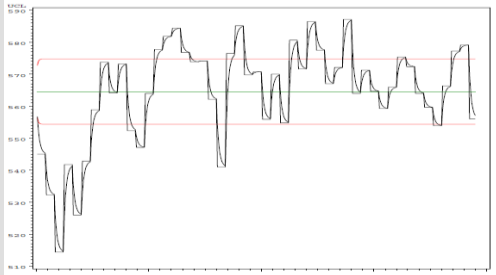
Faculty of Agricultural and Nutritional Science

Christian-Albrechts-University, Kiel
Institute of Animal Breeding and Husbrandy

Detection of mastitis and lameness in dairy cows using wavelet analysis



Bettina Miekley, Imke Traulsen, Joachim Krieter

Institute of Animal Breeding and Husbandry
Christian-Albrechts-University of Kiel

62nd Annual EAAP Meeting Stavanger, Norway
29th August to 2nd September 2011
Session 43

Introduction

- Mastitis and lamess most frequent and costly diseases
- Several studies of health monitoring (Cavero et al., 2008; Lukas et al., 2009; Pastell et al., 2009)
- Transfer problems to practice
  → High error rates
  → High amount of false positive cows per day
- Wavelet filtering effective tool in industrial production system
  →Enhance methods of statistical process control
- **Aim of the study:** Applicability of wavelet filtering combined with CUSUM charts for an early disease detection

Data

- Data:
  - Research farm Karkendamm, University of Kiel
  - Observation period: January 2009 until October 2010
  - 237 cows in their first 200 days in milk

- Traits:
  - Daily milk electrical conductivity:
    reference units (n=44.837)
  - Somatic cell count (SCC): cells/ml (n=6.396)
  - Average pedometer activity per day (n=46.422)
  - Mastitis and lameness treatments

