The Foundations of Info-Metrics

Information-Theoretic Methods of inference

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Course organised by the Wageningen School of Social Sciences (WASS), Wageningen University

Introduction & objectives of the course

The info-metrics framework provides a rational inference framework for dealing with mathematically underdetermined problems caused by insufficient information. It provides a logical framework for converting input information – including noisy and uncertain information – into useful knowledge. It is an interdisciplinary framework for information processing, modelling, inference and decision making of all types of problems. In addition to providing a logical framework for inference and for analyzing complex data, it is also a practical tool. Info-metrics is at the intersection of information theory, statistical methods of inference, applied mathematics, statistics and econometrics, decision analysis, modeling and the philosophy of science. The study of info-metrics helps resolve a major challenge to scientists and decision makers of how to reason (optimize) under conditions of incomplete information.

In this course we will concentrate on the study and practice of info-metrics modeling and inference. We will concentrate on estimation and inference of problems where the information we have is quite limited and often very noisy. Though similar problems arise across most disciplines, we will focus on the study of Information-Theoretic (IT) methods of inference in general (within an interdisciplinary perspective) but with a strong emphasis on problems in the social sciences and economics.

We will emphasize both the fundamental theory, the motivation for using the theory, its background, and practice the theory with real or artificial data. Part of the lectures will be complemented with computer experiment in class. We will compare the info-metrics framework with other methods, like the maximum likelihood and least squares.

For further background a web support with many example, references, codes and software is available. See: http://info-metrics.org/

Target group and learning outcomes

The course is beneficial to graduate students, researchers and academics from across disciplines with an interest in solving all types of empirical problems with complicated data and with minimal imposed structure and statistical assumptions. Examples include modelling and inference of problems with small, ill-behaved or complex data.

After a successful completion of this course participants are expected to be able to:
- Understand the basic info-metrics framework, its motivation and background and under what conditions to use it;
- Construct and use info-metric models for solving applied policy and other problems
- Understand the differences between info-metric, maximum likelihood and least squares approaches;
- Apply info-metric estimation techniques to real world problems;
- Understand the class of Information-Theoretic (IT) methods of inference.
- Perform diagnostics and tests of info-metric (and other information-theoretic) methods.

Assumed prior knowledge

The background needed for the course is statistics and/or econometrics traditionally studied during the first year of graduate school in any quantitative discipline.

Course fees

For PhDs of WASS there is a fee of 125 euros. For PhD students from other Wageningen graduate schools the fee is 250 euros. For all other participants and for staff members (fellows/post docs), there is a fee of 500 euros for the whole course (including drinks, lunches, and a course dinner).

Session Times

Morning sessions are scheduled from 9.00-12.00 and will be mostly used to discuss theory. In most afternoons practical sessions are scheduled from 13.30-16.00 in which participants get hands-on experience in applying info-metrics techniques using statistical, econometric or other publicly available

software. (Note, that depending on class material some computer experiments will be done during the morning sessions, and some more theoretical lectures in parts of the afternoon sessions). There will be a course dinner Thursday evening.

Outline of the Course in Hours

The entire course, including preparation, homework and a small final project consisting of completing a problem set with both theoretical and computational problems involves 3 ECTS (84 hours). Credits can only be obtained by completing the final project. People should start working on the problem set at the end of the course and it is due a eight weeks after the end of the sessions (to be submitted to Golan).

Teaching methods

The course will be composed of lectures, open discussions, and complementing exercises (to be completed after the course).

The exercises and computer practice will allow each participant to gain the most out of this course where a substantial amount of computing and practice is necessary. Those who are used to write their own computer codes, the computing can be done by using different software, such as Matlab, GAMS, Python, R, etc. For those who wish to use common statistical/econometric software, the methods we discuss in this course can be used within some of the main software packages, such as STATA, SAS and NLOGIT (LIMDEP). The basic codes will be provided to the participants and are available on the main book's web page. Temporary licenses for GAMS and NLOGIT will be provided to the participants (STATA and SAS examples will be provided as well).

Detailed Topic Outline

1. Background, motivation and philosophy (Chapters 1 – 2)
   - Why Info-Metrics? Motivation and Examples
   - A Very Brief Historical Perspective
   - The Metrics of Info-Metrics (Chapter 3)
     - Probabilities
     - Information and Entropy
     - Information Gain and Multiple Information Sources
     - Properties (Very Brief)

2. Entropy Maximization (The Problem and Solution; Chapter 4)
   - Formulation and Solution: The Basic Framework
     - Information, Model and Solution – Linear Constraints
     - The Concentrated Model and comparison with Maximum Likelihood
     - Visual Representation of the Problem and Solution
     - Information, Model and Solution – General Constraints
     - Model Interpretation (Lagrange multipliers, Information and Uncertainty)
     - Examples in Perfect Environment (and Differential Entropy)
     - Hypothesis Tests
     - The Covariance
   - Case Studies
   - Computer Experiments

