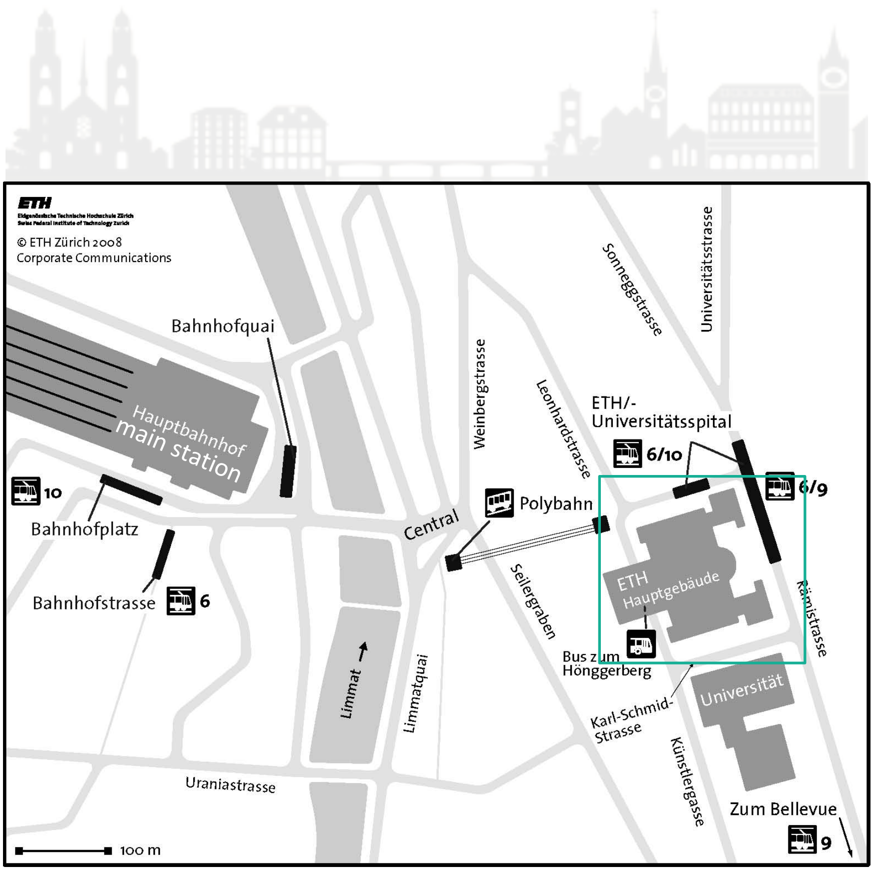
COMPUTATIONALPSYCHIATRYCOURSE

TNU, Zurich, 29.08. – 02.09.2016

WHERE

ETH, Main Building
Rämistrasse 101, 8092 Zürich

Room: HG, E03



Zurich has excellent public transport opportunities.
The following numbers will take you to the ETH Centre, Rämistrasse 101:

- Tram 10 (from *Zürich, Bahnhofsplatz, HB* or *Zürich, Central*)
- Tram 6 (from *Zürich, Bahnhofsplatz, HB* or *Zürich, Central*)
- Polybahn (from *Zürich, Central*)

The stop is called: *Zürich, ETH/Universitätsspital*
Please see www.sbb.ch/en for a precise and helpful time schedule.
A short 10-15mins walk will also take you to the University from the main station.

COURSEMATERIAL

SOFTWARE & SLIDES

2015: https://bitbucket.org/fpetzschner/cpc2015/
2016: https://bitbucket.org/fpetzschner/cpc2016/

VIDEOS

2015: http://www.video.ethz.ch/lectures/d-itet/2015/autumn/227-0971-00L.html
2016: all talks will be recorded (access 1-2 months after the course)

INTERNET

Choose network named *public*.