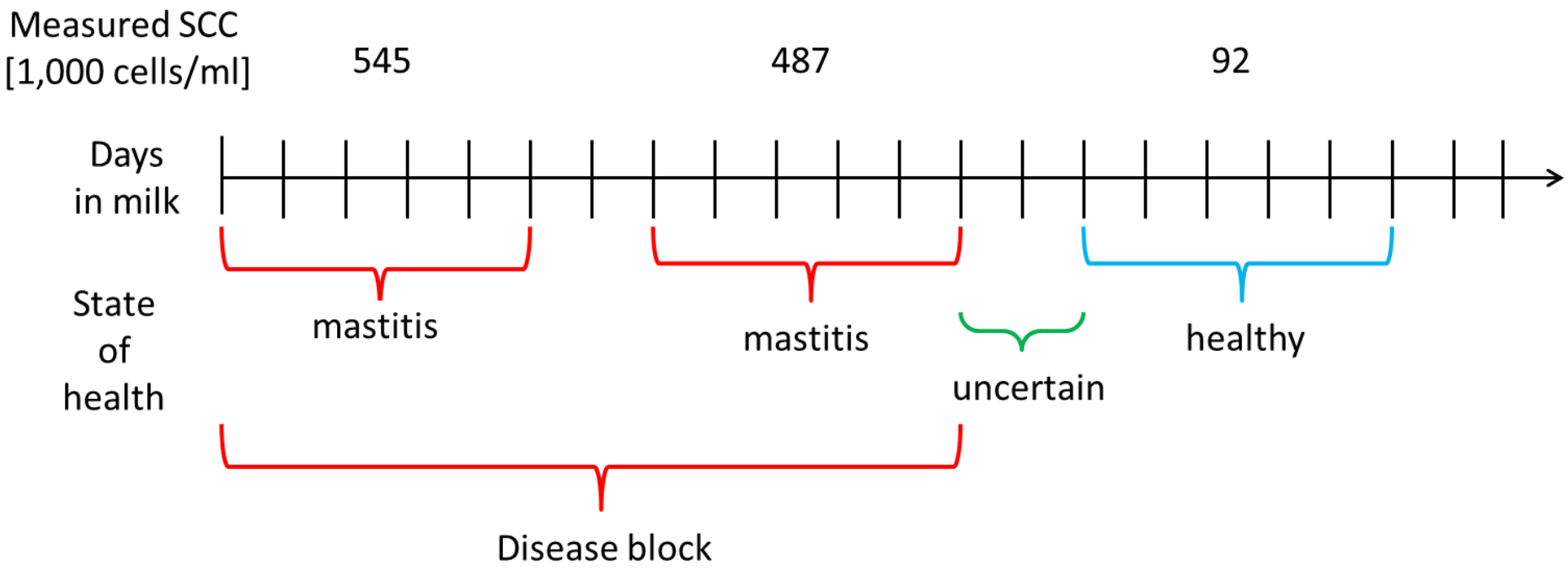
Definition of disease: Mastitis

- Three mastitis definitions (Cavero et al., 2008):

1. Treatment (+ 2 days before)
2. Treatment + 400: Treatment and/or SCC > 400.000/ml (+ 2 days before and after SCC measurement)
3. Treatment + 100: Treatment and/or SCC > 100.000/ml (+ 2 days before and after SCC measurement)

- Development of disease blocks= uninterrupted sequence of days of disease

Definition of disease: Mastitis



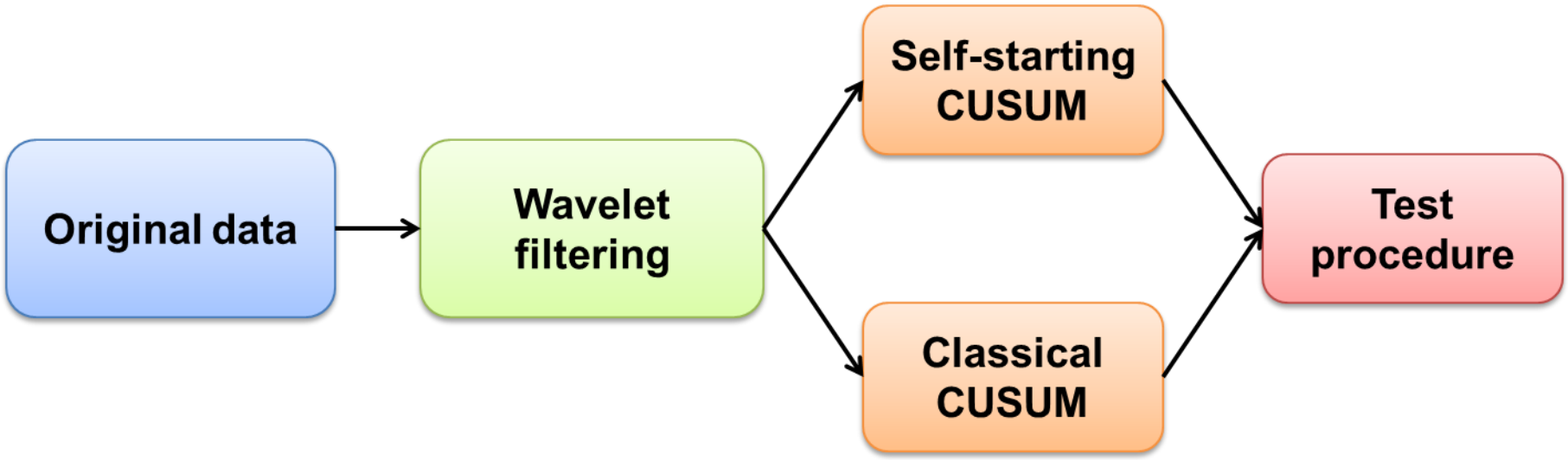
Definition of disease: Lameness

- Two lameness definitions (Kramer et al., 2009):

