British Columbia Institute of Technology, Bachelor of Computer Systems – Network Security Administration.

MacEwan University, Bachelor of Computer Science – System and Information Security

Other Pathways

Red River College, Information Security (Advanced Diploma – 2 years)

Centennial College, Cybersecurity (Graduate Certificate – 1 year)

Bow Valley College, Cybersecurity (Post-Diploma Certificate – 1 year)

Université du Québec à Rimouski, Diplôme d'études supérieures spécialisées en cybersécurité (Certificate – 1 year)

Nova Scotia Community College, Cyber Security (Diploma – 2 years)

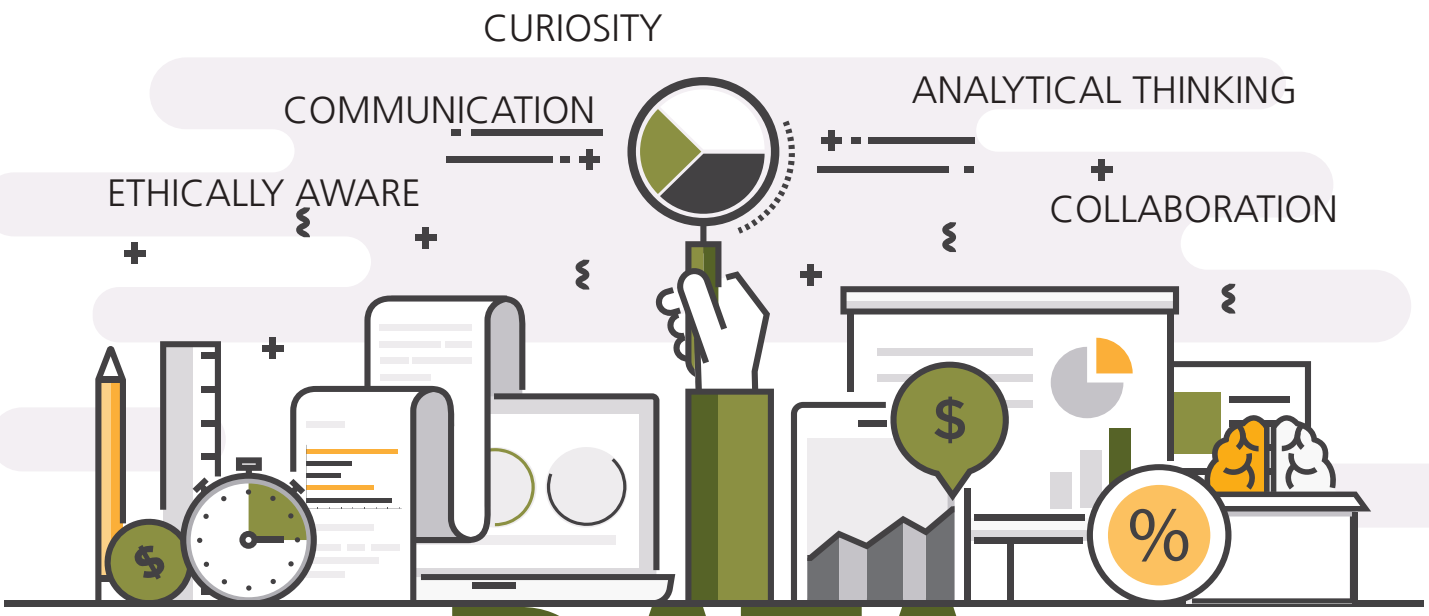
Sprott Shaw College, Cybersecurity (Diploma – 1 year)

Lighthouse Labs, Cybersecurity Bootcamp (12 weeks)

Collège LaSalle, Techniques de l'informatique - Gestion de réseaux et sécurité (DCS - 2 years)

British Columbia Institute of Technology, Industrial Network Cybersecurity (Diploma – 2 years)

Saskatchewan Polytechnic, Cyber Security (Certificate – 1 year)



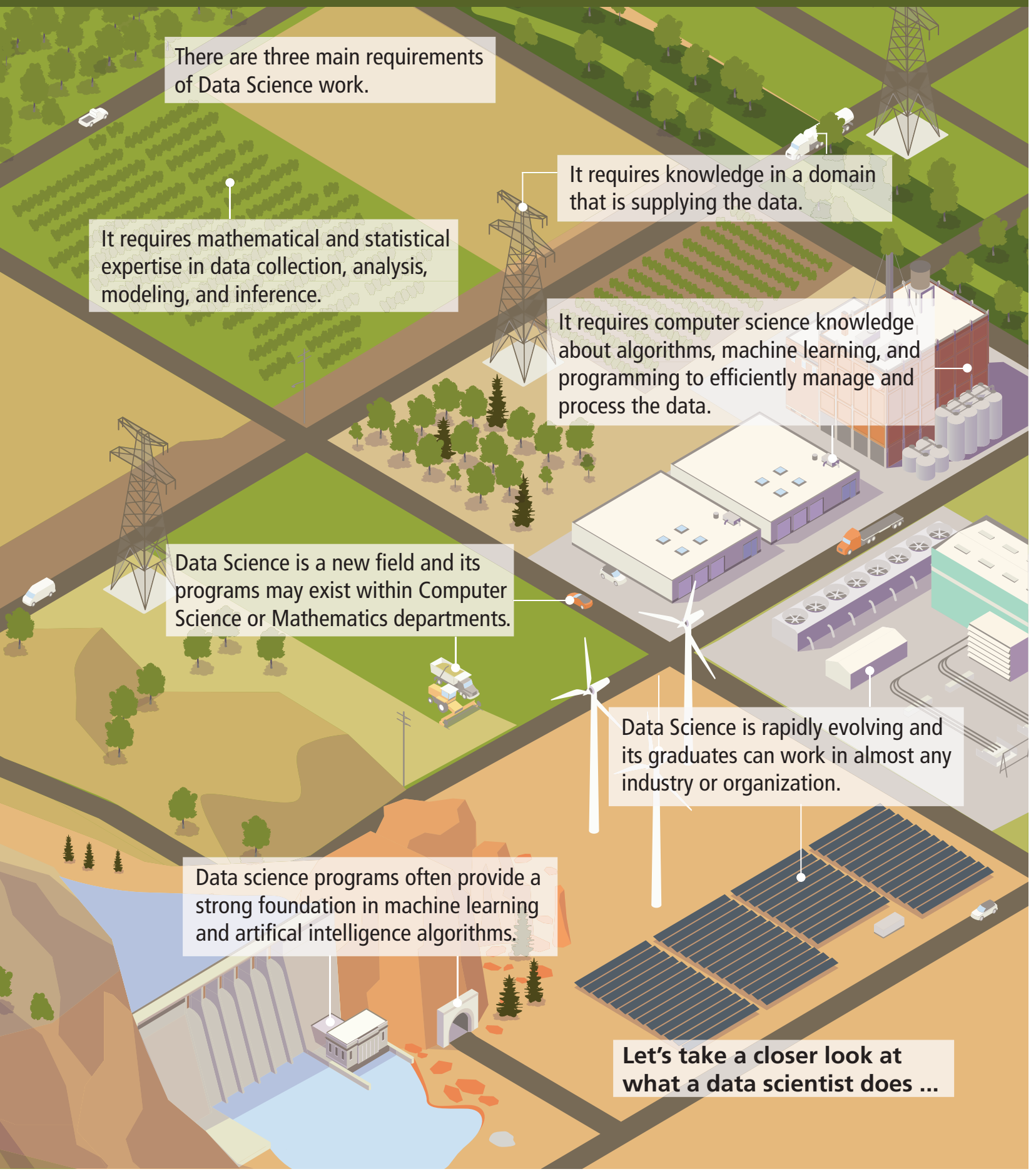
DATA SCIENCE

Data science is a field that combines math, computer skills, and subject knowledge to make sense of data. It involves collecting information, using tools to find patterns, and solving problems based on the results.

Data scientists use coding, statistics, and charts to understand and share their findings, helping people and businesses make better decisions. It's like being a detective but with data, finding clues and answers to important questions.

DATA SCIENCE

The field of Data Science (DS) combines domain data knowledge, computer science, and statistics to interrogate data and extract useful information.



DATA SCIENCE

In Data Science (DS) we are focused on the extraction of knowledge from data using techniques from computer science and mathematics or statistics.

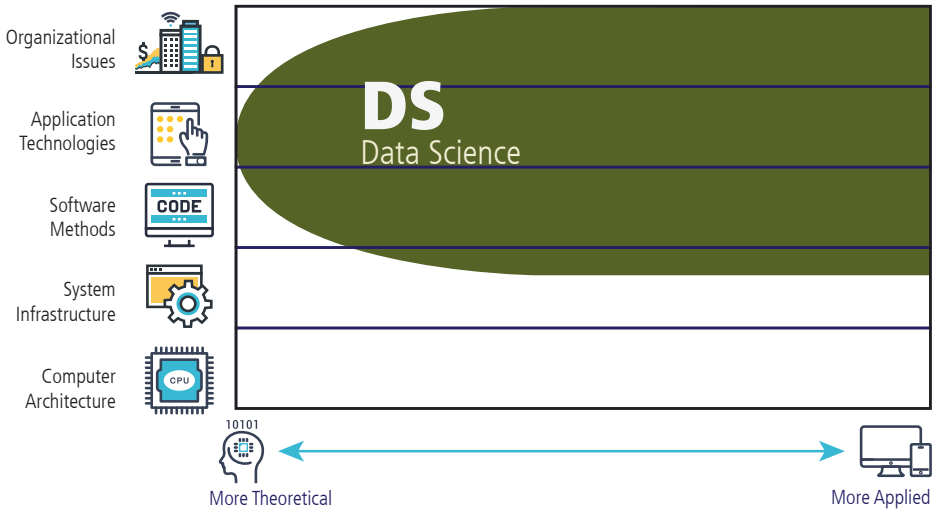
In Information Systems, we are interested in how data and its analysis can help businesses.

In Computer Science, we are also interested in machine learning using large data sets.

DATA SCIENCE

Summary

Data Science is a field that combines math, computer skills, and subject knowledge to make sense of data. It involves collecting information, using tools to find patterns, and solving problems based on the results.



On the Job

Collect and clean data to ensure its accuracy and reliability.

Explore and visualize data to uncover patterns and insights.

Selecting and transforming data features to improve model performance.

Build and deploy models to make predictions and drive decision making.

Report findings and communicate results effectively.

