Scoliosis, is a pathological curvature of the spine affecting a few percent of the population. The curvature tends to develop throughout growth. Therefore regular monitoring is important to make sure the disease doesn’t cause health problems. For years, the gold-standard approach to this has been   
X-raying the back, and measuring the Cobb angle, the greatest angle between the end-plates of any two vertebrae. As you might expect, regularly X-raying adolescents creates health risks. This has motivated research into spatially tracked ultrasound as a means to quantify the disease.

A number of preliminary studies have been done to assess the accuracy and validity of using tracked ultrasound. They consist of finding, and placing points at anatomic landmarks like the transverse processes, shown on my slide. Curvatures are computed from these points’ locations, and compared to the gold-standard X-ray measurement. Regardless of whether these studies have been done on phantom models, or living patients, I suspect that their landmark data is somewhat idealized, like my left picture.

I am only aware of validation work done on mild to moderate cases of scoliosis, Cobb angles mostly up to 45o. There are also idealizations associated with using phantom models, and wide-range transducer setups. Some of these authors themselves acknowledge being unable to locate anatomic landmarks in a few places. Apparently, a quantification method for working with a scope including imperfect data, and cases worse than 45o or with other complications is needed.

I claim that a method using neural networks can be developed addressing this need. Neural networks are known for their robustness and accuracy, indispensable virtues in clinical settings. I have 124 sets of scoliotic patients’ transverse processes locations from CT-derived models, ranging from mild to severe. The accuracy of CT makes this a natural ground-truth from which to extract the correct curvature. I will then programmatically degrade the data, introducing errors expected in ultrasound: noise, missing points, and misplaced points. A pre-processing module will be developed to repair the data sets so they can be used to train a neural network.

After being trained on the basis of the difference between the network’s output and the correct angle, the network can be similarly evaluated. The average curvature estimate error in degrees, and other statistics, will be collected for various experimental setups. I will vary the amounts of input data error, use different training set sizes, networks architectures and functionalities, and so on. With the results of these planned experiments, I hope to demonstrate that the method produces curvature estimates comparable to those of current studies, and within clinically acceptable limits of error, including for these difficult cases.