3. Prior Information (Chapter 8; 195-200 and 221-229).
   - Entropy Deficiency (Minimum Cross Entropy)
   - Grouping Property
   - Other Priors (Maximum Entropy, Empirical)
   - Examples and Case Studies
   - Computer Experiments

4. The Info-Metrics Framework (Chapter 9)

- Information, Uncertainty and Noise
- Formulation and Solution – Mathematical Formulation
    - o The Concentrated Model
    - o Interpretation
    - o Examples in Imperfect (and Uncertain) Environment
- Uncertainty (Very Brief)
    - o Optimal Solution and Lagrange Multipliers
    - o Stochastic Constraints
    - o Support Space
    - o Cost – Benefit Analysis of the Framework
- Visual Representation of the Theory
- Adding Priors

5. Information-Theoretic Methods of Inference I: Discrete Choice (Chapter 12)
    - The Problem
    - A Simple Example
    - Definitions and Detailed Specification of the Problem
    - The Unconstrained Model – Maximum Likelihood
    - The Constrained Model
    - The Info-Metrics Model and Generalized Likelihood
    - Case Studies
    - Computer Practice

6. Information-Theoretic Methods of Inference II: Continuous (Chapter 13)
    - The Problem
    - A Simple Example
    - Definitions and Detailed Specification of the Problem
    - The Unconstrained Model
    - Rethinking the Problem – Constrained Optimization
    - Generalized Entropies
    - Information-Theoretic Methods: Zero Moments
    - ▪ Specific Cases (Empirical and Euclidean Likelihoods)
    - Information-Theoretic Methods: Stochastic Moments
    - Model Misspecification
    - Info-Metrics vs. Classical Statistics
7. Case Studies
8. Benefits of the Approach
9. Computer Practice
10. Applications (Theoretical and Empirical) from Across the Sciences
11. Summary and Thoughts on Future Directions

A Brief Tentative Timeline and Topics:
May 6 (9:00-12:00) Introduction, Rational Inference and Metrics of Info-Metrics
(Chapters 1 – 3)

May 6 (13:30-16:00) Maximum Entropy (Part I).
(Chapter 4)

May 7 (9:00-12:00). Maximum Entropy (Part II); Examples; Test Statistics and Diagnostics (Chapters 4 – 6; Note Chapters 5 – 6 are examples)

May 7 (13:30-16:00) Lab experiments and practice.

May 8 (9:00-12:00) Prior Information; Possibly some computer experiments.
(Chapter 8)

May 8 (13:30-16:00) Computer Lab Experiments; The Info-Metrics Framework (Part I) (Chapter 9)

May 9 (9:00-12:00) The Info-Metrics Framework and Examples (Part II)
(Chapter 9)

May 9 (13:30-16:00) Information Theoretic Methods (Part I – Discrete Choice); Lab Exercises
(Chapter 12)

May 10 (9:00-12:00) Information Theoretic Methods (Part II – Continuous Problems); Lab Exercise
(Chapter 13)

May 10 (13:30-16:00); Computer Lab; Empirical Examples; Class Summary

Location
The sessions will be held in room PC66 in building "De Leeuwenborch", Hollandseweg 1 in Wageningen, The Netherlands.

Registration
Registration is possible electronically via the WASS courses page:
https://www.wur.nl/en/Education-Programmes/PhD-Programme/Graduate-Schools/Wageningen-School-of-Social-Sciences/WASS-PhD-Education-Programme/Course-registration/Registration-form.htm
The maximum number of participants is set at 20, the minimum at 8.

Please make sure that you provide the most recent contact details so that in case of any changes you will be notified promptly. After your internet registration you will receive a short notification that your name has been registered. At least two weeks before the course you will receive a confirmation about the location and the schedule. WASS will also send an invoice to the address indicated in the registration form.

Please e-mail to Marcella.Haan@wur.nl in case you have not received the second confirmation two weeks before the course.

Cancellations
Cancellations may be made free of charge until 1 month before the start of the course. Cancellation fee of 100 % applies if participants cancel the course less than 1 month prior to the course. The organisers have a right to cancel the course not later than 2 weeks before the course starts. The participants will be notified of any changes at their e-mail addresses.