Core Courses

Introduction to Data Science

Mathematics for Data Science (including calculus, linear algebra)

Statistics (descriptive and inferential)

Data Management (databases and data wrangling)

Data Mining and Machine Learning

Algorithms and Data Structures

Programming (Python, R, C++, or Java)

Data Visualization

Ethics in Data Science

Big Data Systems

Artificial Intelligence

Capstone Project or Internship (practical experience)

Sample Degrees

University of Waterloo, Bachelor of Computer Science – Data Science

Mount Royal University, Bachelor of Science – Data Science

Seneca Polytechnic, Bachelor of Data Science and Analytics

Nipissing University, Bachelor of Science – Data Science

Concordia University, Bachelor of Arts or Bachelor of Science in Data Science

York University, Bachelor of Science, Data Science

McGill University, Bachelor of Statistics and Computer Science

Université de Montréal, Bachelor Science des données

University of Manitoba, Bachelor of Science – Data Science

University of Saskatchewan, Bachelor of Science – Data Analytics

Memorial University, Bachelor of Science – Data Science

Other Pathways

University of New Brunswick, Data Analytics (Certificate – 1 year)

Sheridan College, Data Science (Certificate – 1 year)

University of Toronto, School of Continuing Studies, Data Science (Certificate – 1 year)

Southern Alberta Information Technology, Data Science (Certificate – 1 year)

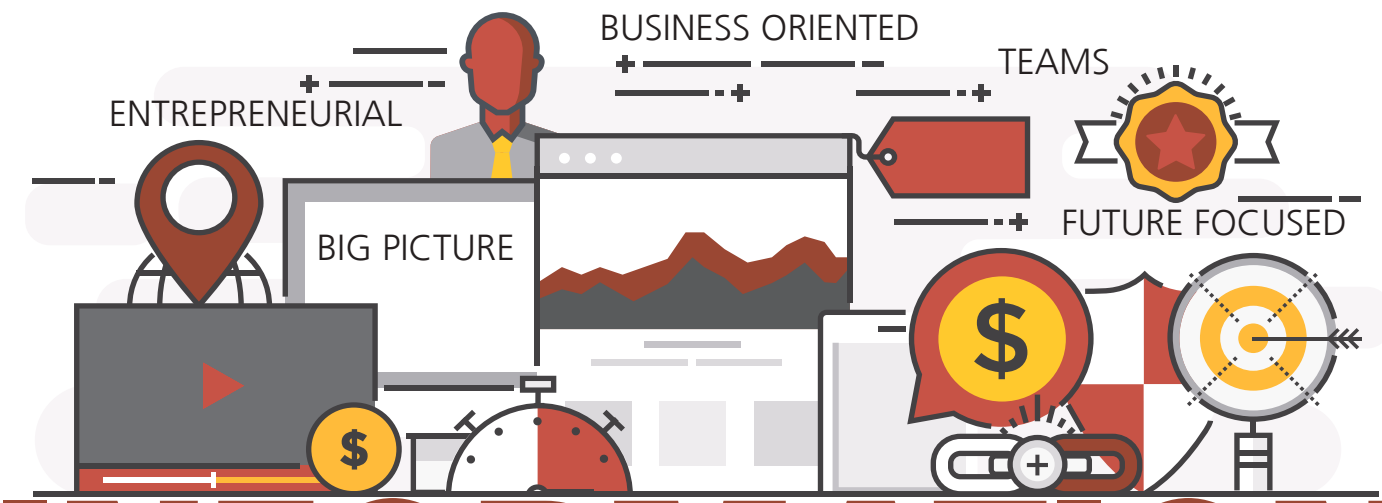
College of the North Atlantic, Data Analytics (Certificate – 1 year)

Saskatchewan Polytechnic, Artificial Intelligence and Data Analytics (Certificate – 1 year)

Thompson Rivers University, Applied Data Science (Diploma – 2 years)

Université du Québec en Outaouais, DESS en science des données et intelligence artificielle (Certificate – 1 year)

Nova Scotia Community College, IT Data Analytics (Diploma – 2 years)



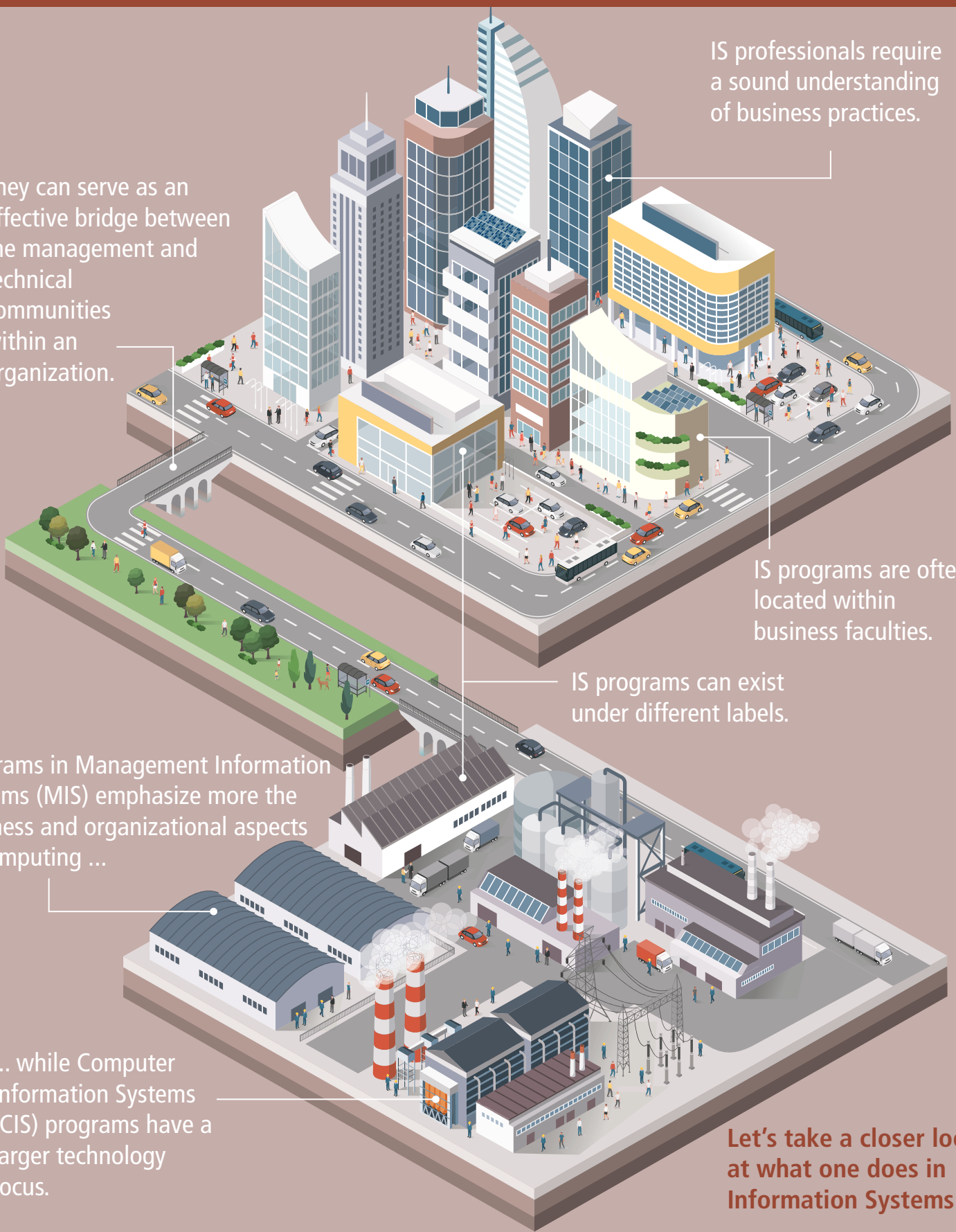
INFORMATION SYSTEMS

Information Systems specialists integrate information technology with business processes. They focus on the processing of information, and must have an understanding of how organizations and technology work.

Their studies combine business and computing coursework, and may have a computing focus or a management focus. They work closely with clients to determine how information and technology can provide a competitive advantage.

INFORMATION SYSTEMS

Information Systems (IS) is focused on integrating information technology and business processes.



IS professionals require a sound understanding of business practices.

They can serve as an effective bridge between the management and technical communities within an organization.

IS programs are often located within business faculties.

IS programs can exist under different labels.

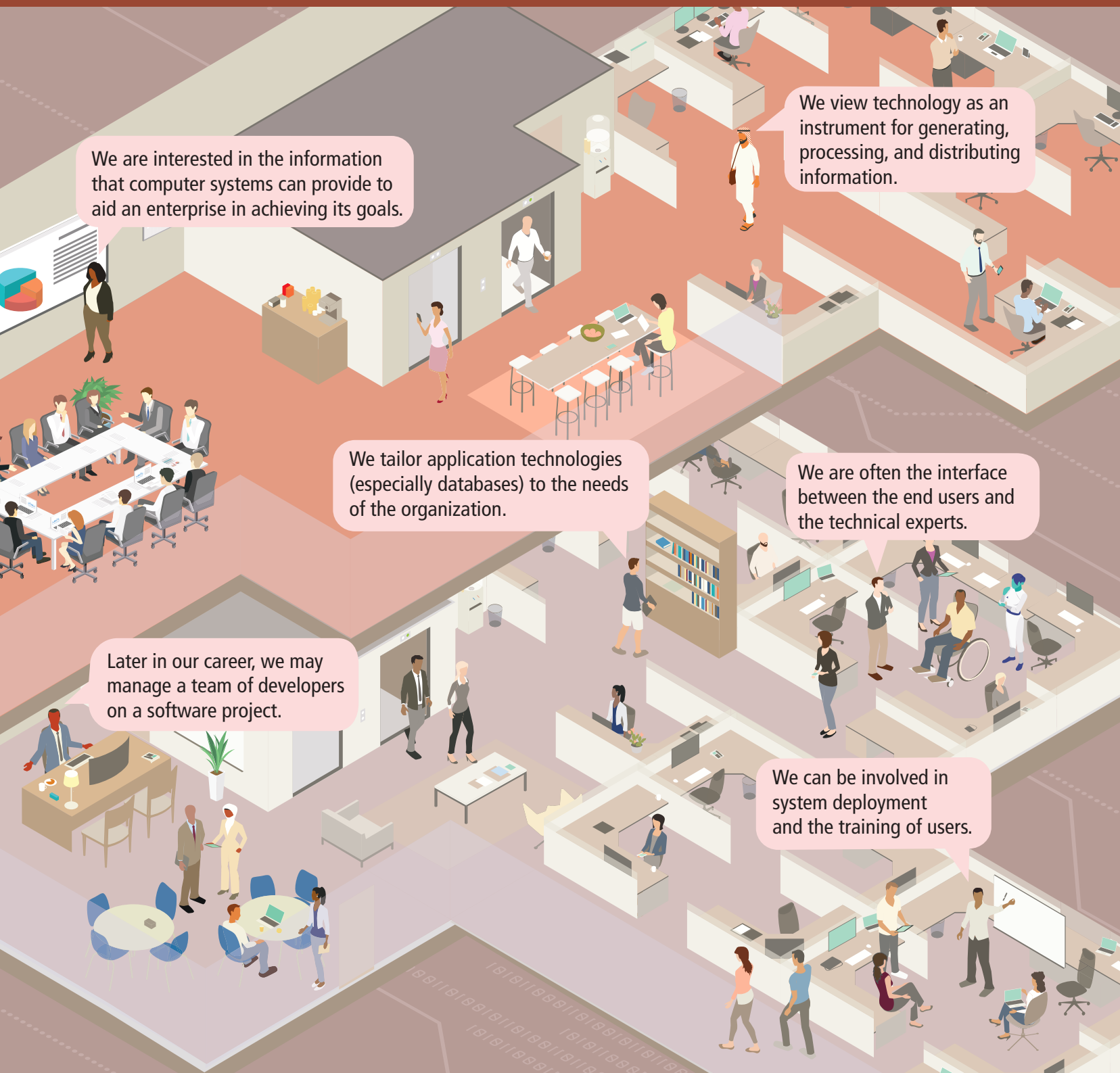
Programs in Management Information Systems (MIS) emphasize more the business and organizational aspects of computing ...

