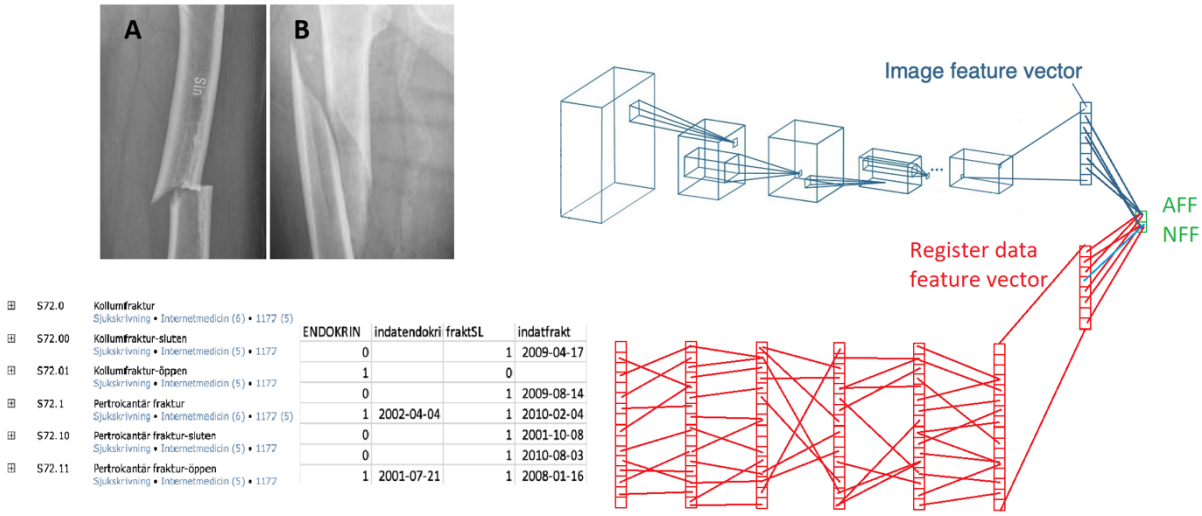
Combining register data and x-ray images for a precision medicine prediction model of thigh bone fractures

Background

Drugs commonly used in the treatment of osteoporosis (bisphosphonates) inhibit cell function of one specific cell type in bone, leading to increased bone mass and reduced fracture risk. This treatment has been used successfully for decades. Long-term inhibition of these bone-specific cells has recently been shown to cause bone material insufficiency, leading to spontaneous stress fractures in the thigh bone – Atypical Femoral Fractures (AFF). These fractures show features on x-ray images that differentiate them from Normal Femur Fractures (NFF). However, these features are very subtle and can easily be overlooked if not specifically sought for (Figure 1). The detection rate of AFF on clinical plain radiographs is <7%, and reports of drug adverse reactions to the Swedish Drug Agency have an even lower detection rate. While these events are rare compared to fractures that can be prevented, they are of clinical concern and have resulted in decreased use of these medications. As these events are so rare, standard statistical models have failed to identify reliable risk factors that would allow a precision medicine approach to identifying which patients to treat and for how long.



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⊞	S72.0	Kollumfraktur Sjukskrivning • Internetmedicin (6) • 1177 (5)				
⊞	S72.00	Kollumfraktur-sluten Sjukskrivning • Internetmedicin (5) • 1177	0		1	2009-04-17
⊞	S72.01	Kollumfraktur-öppen Sjukskrivning • Internetmedicin (5) • 1177	1		0	
⊞	S72.1	Pertrokantär fraktur Sjukskrivning • Internetmedicin (6) • 1177 (5)	0		1	2009-08-14
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⊞	S72.11	Pertrokantär fraktur-öppen Sjukskrivning • Internetmedicin (5) • 1177	0		1	2001-10-08
			0		1	2010-08-03
			1	2001-07-21	1	2008-01-16

Figure 1. Combining x-ray images (top left) and register data (bottom left) can lead to a higher classification accuracy of atypical femur fractures (AFF, image A) and normal femur fractures (NFF, image B), compared to only using x-ray images. Since these types of data are very different, it is not clear how to best combine them in a neural network.

Objectives

Implement a 2D CNN for classification of AFF and NFF, how high classification accuracy can be obtained using only images?

Implement an ANN for classification of AFF and NFF, how high classification accuracy can be obtained using only register data?

Implement a network for classification of AFF and NFF that combines images and register data, is the classification accuracy higher compared to using one type of data? Is the uncertainty of each classification lower when combining two types of data? What is the best way to combine the two data types?

Data

X-ray images from 172 patients with AFF, and X-ray images from 4000 patients with NFF.

Register data from the same patients, several hundred variables per patient.

Required background

Machine learning, deep learning, Python programming

Computing resources

The student will have access to very good computing resources (graphics cards) for deep learning.

Contact persons

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