**The joint estimation of diagnostic test kinetics from observational data**

**Introduction**

The kinetics of diagnostic tests such as antibodies are of relevance for calibrating cut-off values, and calculating sero-incidence. They can also be used to hindcast epidemic trends.

Traditionally, kinetics are estimated via either experimental infection studies or multiple testing of naturally infected individuals. Experimental infection studies are expensive, only ethical in animals, and can require access to facilities with high biosafety level ratings. Observational follow up studies can only measure individuals after they have been tested, which means that they lack test measurements during the incubation period.

In this chapter, we investigate the potential of increasing precision in observational kinetics studies by incorporating multiple tests measures different aspects of the disease process, and prior information on likely times of infection in the form of population level epidemic trends. We base our example on a paper of Simonsen etal [ref], first replicating their results, and then investigating potential performance gains.

The paper will be structured as follows:

First, we will describe the statistical framework used. We will then implement a version of the model described in Simonsen etal, on individuals tested at several time points using only one type of diagnostic test, evaluating the precision attained when estimating kinetic curves.

We will then modify this model in a series of steps: First, by adding a second diagnostic test acting on a different timescale, demonstrating how the precision improves. Second, by incorporating an unknown incubation time before the first sample, reflecting likely real world limitations in collected sample data.

Third, by letting the distribution of infection times follow a non-stable epidemic trend, incorporating information on this trend in the model, and demonstrating that it is still possible to recover kinetic trends if jointly modeling two or more different tests.

**Statistical framework**

**Replicating the Simonsen model**

**Improved performance with two different tests**

**Incorporating incubation time**

**Incorporating a non-stable epidemic trend**

**Discussion**