... while Computer Information Systems (CIS) programs have a larger technology focus.

Let's take a closer look at what one does in Information Systems ...

INFORMATION SYSTEMS

Information Systems (IS) professionals combine business and technical knowledge.



In Information Technology, we are also interested in the applied side of computing.

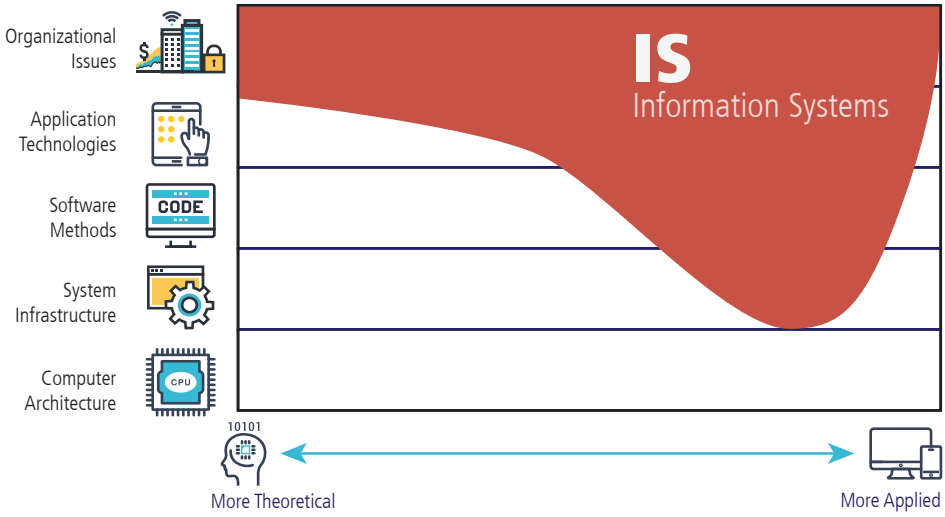
In Cyber Security, we are also interested in computing within organizations, but focus on security aspects.

In Software Engineering, we also learn how to manage large software projects.

INFORMATION SYSTEMS

Summary

Information Systems is focused on the organizational issues of computing. Information Systems also has an interest in the applied aspects of application technologies and software development.



On the Job

Combines knowledge of business with knowledge of technology.

Selects computer systems to improve business processes.

Focuses on information, and views technology as a tool for generating, processing, and distributing it.

Uses technology to give a business a competitive advantage.

Manages projects, teams of software developers or a computing department.

Core Courses

Foundations of Information Systems

Data and Information Management

Enterprise Architecture

IS Project Management

Systems Analysis and Design

Knowledge Management and Business Intelligence Systems

IS Security, Privacy and Ethics

IS Strategy, Management & Acquisition

IT Infrastructure

Sample Degrees

University of Windsor, Bachelor of Science in Computer Information Systems

Queen's University, Bachelor of Commerce in Information Systems

Mount Royal University, Bachelor of Computer Information Systems

McGill University, Bachelor of Commerce – Information Technology Management

St. Francis Xavier University, Bachelor of Information Systems

University of the Fraser Valley, Bachelor of Computer Information Systems

Carleton University, Bachelor of Commerce in Information Systems

Saint Mary's University, Bachelor of Commerce in Computing and Information Systems.

Okanagan College, Bachelor of Computer Information Systems

Other Pathways

North Island College (Campbell River), Computer Information Systems (Certificate – 1 year)

Saskatchewan Polytechnic, Business Information Systems (Diploma – 2 years)

Holland College, Computer Information Systems (Diploma – 2 years)

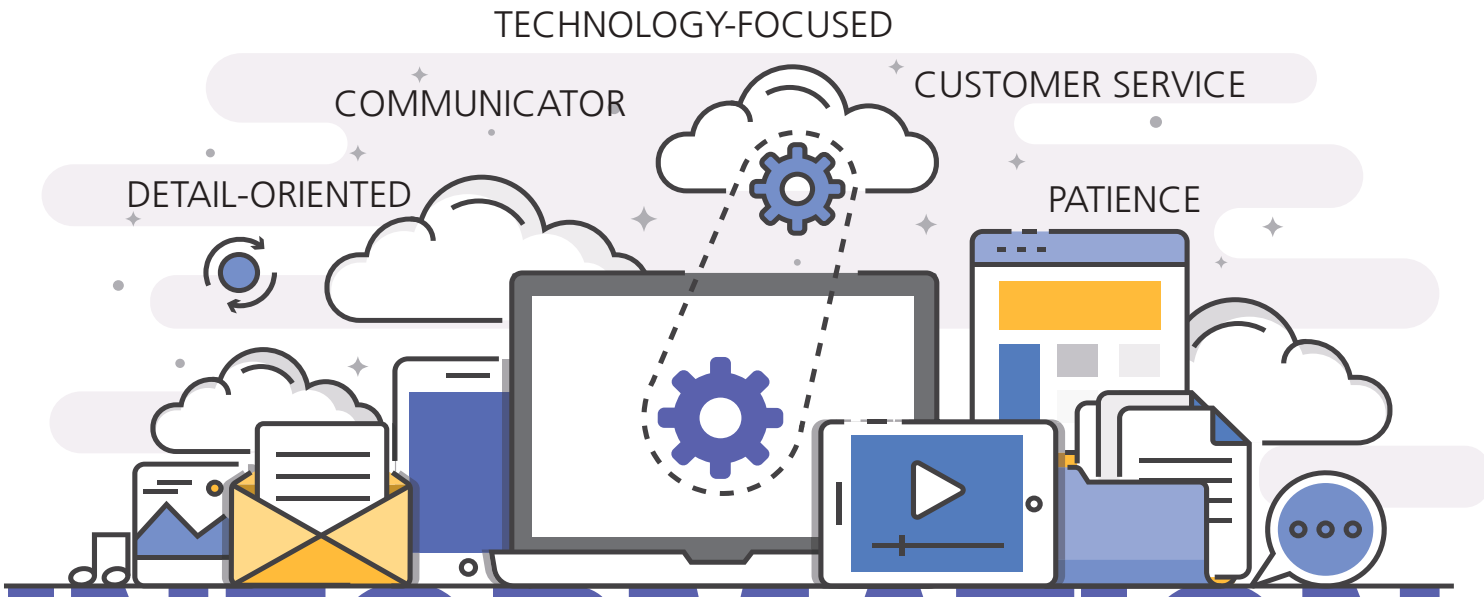
Douglas College, Computer and Information Systems (Diploma – 2 years)

Kwantlen Polytechnic University, Computer Information Systems (Diploma – 2 years)

Northern Lakes College, Computer Network Specialist (Certificate – 1 year)

Université de Saint-Boniface, Diplôme en technologies de l'information (Diploma – 2 years)

Athabasca University, Certificate in Computing and Information Systems (Certificate – 1 year online)



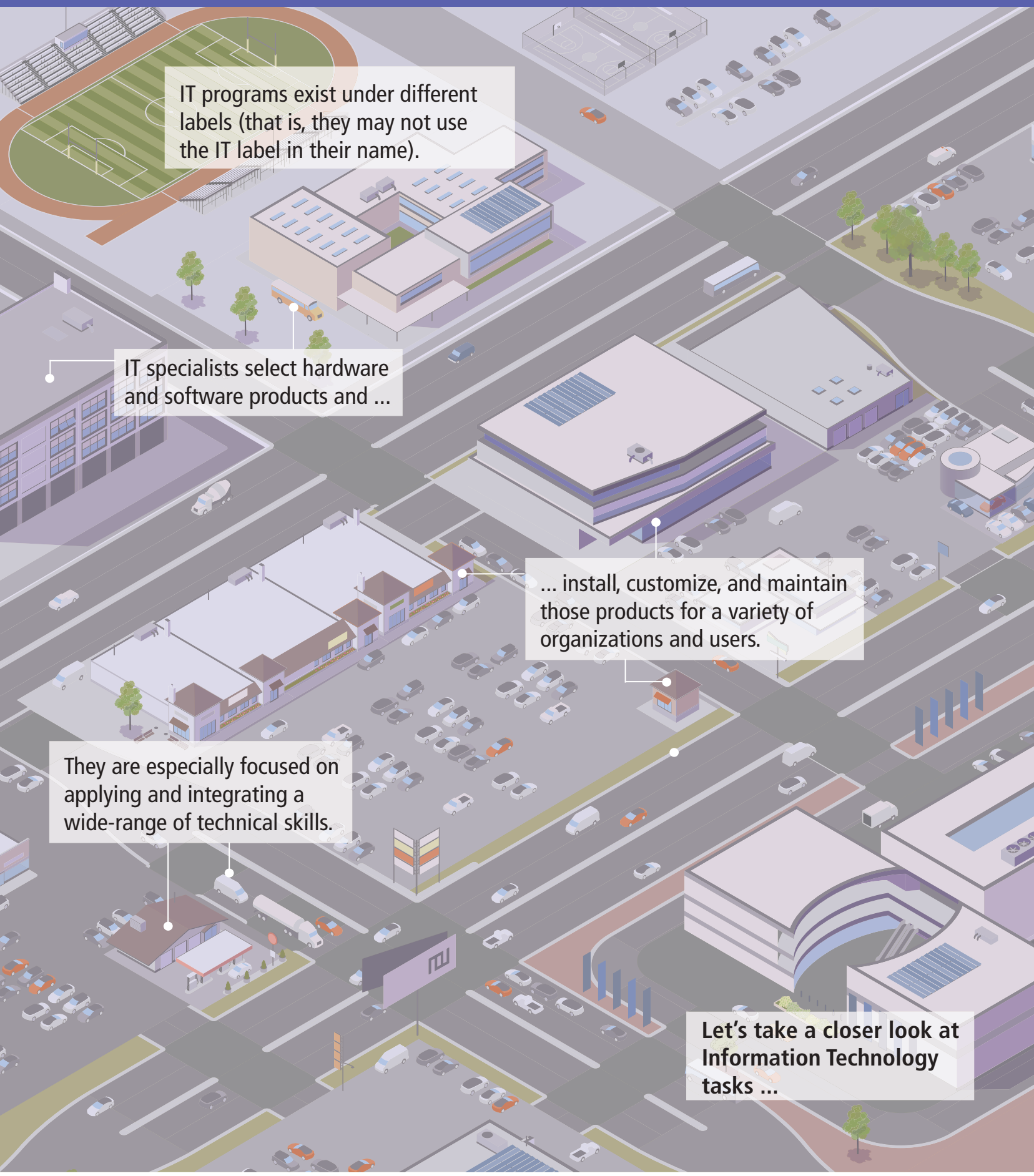
INFORMATION TECHNOLOGY

Information Technology professionals **provide customer service with a focus on technology**. They work to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations. Their emphasis is on the technology itself more than the content or information it conveys.