Open your browser and log in with the following account details:
user name: cpcourse2016
password: cpc_is_fun

SOCIAL

Meeting Point for joint dinners, lunches, socializing:
Every day after the lectures on ETH Polyterrasse

Computational Psychiatry Course Group on Facebook:
https://www.facebook.com/groups/1481318692163550/

Free Sightseeing Tour through Zurich:
Start: Wednesday, 31.08.,16:00 ETH Main Entrance

Plenty of opportunities to hike, bike, climb, swim in and around Zurich (ask us)

SCHEDULE

MONDAY, 29.08.

7:30	8:30	Registration	
8:30	8:45	Welcome & overview	Frederike Petzschner
8:45	9:15	Introduction to Computational Psychiatry	Klaas Enno Stephan
9:15	10:05	Schizophrenia	Katharina Schmack
10:05	10:35	Break	
10:30	11:20	Mood Disorders	Dominik Bach
11:20	12:10	Autism	Helene Haker-Rössler
12:10	14:10	Lunch	
14:10	15:00	Addiction	Martin Paulus & Huang Crane
15:00	16:00	Conceptual Basics of Computational Modeling	Saee Paliwal
16:00	16:30	Break	
16:30	18:00	Variational Bayes (Theory & Software)	Jean Daunizeau

TUESDAY, 30.08.

8:30	8:45	Introduction to Day 2	Klaas Enno Stephan
8:45	10:15	Bayesian Model Selection and Averaging (Theory & Software)	Klaas Enno Stephan & Stefan Frässle
10:15	10:45	Break	
10:45	12:15	Markov Chain Monte Carlo (Theory & Software)	Eduardo Aponte
12:15	14:15	Lunch	
14:15	15:45	Markov Decision Processes (Theory & Software)	Frederike Petzschner & Lionel Rigoux
15:45	16:15	Break	
16:15	17:45	Machine Learning Techniques (Theory & Software)	Maria Joao Rosa

WEDNESDAY, 31.08.

8:30	8:45	Introduction to Day 3	Klaas Enno Stephan
8:45	10:15	Bayes Models for Perception (Theory & Software)	Frederike Petzschner
10:15	10:45	Break	
10:45	12:15	Predictive Coding (Theory & Software)	Rafal Bogacz
12:15	14:15	Lunch	
14:15	15:45	Active Inference (Theory & Software)	Karl Friston & Philipp Schwartenbeck
16:00	18:00	Free sightseeing tour through Zurich	

THURSDAY, 01.09.

8:30	8:45	Introduction to Day 4	Klaas Enno Stephan
8:45	10:15	Hierarchical Bayesian Inference (Theory & Software)	Christoph Mathys
10:15	10:45	Break	
10:45	12:15	DCM for fMRI (Theory & Software)	Jakob Heinzle & Hanneke den Ouden
12:15	14:15	Lunch	
14:15	15:45	DCM for EEG (Theory & Software)	Dario Schöbi
15:45	16:15	Break	
16:15	17:45	Reinforcement Learning (Theory & Software)	Quentin Huys

FRIDAY, 02.09.

8:30	8:45	Introduction to Day 5	
8:45	9:35	Compulsion, control, and habits	Nathaniel Daw
9:35	10:05	Break	
10:05	10:55	The search for the "Bayesian Priors" in the Brain, in Health and Mental Illness.	Peggy Series
10:55	11:55	Panel Discussion	
11:55	14:00	Lunch	
14:00	14:50	Computational neuromodulation in human decision-making	Read Montague
14:50	15:40	Biophysical models and NMDA channelopathies: Psychiatric Insights	Rosalyn Moran
15:40	16:10	Break	
16:10	17:00	TBA	Ed Bullmore
17:00	17:50	TBA	Christian Büchel

