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Strategic Directions in Computing Education and Research

The pace of change in computing technology continues to rapidly increase. For example, estimates of the number of digital devices connected worldwide in the Internet of Things are on the order of 8 billion in 2017, and projected to reach 20 billion by 2020. Virtually every enterprise or operation is digital, including such things as online businesses, health care systems, self-driving cars, drones, sensor networks, government systems, power grids, social networks, industrial processes, or supply chains. The term digital ecosystem refers to the environment and context in which a viable enterprise functions.

Within a digital ecosystem there are numerous computing topic areas that are of importance. Some of the established topic areas of continued importance include database management, networks, programming languages, software engineering, and operating systems. There are topic areas that do have established history, but are also rapidly adapting and emerging. The three most prominent ones are Cybersecurity, Data Science, and Artificial Intelligence. Within computing education within the NDUS, it is of special importance to continuously improve, adapt and explicitly include leading edge treatment of these three topic areas that are expanding very rapidly in importance. In current faculty recruiting in the U. S. Cybersecurity is the most sought after expertise, with Data Science second, and Artificial Intelligence third. We describe here some strategic directions in education for these three areas.

CYBERSECURITY. There is great need in North Dakota and beyond for research advances, learned educators, and workforce development and training in Cybersecurity. No system that we rely upon in our digital ecosystems to conduct our working and personal lives is immune from cyber security concerns. The core principles of cyber security are confidentiality, integrity, and availability. The dollar costs and human costs of lapses in the protection of such systems are enormous. Into the future, the need for Cybersecurity professionals is rapidly growing. Cyber-attacks and digital spying can take many forms, including high visibility and very damaging offenses such as data breaches, phishing, and identity theft. Attacks can take place within databases, while data is processed, or when it is transmitted across networks. In the world of today, cyber-attacks may be a greater threat than physical terrorism. A graduate certificate program in cybersecurity has been established with cooperative delivery by NDSU, UND, and Minot State. An undergraduate option was recently established at NDSU. A proposal to establish a Cybersecurity Consortium in North Dakota is being developed and a national Center for Academic Excellence (CAE) is being proposed.

DATA SCIENCE. Nearly every digital ecosystem involves the active collecting, processing, and storing of data that is often large in scale. Often data arrives at high velocity as well as large volume. For intrusion detection purposes, particularly large data sets must be processed to identify patterns that reveal malevolent intent. Networks of sensors generate huge volumes of data in applications like the Smart Grid. Data science concerns statistical and data mining methods aimed at extracting knowledge from such data. Social networks such as Facebook and Twitter use customized nonstandard data representation methods to process their huge

volumes of data. Empirical work of this kind is sometimes referred to as the “fourth paradigm” of modern science.

ARTIFICIAL INTELLIGENCE. Advances in Artificial Intelligence (AI) in the last few years are making it possible for machines to carry out tasks like learning, seeing, talking, socializing, reasoning, and problem solving. Self-driving cars will rely upon AI to make moral decisions in the face of an impending accident. AI systems are already determining if an individual will get credit, get a correct diagnosis in medicine, or be given a particularly sentence by a judge. Deep learning is a recent advance in AI that makes many of these kinds of things possible. AI systems will systematically and rapidly alter the types of jobs that are available to people in the computing sciences.