IT professionals select appropriate hardware and software products for the organization, and integrate these with existing hardware. Their responsibilities may include installation of networks, security, design of web pages, multimedia resource development, and the installation of communication components such as email systems. They are responsible for planning and managing the entire technology lifecycle.

INFORMATION TECHNOLOGY

Information Technology (IT) programs prepare students to meet the computer technology needs of businesses and other organizations.



INFORMATION TECHNOLOGY

In Information Technology (IT) we are principally focused on how to configure, use, and support technology infrastructures within organizations.

Organizations are dependent upon information technology and IT professionals help support it.

We understand computer systems and their software and help to solve computer-related problems.

We install, customize, and maintain both applications and devices for an organization and its users.

This means we can take care of an organization's information technology infrastructure.

We possess a combination of theoretical knowledge and practical, hands-on expertise.

We also do software development, especially in applied areas such as web sites and mobile apps.

We can help configure and improve an organization's security infrastructure.

In Information Systems, we are mainly interested in the business aspects of information technology.

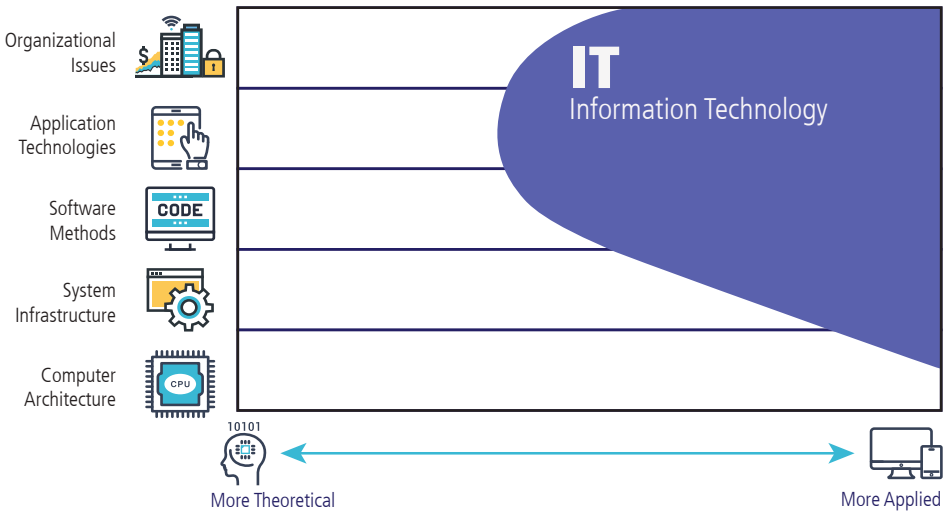
In Cyber Security, we are also interested in computing within organizations, but focus on security aspects.

In Computer Engineering, we are also interested in hardware, but we focus on designing and creating it.

INFORMATION TECHNOLOGY

Summary

Information Technology is focused on the applied side of computing. It covers all aspects of technology infrastructure, including hardware, operating systems, applications, data storage and communication systems.



On the Job

Integrates hardware and software.

Applies technology to solve practical problems.

Provides a support role, within an organization, to help others make the best use of its technical and information resources.

Uses a wide range of foundational knowledge to adapt to new technologies and ideas.

Understands both technology and business, but with a focus more on the technical side.

Core Courses

Communications and Networking

Computer Forensics

Database Systems

Fundamentals of Web Systems

Information Assurance and Security

Information Storage and Retrieval

Managing IT Infrastructure

Operating Systems

Programming Fundamentals

Project Management

System Administration and Maintenance

Technology in the Global Arena

Virtualization and Cloud Computing

Web Architecture and Administration

Sample Degrees

York University, Bachelor of Arts in Information Technology

Algoma University, Bachelor of Arts in Information Technology

Concordia University College of Alberta, Bachelor of Science in Information Technology

Bishop's University, Bachelor of Arts in Information Technology

Mount Saint Vincent University, Bachelor of Applied Arts in Information Technology

Carleton University, Bachelor of Information Technology

Seneca College, Bachelor of Technology – Informatics and Security

Trent University, Bachelor of Arts in Computing Systems

Brock University, Bachelor of Science in Computing and Network Communications.

Other Pathways

Mohawk College, Computer Systems Technology (Advanced Diploma – 3 years)

Arctic College (Nunavut), Computer Systems Technology (Certificate – 1 year)

Thompson Rivers University, Information Technology (Certificate – 30 credits)

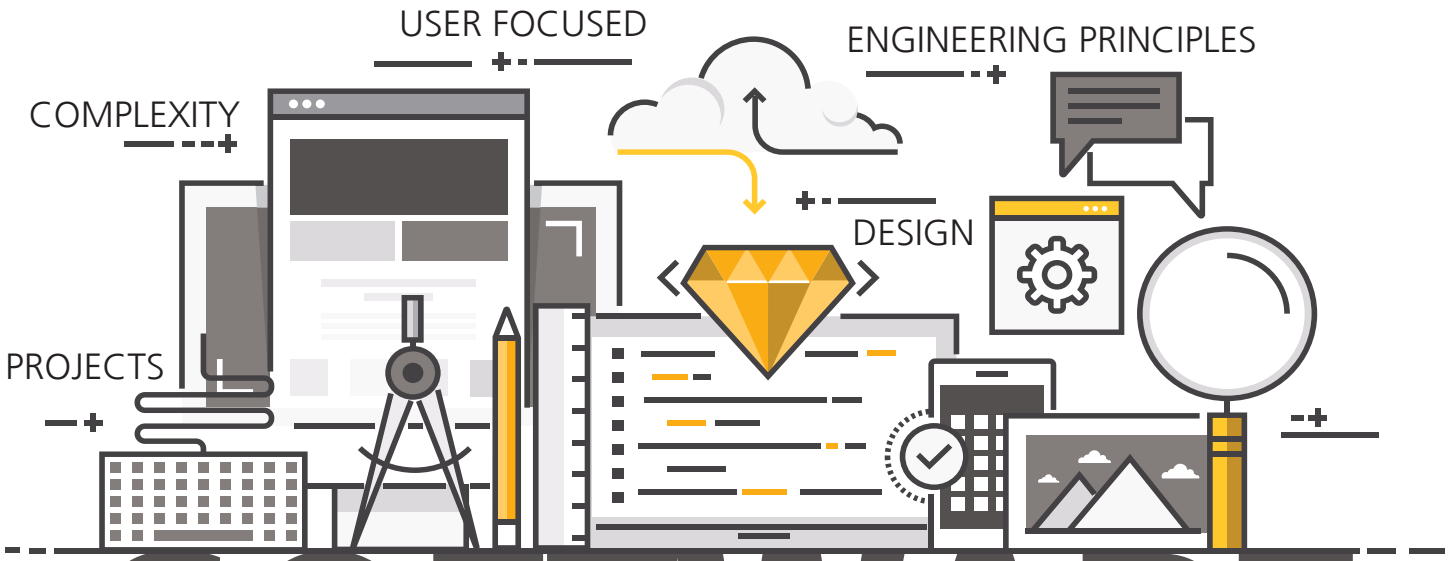
Conestoga College, Information Technology Business Analysis – Operations (Certificate – 2 years)

McGill University, Comptuers and Information Technology (Certificate – 1 year)

Red River College, Business Information Technology (Diploma – 2 years)

Nova Scotia Community College, Information Technology (Diploma – 2 years)

Portage College, Computer Programming and Information Technology (Certificate - 1 year)



SOFTWARE ENGINEERING

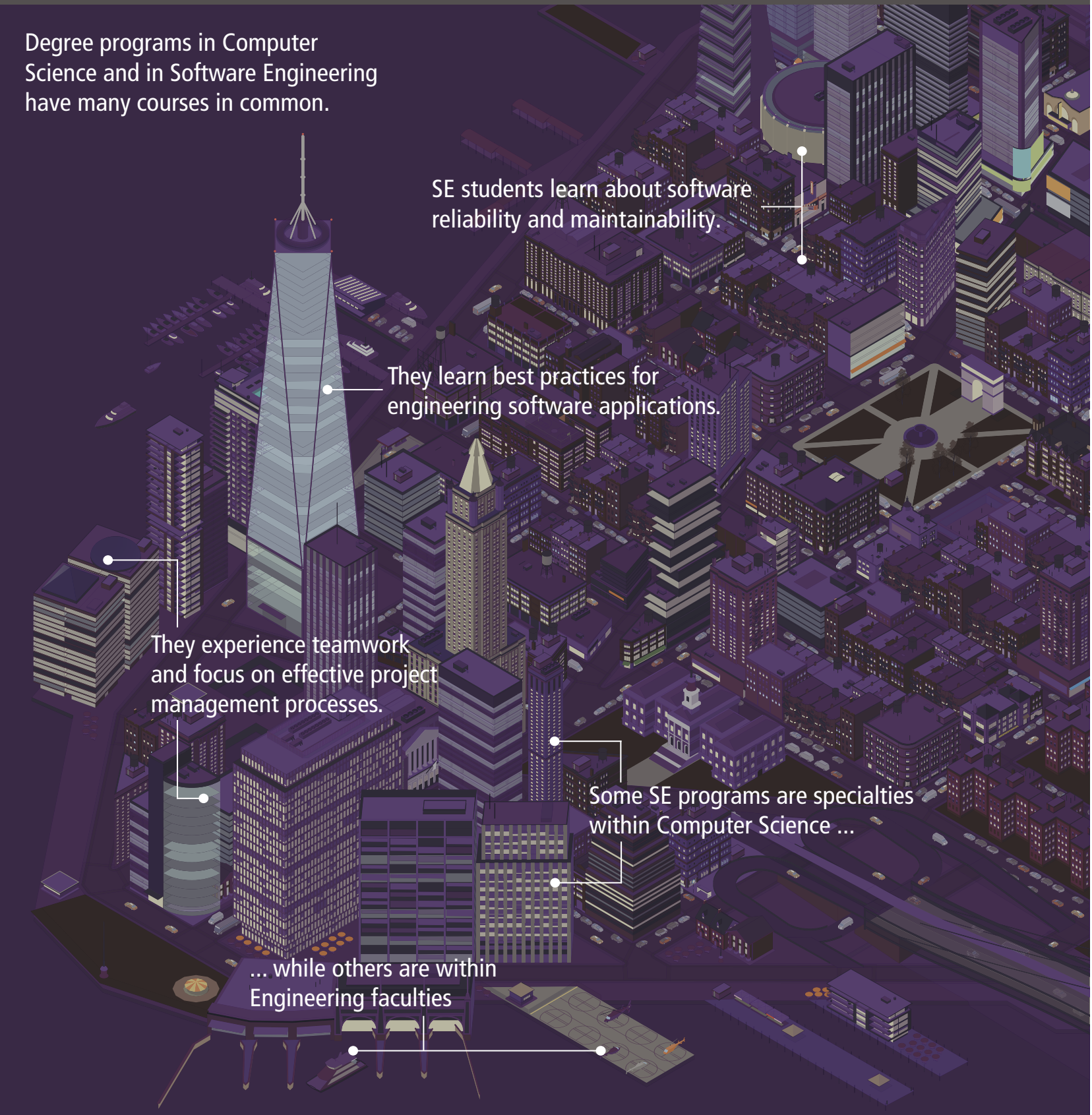
Software Engineers develop and maintain large-scale software systems. Using the principles of mathematics and computer science, and the practices of engineering, software engineers learn how to develop software that meets customer needs.

