DS-GA 3001 Project Proposal ---- In-depth Literature Review on Deep Kalman Filter (Krishman, Shalit & Sontag 2015)

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I. Question

How does the deep kalman filter work? Particularly, in what way does it improve the efficacy of temporal generative models for counterfactual inference?

II. Data

In the project we start with the MNIST dataset. The dataset consists of handwritten digit images and it is divided in 60,000 examples for the training set and 10,000 examples for testing.
See below some examples of MNIST digits:

Then we will add noise to each data in the dataset. Also, we will rotate each picture to form a sequence of 5 rotated digits in order to introduce temporal dependency. Each sequence represents a patient's situation through time and the rotations represent the treatment we choose for the patient. The new dataset is also called healing MNIST.

III. Algorithm

Krishman et al. aimed to fit a generative model in order to detect the effects of external intervention on latent states. Due to the non-linear model assumption and the number of dimensions, the posterior distribution of latent states is generally intractable. To contrast the deep Kalman filter with traditional Kalman filter we learned in class, we plan to set the traditional Kalman filter as the baseline model and compare its performance with deep Kalman filter.

To learn the parameters of deep Kalman filters, we plan to apply EM algorithm following the ideas in the paper, by which we perform inference and parameter learning at the same time. To approximate posterior parameters, Krishman et al. presented four different implementations of variational autoencoder. We plan to compare the performance of models parametrized by multi-layer perceptrons as well as RNN based on the rotated and healing MNIST data set.

IV. Evaluation

We are going to follow the path of the author to first verify whether our reimplemented model can achieve similar results. Most importantly, can the model correctly respond to the actions we send as input and result desired result. We will also examine whether the log likelihood is a good and only feasible evaluation to the variational autoencoder.

V. Distribution of tasks

Introduction ---- Yuan Ding
Related work ---- Together
Traditional Kalman Filter implementation and write-up ---- Yuan Ding
Deep Kalman Filter with MLP (multi-layer perceptron) implementation and write-up ---- Mufeng Gao
Deep Kalman Filter with RNN implementation and write-up ---- Mu Li