Transcript of 2021 3MT® presentation by Valerie Bauman, MASc Engineering & Artificial Intelligence candidate at the University of Guelph

What's the first thing that pops in your head when you hear the words artificial intelligence? Maybe you think of self-driving cars or robots taking over the world. But today, I am going to challenge you to open your mind to how humans and machines can work together to improve our quality of health. More specifically, how artificial intelligence can assist adults relearning how to walk, including those individuals recovering from a stroke.

Physical therapy is one approach that can be taken to relearn how to walk. This approach involves a trained individual guiding the person's leg as they walk to instill good walking patterns in the patient.

A more recent technique is use of powered lower limb exoskeletons, like the one shown on the right that actively apply forces to the leg as the person moves. So, the idea is that the person wears the exoskeleton, and the exoskeleton provides forces to the person's leg as they are walking, just like a physiotherapist would. In order for our exoskeleton to provide adequate support, it has to know what motion the user is doing at any given time. Why does the exoskeleton need to know this? Well, think about how our legs move when you're walking upstairs compared to when you're walking on flat ground. When you walk upstairs, your knees bend more to make you clear the step ahead of you. Because your legs move differently depending on what motion you're doing, your exoskeleton needs to know what you're doing so it can provide appropriate support.

My research involves using artificial intelligence algorithms to detect what motion as well what phase of the motion the user is in for walking, going upstairs, and going downstairs. So, for example, not only does my algorithm know the user is walking, but also that the user's leg is in the air during walking. Inputs to the algorithm are sensor readings from two sensors placed on the leg, as seen in the picture on the left. These sensors measure speeds and accelerations of the segment they are attached to. So far in literature, motion and phase recognition has been done for level-ground walking. Based on this, I am using existing algorithms that were successful for walking as a starting point for my algorithms that were recognized walking, going upstairs, and going downstairs.

To be successful, my algorithms need to be able to recognize these different motions and their phases. To do this, I first recruited 80 volunteers to walk, go upstairs, and go downstairs while wearing the sensor shown on the left, as well as additional pressure pads beneath the foot. Just like how a person studies for a test by doing homework problems and checking their answers, the homework problems from my algorithms are the information coming from the sensors on the legs, and the answers are the information coming from the pads beneath the foot.

Once the algorithm has seen enough leg sensor readings paired with footpad readings, it can see brand new leg sensor readings and recognize what motion and phase the person is performing. At this stage, the algorithm and leg sensors can be integrated into an exoskeleton and used by someone relearning how to walk. The addition of stair walking to an exoskeleton's controller will improve its functionality and better assist those relearning how to walk.

So, while there maybe are mixed feelings about how artificial intelligence has been integrated in our lives, I hope hearing about my research today gives you an idea of how humans and machines can work together to improve life.

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