Their expertise is in software reliability, and they focus on techniques for developing and maintaining appropriate software solutions.

Software engineers work closely with customers, they learn how to assess customer needs and they often manage large, complex and/or safety-critical software projects.

SOFTWARE ENGINEERING

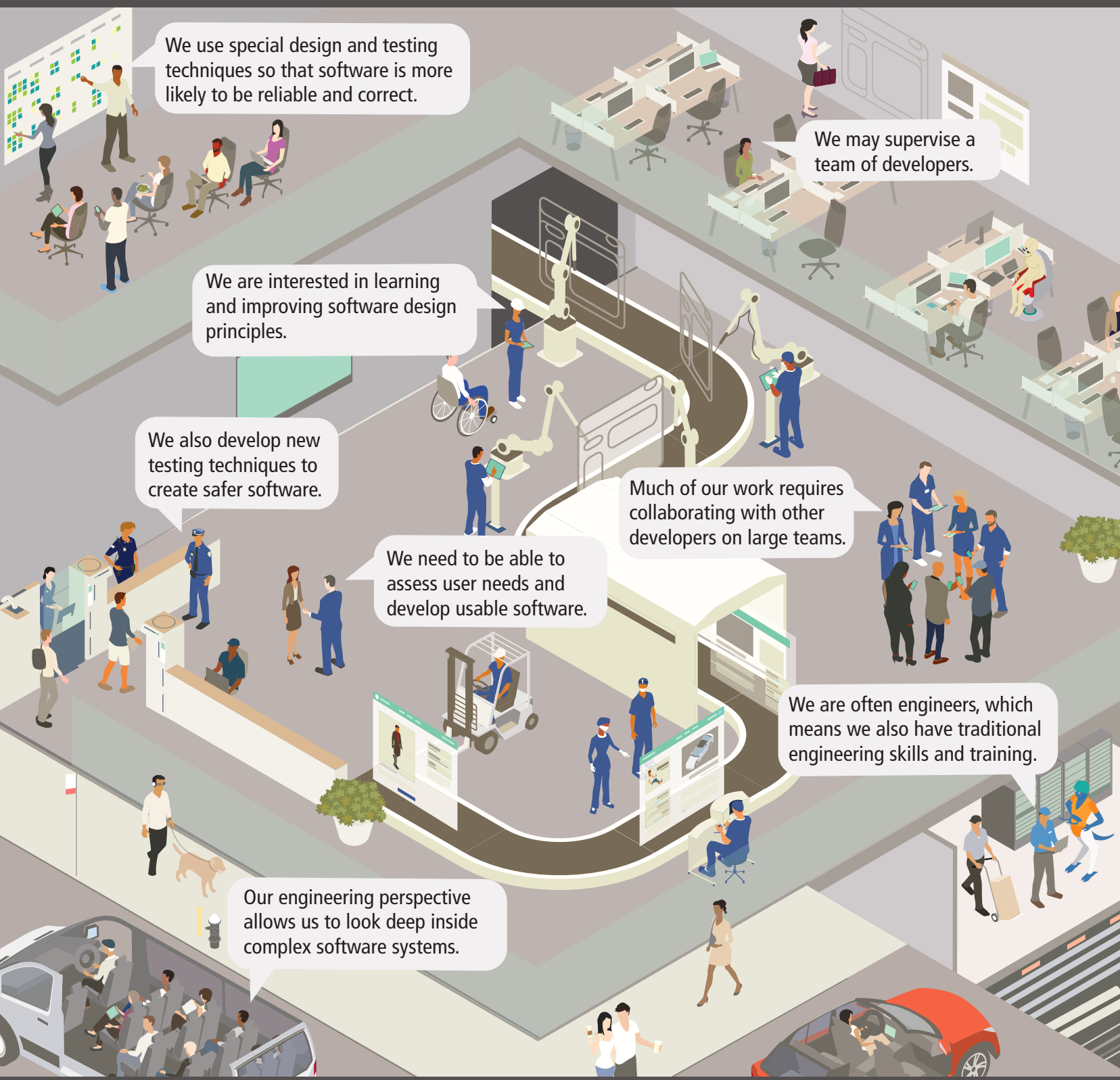
Software Engineering (SE) is the discipline of developing and maintaining large software systems.



Let's take a closer look at what a software engineer can do ...

SOFTWARE ENGINEERING

In Software Engineering (SE) we are focused on how to best develop reliable large-scale software systems.



We may do many of these same tasks over in Computer Science.

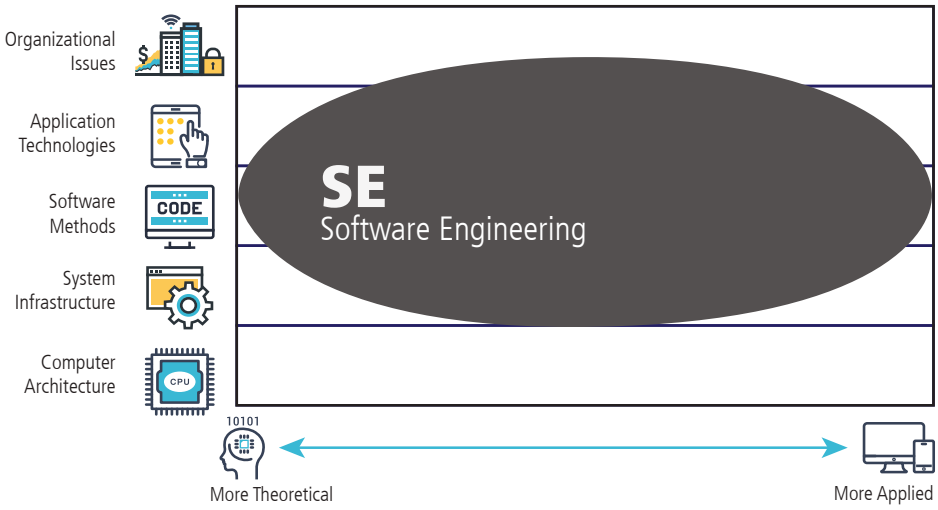
Computer Engineering has some similarities, but we are more focused on the connection between software and hardware.

In Data Science, we also are interested in development best practices, but in the context of data analysis and evaluation.

SOFTWARE ENGINEERING

Summary

Software Engineering is focused on everything (from applied to theoretical) related to software methods, that is, writing software. Infrastructure and application technologies are also part of software engineering.



On the Job

Focuses on large-scale systems development.

Designs testing procedures for large-scale systems.

Utilizes theory to research and design software solutions.

Develops software systems that are maintainable, reliable, efficient, and satisfy customer requirements.

Utilizes sound engineering practices to create computer applications.

Manages a team of software developers.

Core Courses

Algorithm Analysis

Computer Architecture

Data Integration and Analysis

Data Structures and Algorithms

Data Visualization

Fundamentals of Complex Systems

Mathematical and Engineering Fundamentals

Programming Fundamentals

Project Management

Requirement Analysis

Software Design and Processes

Software Modeling and Analysis

Software Testing and Quality Assurance

Sample Degrees

York University, Bachelor of Engineering – Software Engineering

University of Victoria, Bachelor of Engineering in Software Engineering

University of Calgary, Bachelor of Science in Software Engineering

University of Manitoba, Bachelor of Science in Software Engineering

Concordia University, Bachelor of Engineering in Software Engineering

University of New Brunswick, Bachelor of Science in Software Engineering

University of Waterloo, Bachelor of Software Engineering

Carleton University, Bachelor of Engineering – Software Engineering

Lakehead University, Software Engineering – Bachelor of Engineering

École de technologie supérieure, Bachelor of Software Engineering

Université Laval, Informatique et de génie logiciel

Other Pathways

Durham College, Computer Programmer Analyst (Advanced Diploma – 3 years)

Centennial College, Software Engineering Technician (Diploma – 2 years)

Sheridan College, Computer Systems Technician – Software Engineering (Diploma – 2 years)

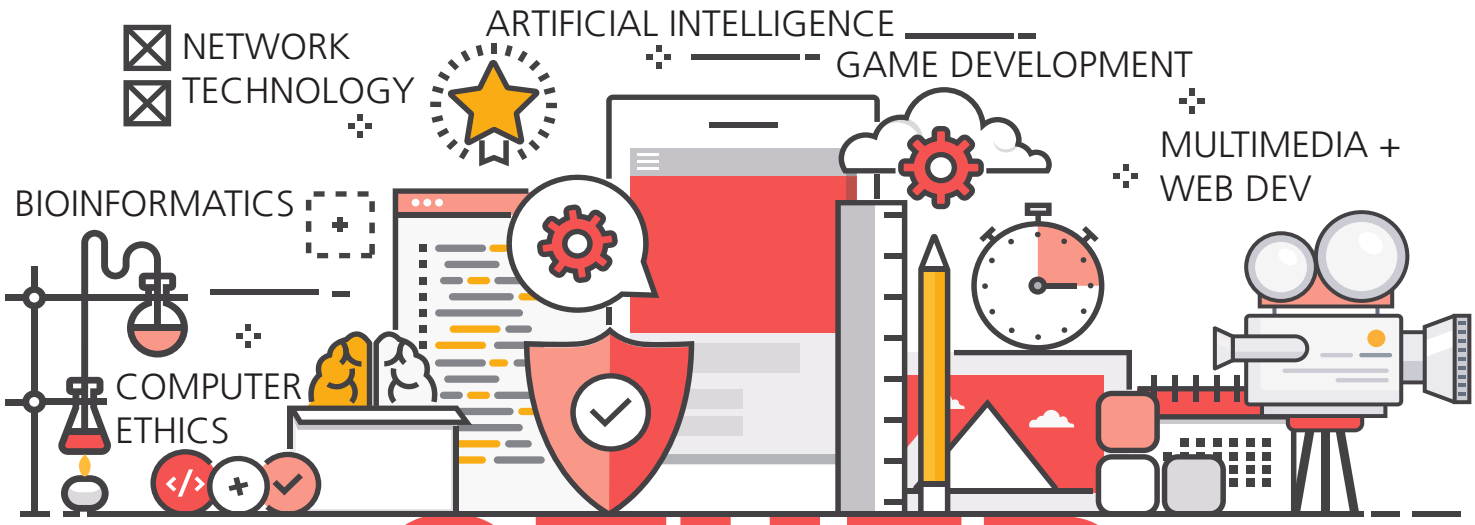
Humber College, Computer Programming (Diploma – 2 year)