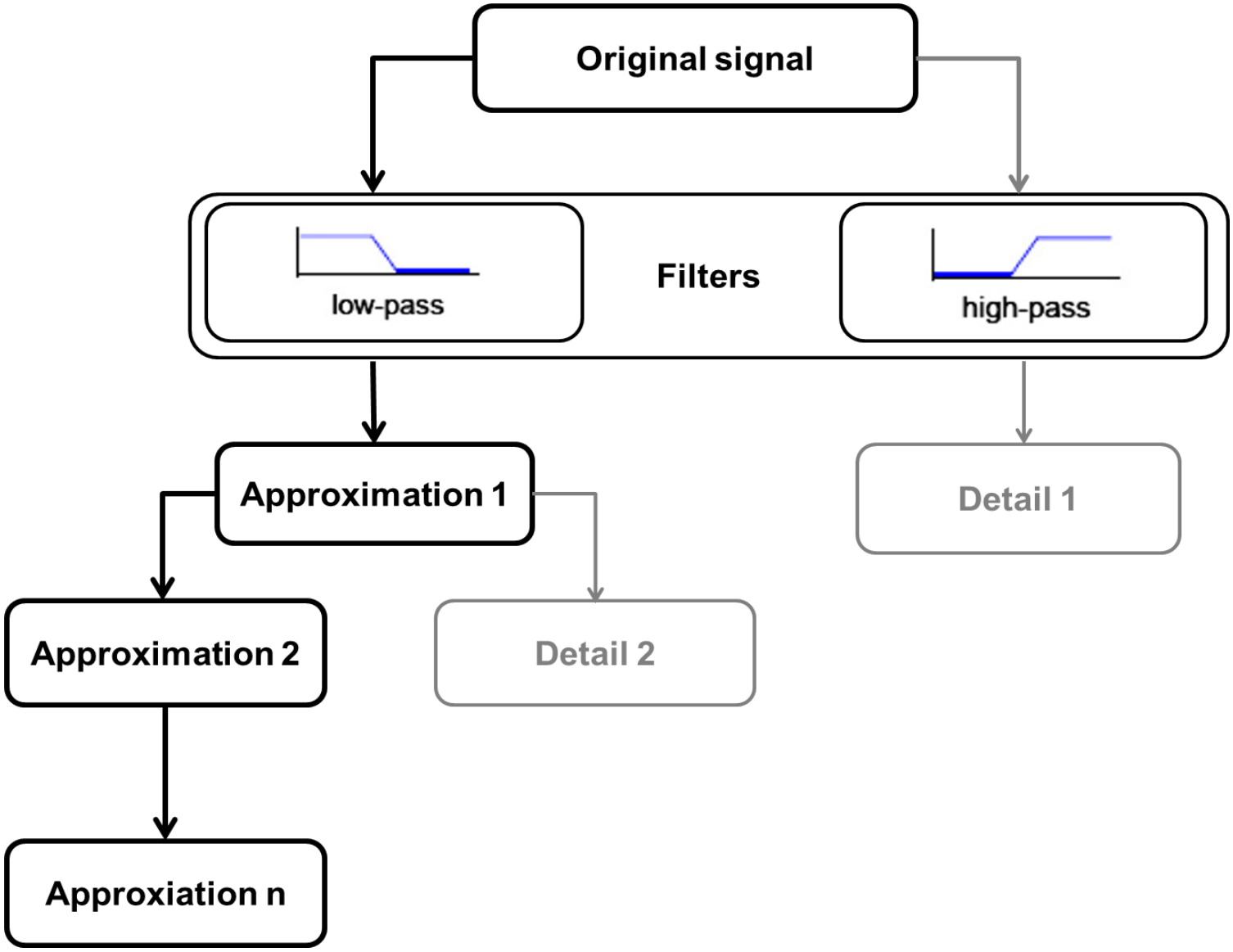
1. Treatment + 3: Day of treatment plus three days before
2. Treatment + 5: Day of treatment plus five days before