Further information
On course content please contact the course organiser, dr. ir. Koos Gardebroek . He can be reached through phone: +31 (0) 317 482951 or koos.gardebroek@wur.nl

On WASS: www.wageningenur.nl/wass

For details about the logistics, accommodation, registration, fees, study materials, etc. please contact
Marcella Haan
Tel +31 317 484126
Marcella.haan@wur.nl

Contact addresses:

Wageningen School of Social Sciences
Wageningen University
Hollandseweg 1
6706 KN WAGENINGEN, The Netherlands

Useful information on accommodation for participants from outside Wageningen

Hotels:
Hof van Wageningen: 62.50 euro for 1 persons room, 70 euros for 2 persons room, both prices are including breakfast;
www.hofvanwageningen.nl

Hotel de Wageningseberg: 85 euro for 2 persons room, also including breakfast;
http://hoteldewageningscheberg.nl/en/

Hotel Nol in 't Bosch: 79 euro for 1 person room, 85 euro for 2 persons room, also including breakfast; http://www.nolintbosch.nl/

Bed&Breakfast:
See: https://www.bedandbreakfast.nl/bed-and-breakfast/wageningen/netherlands/c2745088
or http://www.shortstaywageningen.nl/

B& B De Heksenspeeltuin: 30 euro for a 1 person room
Address: Einthovenstraat 15, 6706JA Wageningen
Phone: +31 317-418161
E-mail: callyd@zonnet.nl
Website: www.heksenspeeltuin.nl

Villaria Bed en Breakfast: 39-58 euro for a 1 person room
Address: Nassauweg 21, 6703CG Wageningen
Phone: +31 317-419636
Emai: info@villaria.nl
Website: http://villaria.nl/
Possibilities to rent a bike

Ons Bakhuus Bed & Breakfast: 45 euro for a 1 person room
Address: Dolderstraat 64, 6706 JG Wageningen
Phone.:+31 317-411994
E-mail: info@onsbakhuus.nl
Website: www.onsbakhuus.nl

De Herbergh Bed & Breakfast: 60 euro for a 1 person room
Address: Generaal Foulkesweg 8, 6703 BR Wageningen
Phone: +31 317-410747
E-mail: glindenbergh@wanadoo.nl
Website: https://www.bedandbreakfast.nl/bed-and-breakfast/wageningen/de-herbergh/3269/

Toproom B&B: 55 euro for a 1 person room
Vossenlaan 17
6705 CD Wageningen-Hoog
Phone: +31 317-450214
E-mail: info@toproom.nl
Website: www.toproom.nl
Possibilities to rent a bike

From Schiphol Amsterdam Airport to Wageningen

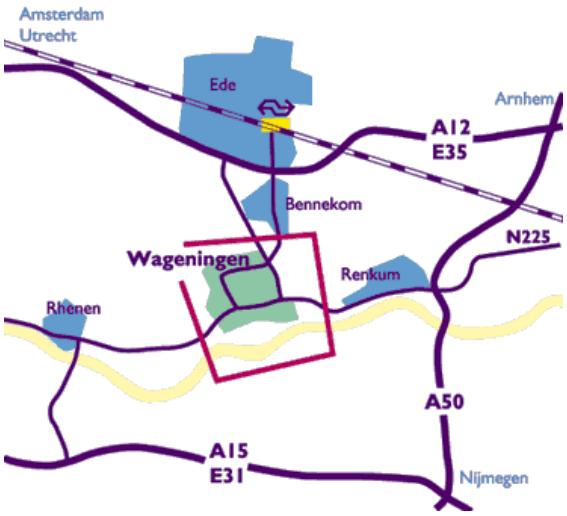
At the Airport you can buy a train ticket in the ‘arrivals’ area by the baggage claims. You will see the sign "Train tickets" near the exit. Then follow the signs 'Nederlandse Spoorwegen' (NS) or 'Trains and busses' to the railway station.

Buying a single-use chipcard
You can travel with the train on NS with a **single-use chipcard** The single-use chipcard is a paper ticket with a chip inside.
• The most important thing to be aware of when buying a single-use chipcard is that you can only buy these tickets from an NS ticket machine (with the blue sign and white NS logo across the top).
• Tickets can also be purchased from the Tickets & Service desks at major stations.

Travelling with a single-use chipcard or OV-chipkaart
To travel with a single-use chipcard or OV-chipkaart you have to **check in** and **out** at an access gate or check-in/check-out point. When travelling with NS you have to check in and out with an NS reader at a gate or post. If you change to a different carrier during your journey, you have to check in and out then as well. For questions about using the card, please contact our staff at the Tickets & Service counter, at the station or on the train.

There are direct connections from Schiphol Amsterdam Airport to Ede-Wageningen every 30 minutes. Additionally, twice an hour there is a connecting service from Schiphol to Ede-Wageningen where you have to change trains in Utrecht. The destination boards on the platform will indicate the different stations where the train will stop. Check for the names Ede-Wageningen or Utrecht and board the train and when necessary change in Utrecht. The trip from Schiphol to Ede-Wageningen takes you a bit more than one hour.

For Dutch train connections use www.ns.nl, www.thalys.com, www.db.de



The train station is not located directly in Wageningen. This lack is fully compensated by fair means of transportation by buses and taxis. From railway station Ede-Wageningen you can take a taxi (approx.15 min.). Taxis leave at the north side of the station. You can also come by bus: line 84, line 86 or line 88 (direction Wageningen/ Arnhem) leaves from the north side of the station. You have to purchase a ticket from the driver in the bus, which will cost about 3 euros.