Bow Valley College, Software Development (Certificate – 1 year)

British Columbia Institute of Technology, Applied Software Development (Associate Certificate - 1 year)

George Brown College, Mobile Application Development and Strategy (Certificate – 1 year)

Conestoga College, Software Engineering technology (Advanced Diploma – 3 years)

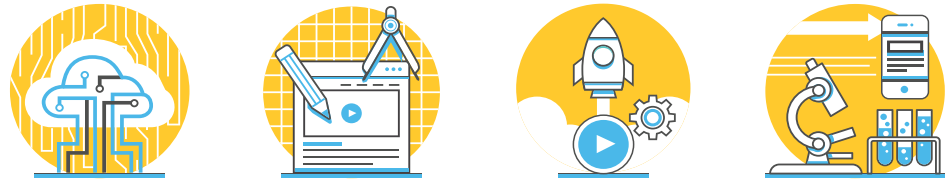


OTHER SPECIALIZATIONS

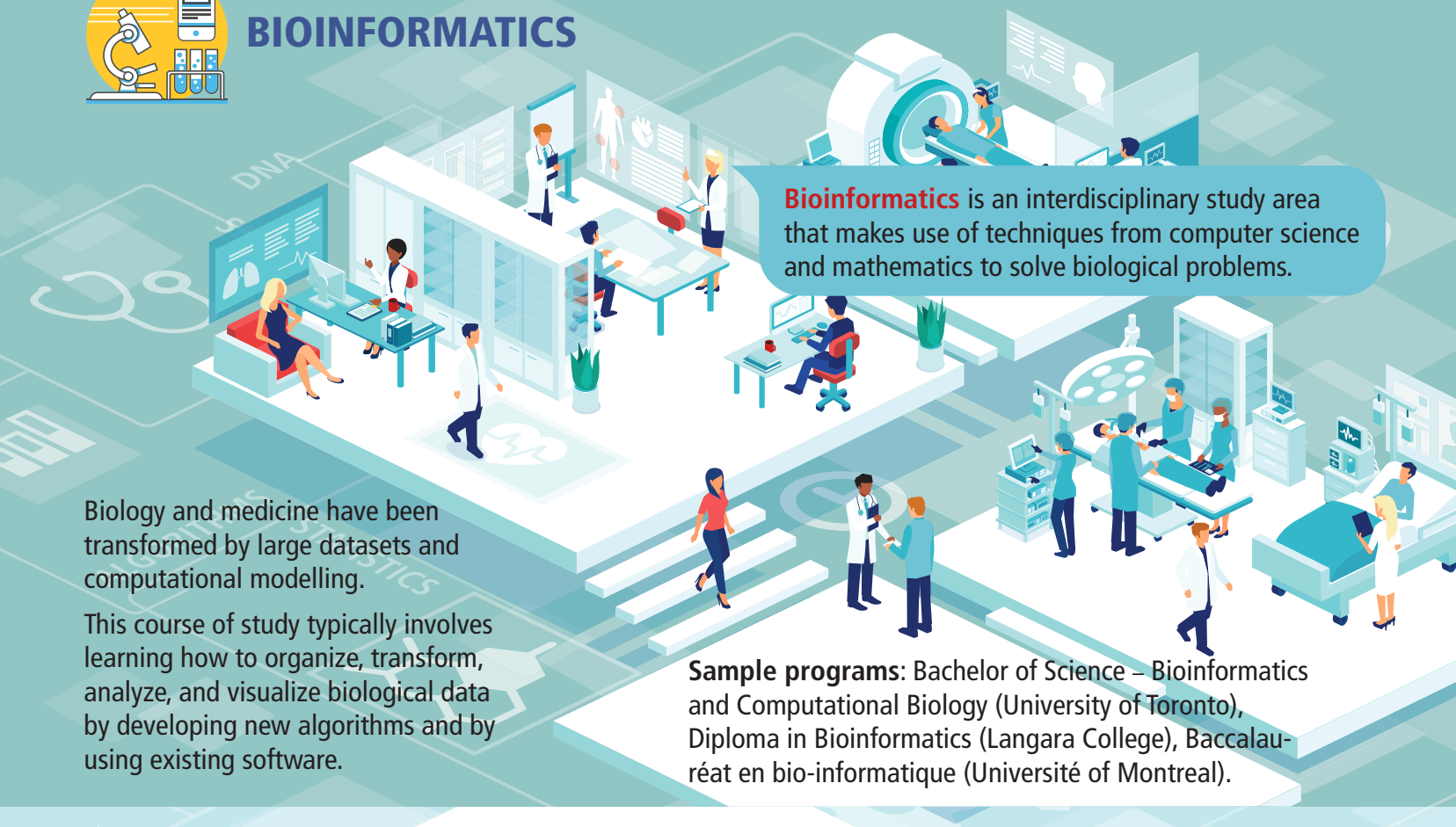
Not every computing program that you find in a college or university will have one of these seven ACM discipline titles. For example, there are undergraduate degrees in Game Design, Artificial Intelligence, and Network Technology. Many universities also offer mixed majors that combine computing with a variety of other disciplines, including Computational Science, BioInformatics, Computational Arts, and Computer Ethics.

One-year certificates, two-year diplomas, and three-year applied or associate degrees provide dozens of other options, either as stand-alone training or post-degree specialization. These programs often use a variety of titles which don't always map to the seven ACM discipline areas.

The next several pages provide more information about four popular specializations; this isn't an exhaustive list but hopefully provides some inspiration if the seven ACM disciplines covered in the previous pages don't match your precise career goals.



BIOINFORMATICS



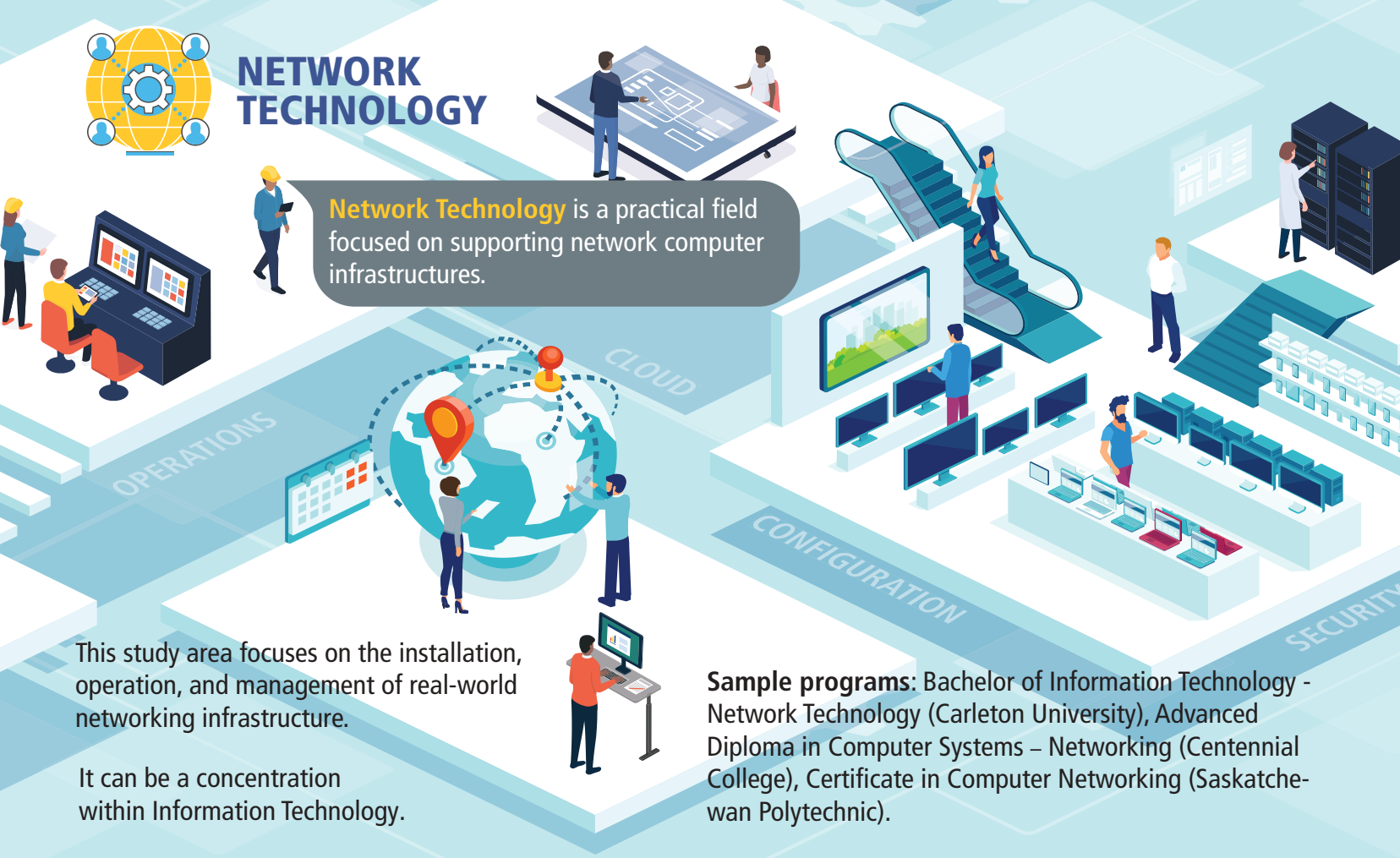
Bioinformatics is an interdisciplinary study area that makes use of techniques from computer science and mathematics to solve biological problems.

Biology and medicine have been transformed by large datasets and computational modelling.

This course of study typically involves learning how to organize, transform, analyze, and visualize biological data by developing new algorithms and by using existing software.

Sample programs: Bachelor of Science – Bioinformatics and Computational Biology (University of Toronto), Diploma in Bioinformatics (Langara College), Baccalauréat en bio-informatique (Université of Montreal).

NETWORK TECHNOLOGY



Network Technology is a practical field focused on supporting network computer infrastructures.

This study area focuses on the installation, operation, and management of real-world networking infrastructure.

It can be a concentration within Information Technology.

Sample programs: Bachelor of Information Technology - Network Technology (Carleton University), Advanced Diploma in Computer Systems – Networking (Centennial College), Certificate in Computer Networking (Saskatchewan Polytechnic).

GAME DEVELOPMENT

Game Development focuses on the unique programming and design tasks involved in creating video games.

It can be a concentration within Computer Science ...

... or it can be a dedicated program that covers not just programming, but also design, interaction, 3D, animation, graphic formats, and testing.

Sample programs: Bachelor of Fine Arts in Game Design & Development (Wilfrid Laurier University), Advanced Diploma in Game Development (Niagara College), Graduate Certificate in Game Development (Fanshawe College).