FURTHERREADING

Variational Bayes

Chapter 1 and 2

http://www.cse.buffalo.edu/faculty/mbeal/thesis/

Bayesian Model Selection & Averaging

Bayesian model selection for group studies

Stephan KE, Penny WD, Daunizeau J, Moran RJ, Friston KJ

Neuroimage (2009) 46(4): 1004-1017

http://www.sciencedirect.com/science/article/pii/S1053811909002638

Markov Chain Monte Carlo

A quick introduction to Markov chains and Markov chain Monte Carlo

Waagepetersen R

http://people.math.aau.dk/~rw/Papers/mcmc_intro.pdf

Chapter *on sampling methods* in the book "pattern recognition and machine learning" Bishop C

Hierarchical Gaussian Filter

Uncertainty in perception and the Hierarchical Gaussian Filter

Mathys CD, Lomakina, EI, Daunizeau J, Iglesias S, Brodersen KH, Friston, KJ, & Stephan KE

Frontiers in Human Neuroscience (2014) 8:825

http://doi.org/10.3389/fnhum.2014.00825

Markov Decision Models

Planning and acting in partially observable stochastic domains

Kaelbling LP, Littman ML & Cassandra AR

Artificial Intelligence (1998),101(1-2): 99–134

https://www.cis.upenn.edu/~mkearns/papers/barbados/klc-pomdp.pdf

Dynamic Causal Modeling for fMRI

Understanding DCM: Ten simple rules for the clinician

Kahan J, Foltynie T

Neuroimage (2013) 83: 542-549

http://www.sciencedirect.com/science/article/pii/S105381191300760X

Analyzing effective connectivity with functional magnetic resonance imaging.

Stephan KE and Friston KJ, WIREs Cognitive Sience (2010), 1:446-459,

http://www.fil.ion.ucl.ac.uk/spm/doc/papers/Stephan_WIREsCognSci_1_446_2010.pdf

Dynamic Causal Modeling for EEG

Losing Control Under Ketamine: Suppressed Cortico-Hippocampal Drive Following Acute Ketamine in Rats, Moran RJ, Jones MW, Blockeel AJ , Adams RA, Stephan KE & Friston KJ

Neuropsychopharmacology (2015) 40: 268–277

http://www.nature.com/npp/journal/v40/n2/abs/npp2014184a.html

FURTHERREADING

Bayesian Models for Perception

Petzschner FH, Glasauer S, Stephan KE (2015) A Bayesian perspective on Magnitude Estimation. Trends in Cognitive Sciences. 19(5):285–293

Perception as Bayesian Inference, Knill CD & Richards W, 2008

Predictive Coding & Active Inference

Computational psychiatry: the brain as a phantastic organ
Friston KJ, Stephan KE, Montague R, Dolan RJ
Lancet Psychiatry (2014) 1:148–158
http://www.fil.ion.ucl.ac.uk/~karl/Computational%20psychiatry.pdf

Optimal inference with suboptimal models: Addiction & active Bayesian inference
Schwartenbeck P , FitzGerald THB, Mathys C, Dolan R, Wurst F, Kronbichler M, Friston K
Medical Hypotheses (2015) 84 :109–117
http://www.medical-hypotheses.com/article/S0306-9877(14)00442-3/pdf

Reinforcement Learning

Decision-theoretic psychiatry, Huys QJM, Guitart-Masip M, Dolan RJ and DayanP ,Clin Psychol Sci (2015) 3(3):400-421
http://quentinhuys.com/pub/HuysEa15- DecisionTheoreticPsychiatry.pdf

Sutton & Barto , Reinforcement learning , MIT Press, 1998
https://webdocs.cs.ualberta.ca/~sutton/book/the-book.html

Machine Learning

PRoNTo: Pattern Recognition for Neuroimaging Toolbox, J. Schrouff & M. J. Rosa & J. M. Rondina &, A. F. Marquand & C. Chu & J. Ashburner & C. Phillips & J. Richiardi & J. Mourão-Miranda, Neuroinform (2013) 11:319–337

CHEATSHEET

Bayesian inference: a method of inferring upon properties of the underlying distribution generating a set of data using Bayes' theorem. In this method, both the likelihood of a data set and prior distributions on the sufficient statistics of the underlying data distribution are incorporated in the inference process.