- Development of blocks analogue to mastitis

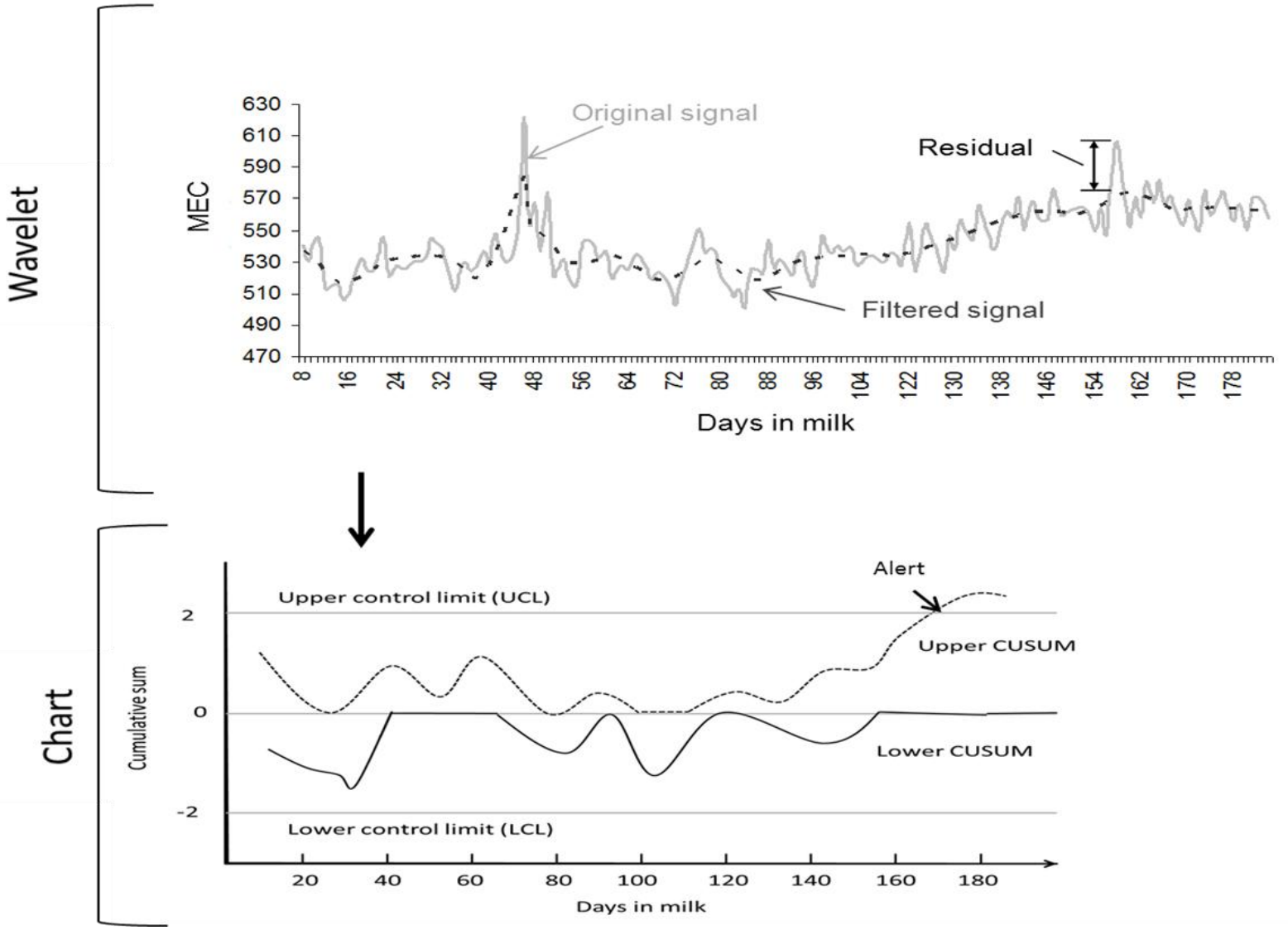
Methods: General procedure



Methods: Wavelet filtering

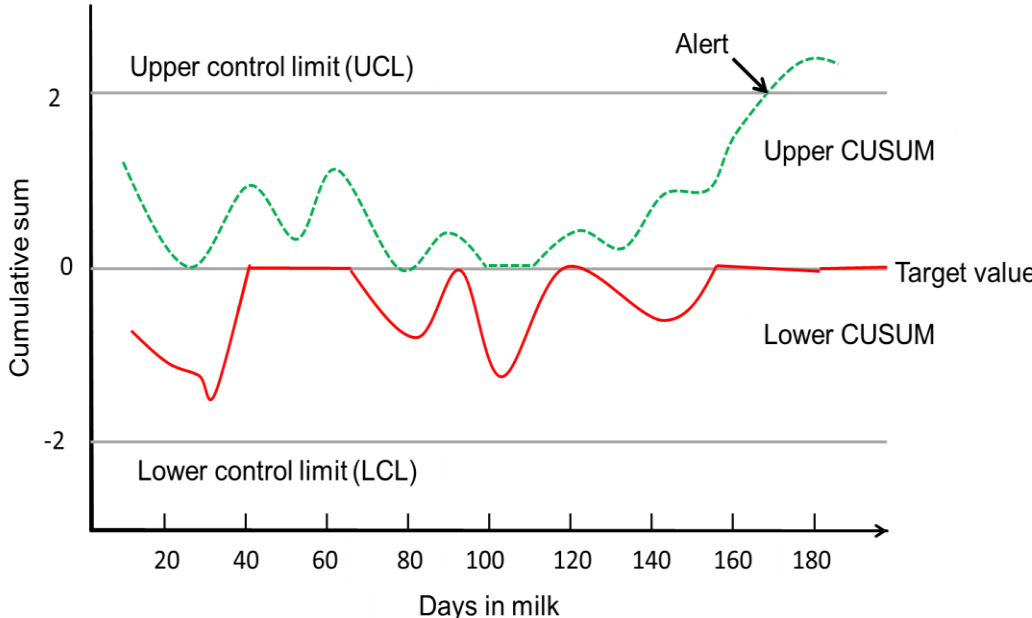


Methods: Wavelet filtering



Methods: CUSUM charts

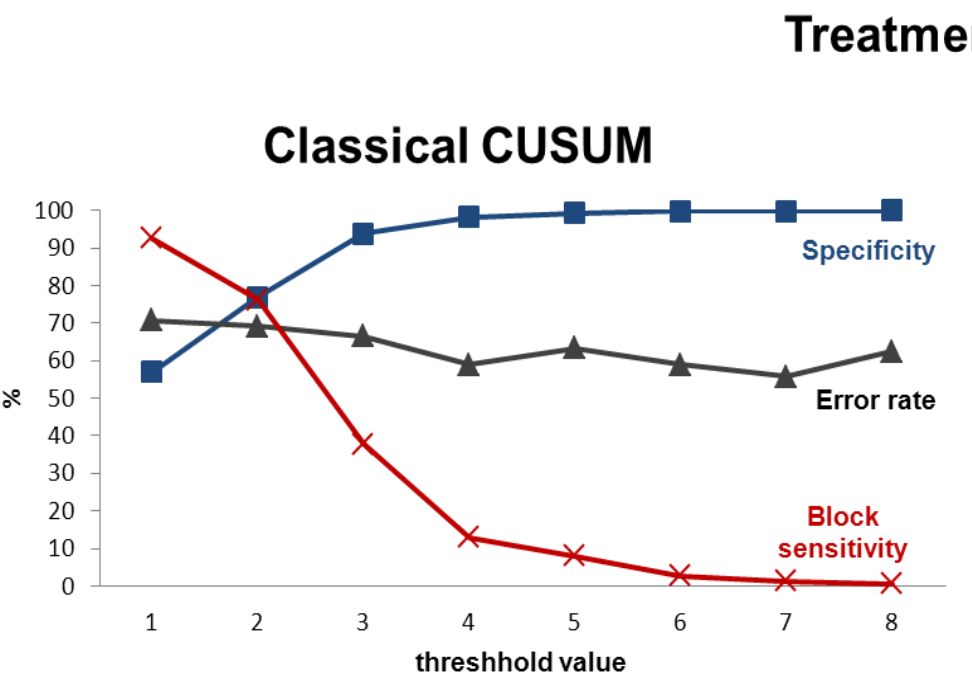
- Plots cumulative sums of deviations from a target value
  - Differentiates between upward (C_i^+) and downward (C_i^+) drifts
- Classical CUSUM:
  Target value based on prior data (test dataset)
- Self-starting CUSUM:
  Running mean and variance
  (no test dataset)