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

These programs typically focus on applying AI models and ML algorithms to practical applications such as natural language processing, image processing, computer vision and business decision making.

This speciality often assumes the student has already-existing programming, mathematics, and statistics knowledge.

Sample programs: Bachelor of Computer Science, Artificial Intelligence and Machine Learning (Carleton University), Post-Baccalaureate Diploma, Artificial Intelligence and Machine Learning Applications (Nipissing University), Artificial Intelligence Post-Diploma Certificate (Keyano College).

COMPUTING + *X*

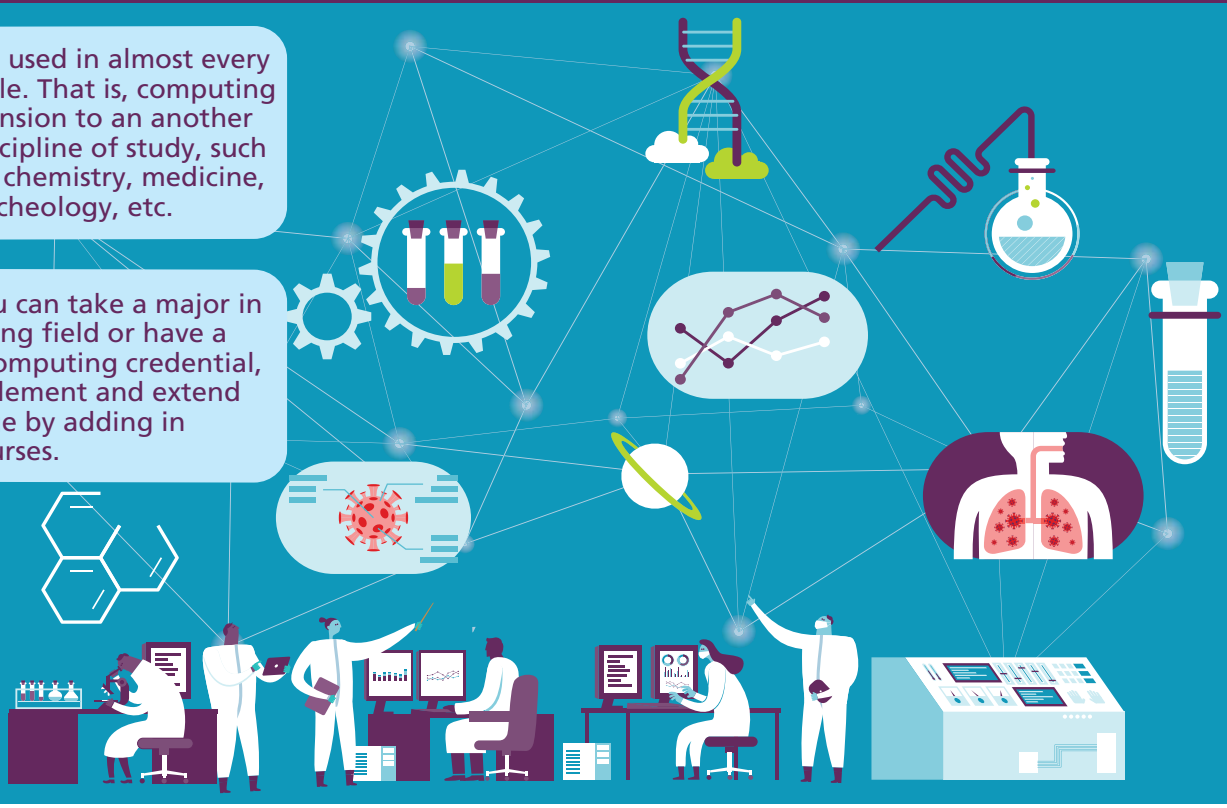
More and more computer educators have recognized that the field of computing can be enhanced by supplementing its knowledge base with other disciplines' knowledge.

This means adding a set of courses from another discipline—such as linguistics, art, physiology, music, law, or the humanities—to one of the existing computing disciplines, will expand your future possibilities.

X + COMPUTING

Computers are used in almost every field imaginable. That is, computing can be an extension to an another established discipline of study, such as accounting, chemistry, medicine, psychology, archeology, etc.

This means you can take a major in a non-computing field or have a existing non-computing credential, and then supplement and extend that knowledge by adding in computing courses.

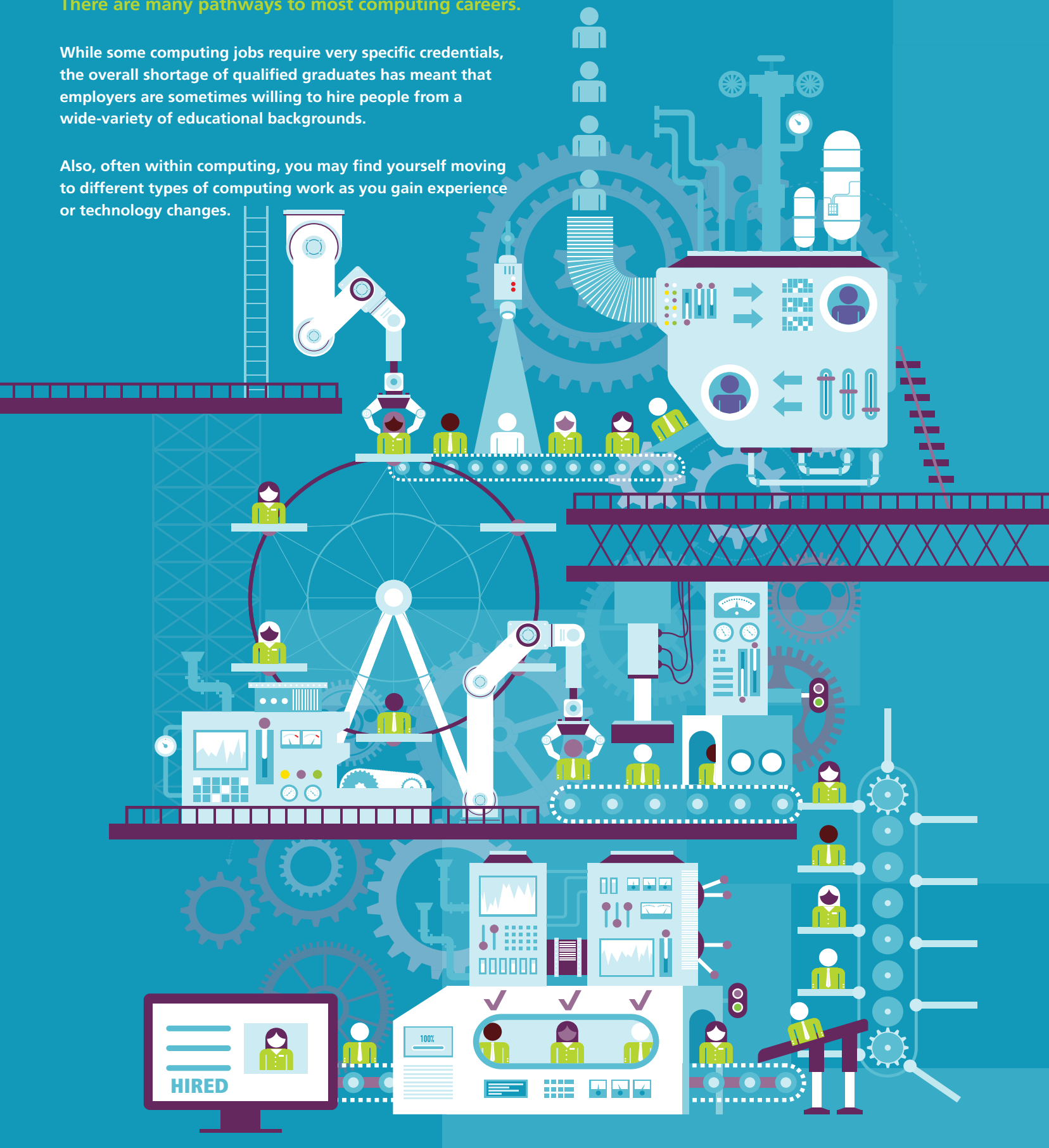


CAREER PATHWAYS

There are many pathways to most computing careers.

While some computing jobs require very specific credentials, the overall shortage of qualified graduates has meant that employers are sometimes willing to hire people from a wide-variety of educational backgrounds.

Also, often within computing, you may find yourself moving to different types of computing work as you gain experience or technology changes.



SAMPLE CAREER PATHWAYS

Here are some hypothetical examples of the different pathways that different people might take in order to arrive at the same specific job.

These are only examples. One of the amazing (but confusing) aspects of computing is the wide variety of paths to any given job!

STUDY PATHWAYS

WORK PATHWAYS

GAME DEVELOPER

BA English → Code Camp → Online Courses → University Certificate (Game Design) → College Diploma (Computing)

CS Degree → Post-Graduate Certificate

CS Degree

Senior Developer ← Front-End Developer ← Junior Programmer ← Computing Diploma

Quality Assurance Engineer ← Post-Graduate Certificate ← Usability Tester ← QA Intern ← SE Degree

CLOUD SECURITY ANALYST

High School → Online Courses → College Diploma (Computing) → Networking Certification → Security Certification

Computer Technology Diploma → Security Certification

Cybersecurity Degree

Security Certification ← Network Administrator ← Networking Certification ← Computer Administrator ← Help Desk Technician ← High School

Cloud Administrator ← Network Architect ← Network Analyst ← Support Specialist ← IT Degree

MACHINE LEARNING SPECIALIST

Engineering Diploma → Data Analytics Certification → University Certificate (Machine Learning)

IS Degree → Statistics Online Course

Data Science Degree

Recommendation Engine Specialist ← Web Architect ← Web Developer ← CS Degree

Data Science Certificate ← Web Analytics Specialist ← Web Content Marketer ← Business Diploma

For new technological areas within computing, precise educational pathways often don't exist yet or are only newly emerging.

The value of a general computing credential in one of the ACM disciplines is that they prepare their graduates to learn these new areas when they eventually emerge.

ALUMNI STORIES

"Ok, this does sound interesting ... but what do graduates really think about their studies, their work, and computing in general?"

The next two pages provide a small sampling of some stories and experiences from real computing graduates across the country. There are of course as many different stories as there are graduates, but we hope this selection of quotes gives you another picture of what a computing career can look like.

Shira Eisen
Bachelor Computer Science, Masters Biotechnology
Consider something you're passionate about outside of tech, be it healthcare, finance, supply chain, fashion, outer space - anything! - and look for work where these two worlds meet.

If you can combine your technical skills with a field you love, or even one you're eager to learn more about, you might find a career that feels less like "work" and more like something that can be a fulfilling part of your life.

Jay Gandhi
Bachelor in Management Information Systems
When you first start out, instead of becoming a specialist I would recommend becoming a generalist to get a wide breadth of exposure and experience to continue learning in all facets.