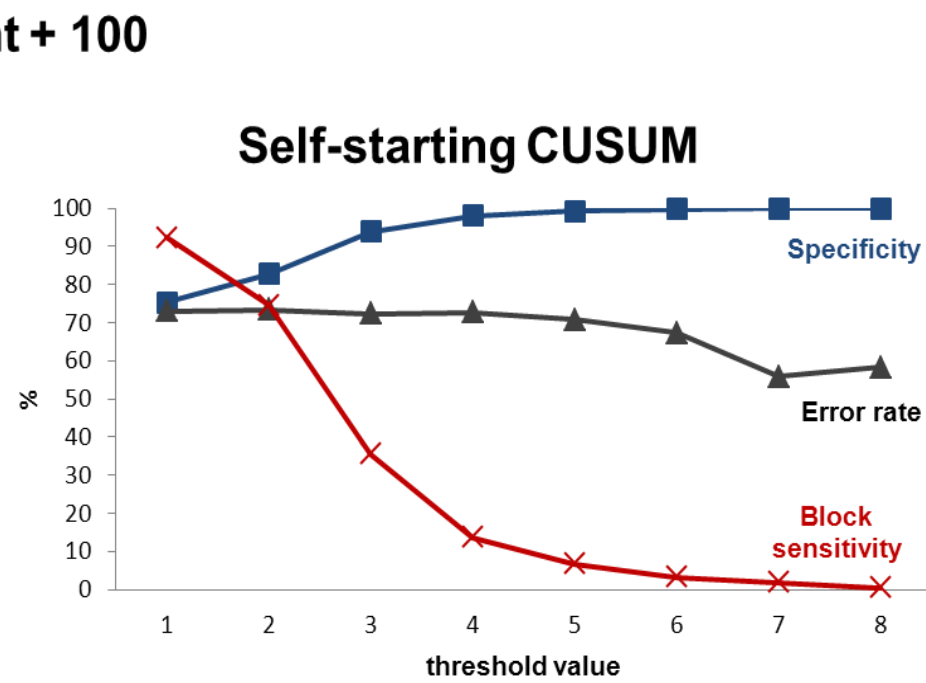


Test procedure: Quality parameters

- **Sensitivity:** Percentage of correctly detected days of disease of all days of disease
- **Specificity:** Percentage of correctly detected days of health of all days of health
- **Error rate:** Percentage of days outside the disease periods of all the days where an alarm was produced
- **Block sensitivity:** Percentage of detected disease blocks within the days before a treatment or the first five days (mastitis)

Results: Interdependency





Results: Mastitis

Definition	Chart	Block sensitivity [%]	Specificity [%]	Error rate [%]	FP cows/day
Treatment+400	Classical	72.6	77.0	94.4	15.0
	Self-Starting	72.1	82.8	95.7	11.3
Treatment+100	Classical	76.3	77.0	69.2	11.2
	Self-Starting	74.5	82.7	73.4	8.4

Treatment+400: Treatment and/or SCC > 400.000/ml
Treatment+100: Treatment and/or SCC > 100.000/ml
FP(false positive): Cow incorrectly classified as ill

Results: Lameness

Definition	Chart	Block Sensitivity [%]	Specificity [%]	Error rate [%]	FP cows/day
Treatment+3	Classical	40.4	72.5	91.3	11.2
	Self-Starting	47.2	85.5	93.3	9.5
Treatment+5	Classical	48.3	72.4	90.6	11.0
	Self-starting	63.5	85.5	92.6	9.4

Treatment+3: Treatment plus three days before
Treatment+5: Treatment plus five days before
FP(false positive): Cow incorrectly classified as ill

Conclusion

- Wavelet filtering possible

- Comparability between studies difficult:
  Varying characteristics of the studies (definitions, block lengths…)

- Here: Block sensitivity of 70%

→ **But**: Error rates and amount of false positive cows too high

- Mastitis and lameness complex diseases

→ Multivariate consideration (milk yield, previous diseases…)?

- Different (multivariate) process control methods?

Questions???