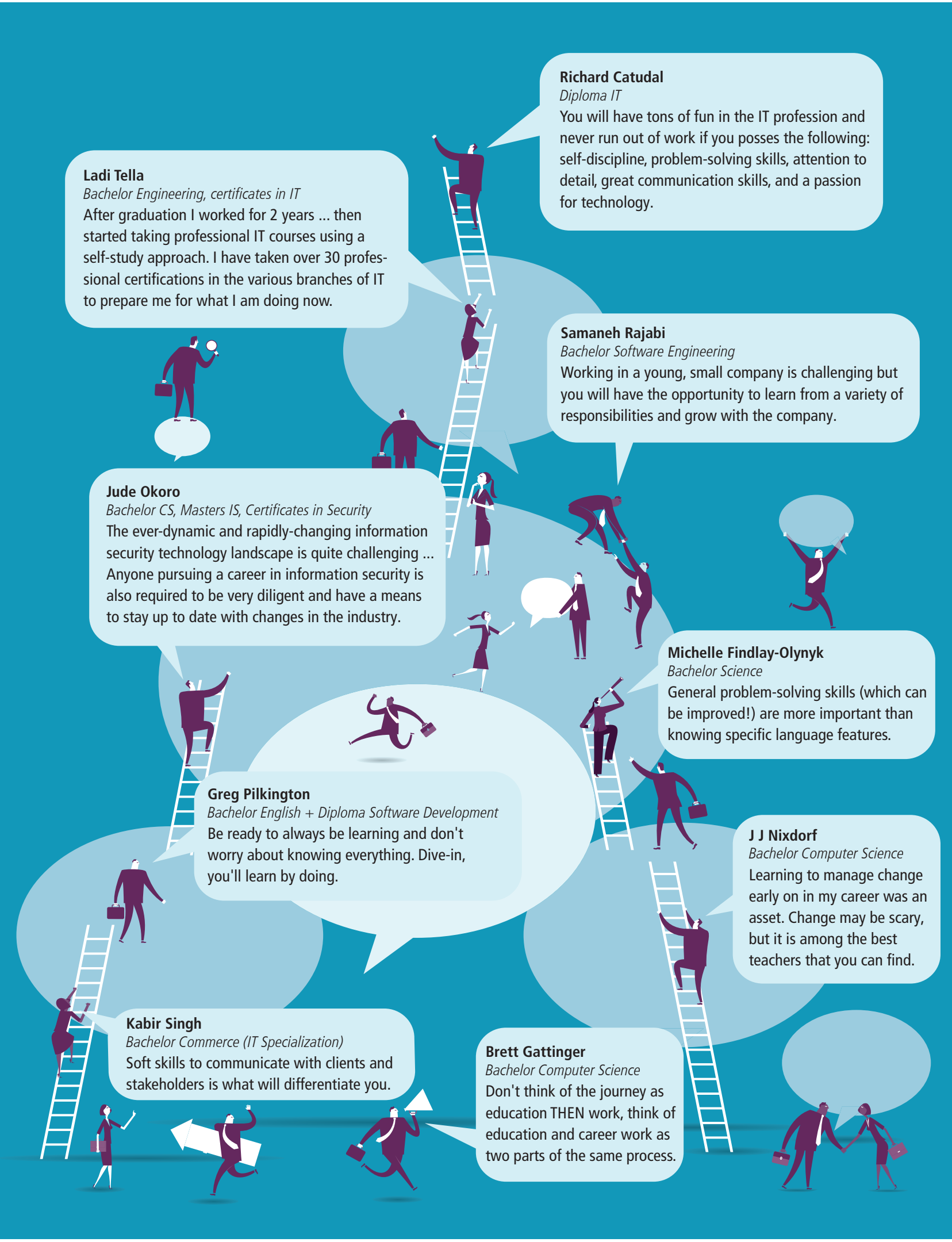
Scott Watmough
Bachelor English + Diploma Networked Systems
The reality is that I interact with coworkers and clients for about 60 - 80% of my day, and almost every other person in my industry does as well. Taking the time to develop a bit of social skills is just as valuable as being able to code, or build a computer.

Chinomso Uzoka
Bachelor Information Technology, Masters Computer Science
High school students looking to enter the field of technology should keep an open mind and always have the willingness to learn. Where you start might not be always where you will end up.

Daniel Nwaroh
Bachelor Computer Science
Be a sponge wherever you are. Always be open to learning new things and when possible, look to step out of your comfort zone.

Pranay Patel
Bachelor in Computer Information Systems
Building a strong and long-lasting career is a process. It is full of setbacks, challenges, and changes. For a successful career, you will need a positive attitude, willingness to learn, adaptability to change, and most importantly patience.

Aida E
Bachelor Computer Engineering
Be patient, work on your problem-solving skills; don't be afraid of failure; be curious and search about anything that is new to you, don't be afraid of not knowing something.


Richard Catudal
Diploma IT
You will have tons of fun in the IT profession and never run out of work if you posses the following: self-discipline, problem-solving skills, attention to detail, great communication skills, and a passion for technology.
Ladi Tella
Bachelor Engineering, certificates in IT
After graduation I worked for 2 years ... then started taking professional IT courses using a self-study approach. I have taken over 30 professional certifications in the various branches of IT to prepare me for what I am doing now.
Samaneh Rajabi
Bachelor Software Engineering
Working in a young, small company is challenging but you will have the opportunity to learn from a variety of responsibilities and grow with the company.
Jude Okoro
Bachelor CS, Masters IS, Certificates in Security
The ever-dynamic and rapidly-changing information security technology landscape is quite challenging ... Anyone pursuing a career in information security is also required to be very diligent and have a means to stay up to date with changes in the industry.
Michelle Findlay-Olynyk
Bachelor Science
General problem-solving skills (which can be improved!) are more important than knowing specific language features.
Greg Pilkington
Bachelor English + Diploma Software Development
Be ready to always be learning and don't worry about knowing everything. Dive-in, you'll learn by doing.
J J Nixdorf
Bachelor Computer Science
Learning to manage change early on in my career was an asset. Change may be scary, but it is among the best teachers that you can find.
Kabir Singh
Bachelor Commerce (IT Specialization)
Soft skills to communicate with clients and stakeholders is what will differentiate you.
Brett Gattinger
Bachelor Computer Science
Don't think of the journey as education THEN work, think of education and career work as two parts of the same process.

RELATING JOB TITLES TO THE ACM COMPUTING DISCIPLINES

The following table provides examples of how some sample job titles relate to the seven ACM disciplines, and shows where additional training may be needed.

As you can see, there is a lot of overlap. One of the amazing things about the computing industry is that over one's career, one can potentially have a variety of different jobs.

	Computing Discipline							
Job Title	 **CE**	 **CS**	 **CY**	 **DS**	 **IS**	 **IT**	 **SE**	**Possible Additional Training**
AI Ethics Consultant		☆	☆	☆	☆			Philosophy
Business System Analyst					☆		☆	Business/Commerce
Business Intelligence Analyst				☆	☆			
Cloud Security Architect			☆			☆		
Computational Scientist		☆		☆				Mathematics, Sciences
Computer Network Support Specialist	☆		☆			☆		CISA, CISSP
Cybersecurity Consultant			☆			☆		
Database Administrator				☆	☆	☆		
Data Scientist		☆		☆				Statistics
Gaming & Multimedia Specialist		☆					☆	Graphic Design, Creative Writing
Hardware Engineer	☆							Electrical/Electronic Engineering
Incident Responder			☆			☆		Certified Incident Handler
Information Security Analyst			☆		☆	☆		
IT/IS Consultant		☆			☆	☆	☆	
Machine Learning Analyst		☆		☆				
Medical Computing / Bioinformatics		☆	☆					Biology, Health Sciences, Statistics
Network Security Administrator			☆			☆		CompTIA Network+, CCNA
Network Engineer	☆					☆		
Project Manager	☆	☆	☆	☆	☆	☆	☆	
Quality Assurance Specialist	☆	☆			☆	☆	☆	
Robotics Engineer	☆	☆				☆		
Software Developer	☆	☆	☆	☆	☆	☆	☆	
Systems Analyst and Designer	☆				☆		☆	
Web Developer / Designer		☆		☆	☆	☆	☆	Graphic Design

RESOURCES

For more occupational information, consider these free Canadian resources.

Canada – explore careers, wages, etc:
www.jobbank.gc.ca/trend-analysis
www.guichetemplois.gc.ca/analyse-tendances (french)

Canadian Occupational Projection System:
occupations.esdc.gc.ca/sppc-cops

Simply Hired (Canada)
www.simplyhired.ca
fr.simplyhired.ca (french)

Working in Canada:
www.workingincanada.gc.ca/home-eng.do
www.guichetemplois.gc.ca/accueil-fra.do (french)

Ontario – Job Profiles:
www.ontario.ca/page/labour-market
www.ontario.ca/fr/page/marche-du-travail (french)

Québec – Exploring Trades and Occupations
www.quebec.ca/en/employment/trades-occupations/exploring-trades-occupations
www.quebec.ca/emploi/metiers-et-professions/decouvrir-des-metiers-et-des-professions (french)

Alberta – Occupational Information:
www.alis.gov.ab.ca/occinfo

British Columbia: Work BC
www.workbc.ca/Jobs-Careers/Explore-Careers.aspx

Manitoba – Career Development:
www.manitobacareerdevelopment.ca

New Brunswick – Explore Careers:
www.nbjobs.ca/explore

Newfoundland and Labrador:
www.gov.nl.ca/labourmarketinformation

Nova Scotia – Explore Careers:
explorecareers.novascotia.ca

PEI – Career Development:
www.cdspei.ca

Saskatchewan – Jobs, Working, Training:
https://www.saskatchewan.ca/residents/jobs-working-and-training

Yukon – Explore careers:
yukonworkfutures.gov.yk.ca

For additional information about computing education and careers, consider these additional sites.

The Information and Communications Technology Council (ICTC):
www.ictc-ctic.ca

Canada's Assocaition of IT Professionals (CIPS):
www.cips.ca

Information Technology Association of Canada:
www.itac.ca

CS-CAN / Info-Can
cscan-infocan.ca

Association for Computing Machinery (ACM):
www.acm.org

IEEE Computer Society
computer.org

ACM Computing Curricula Recommendations:
www.acm.org/education/curricula-recommendations

Careers in Computing:
www.computerscienceonline.org

Computer Occupations (US Bureau of Labor):
www.bls.gov/ooh/computer-and-information-technology/home.htm

Association for Women in Computing:
www.awc-hq.org

To download a free copy of this guide in English or French, go to:
ceric.ca/computing

To view additional content for this handbook, which includes additional interviews, links, and references, visit:
computingcareers.ca

COMPUTING CAREERS & DISCIPLINES

A QUICK GUIDE FOR PROSPECTIVE STUDENTS AND CAREER ADVISORS

Why should you consider computing when choosing a career?

What kind of computing jobs are out there?

What kind of education pathways will guide you to the computing career you desire?

This guide provides answers to these questions!

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