Bayesian: adjective describing methods that employ Bayes' rule, including prior information in the statistical process.

Bounded rationality: the idea that decision-makers are limited by various constraints (time, information, cognitive limitations, etc) and thus make rational decisions insofar as these constraint allow.

Dynamical system: set of differential equations that describes, for example, how a set of neuronal populations changes activity as a function of input. It can include complicated non-linear dynamics and interactions between the nodes.

Dynamical systems theory: area of maths used to describe time-evolving systems using differential equations or difference equations, depending on whether the systems states are continuous or discrete.

Effective connectivity: causal and, therefore, directed influences between neurons, or neuronal populations, as opposed to purely anatomical or functional (statistical dependencies) connectivity.

Free energy: in statistics, the lower bound on log model evidence. In physics, the total amount of work extractable from a statistical system. In cognition, a functional representing the trade-off between information and constraint; a model of bounded rationality.

Good regulator theorem: a theorem proved by Conant & Ashby (1970) stating that in order for an agent to be maximally both successful at regulating its environment and simple, it must have a model of its environment. This means that the brain must necessarily develop a model of its environment.

Hemodynamics: in fMRI hemodynamics stands for all the neuronally induced changes in blood flow, volume and oxygenation. These changes lead to the observed signal, also called the blood oxygen level dependent (BOLD) signal, and are characterized by the hemodynamic response to an input stimulus.

CHEATSHEET

Hierarchical Gaussian Filter (HGF): a set of prescriptions for updating beliefs about the state of an agent's environment. In response to a time series of observations, an agent can use the HGF to update its beliefs about environmental states including - crucially - its uncertainty about states. This allows such an agent dynamically to adapt its learning rate in order to minimize surprise. There is mounting empirical evidence that the quantities relevant to HGF updates have correlates in neural activity.

Inverse problem: an inverse problem in science is the process of calculating from a set of observations the causal factors that produced them. It is called an inverse problem because it starts with the results and then calculates the causes. This is the inverse of a forward problem, which starts with the causes and then calculates the results.

Kullback-Leibler (KL) divergence: a non-symmetric non-negative measure of the dissimilarity of two probability densities; zero if the two densities are identical and increasingly positive with growing dissimilarity.

Markov chain Monte Carlo (MCMC): a class of algorithms for sampling from a probability distribution based on constructing a Markov chain that has the desired distribution as its equilibrium distribution. The state of the chain after a number of steps is then used as a sample of the desired distribution. The quality of the sample improves as a function of the number of steps.

Markov Decision Process: provide a mathematical framework for modeling decision making in situations where outcomes are partly random and partly under the control of a decision maker.

Minimization of Shannon surprise: the Shannon surprise associated with an observation is the negative logarithm of the probability of that observation under a given model. This means that impossible observations lead to infinite surprise, while entirely certain observations lead to no surprise at all. A model that makes good predictions minimizes Shannon surprise.

Model evidence: the conditional probability of the data given the model and the denominator from Bayes theorem; represents the decisive quantity for Bayesian model comparison and selection; its log can be decomposed into a trade-off between model fit and model complexity.

Negative free energy: a lower bound approximation to the log evidence which derives from a variational perspective; maximising the negative free energy not only yields an estimate of the log evidence, but also provides an estimate of the posterior by minimising the KL divergence between an approximate posterior and the true posterior.

Neural Mass Model: model that describes the average activity of a subset of neurons, using a small number of state variables that summarize the average activity of millions of interacting neurons.

Neuronal Oscillations: repetitive neural activity in the CNS, driven by either the activity of a single neuron or interactions within a population of neurons.

ODE (ordinary differential equation): differential equation that is a function of only one independent variable and its derivatives.

Optimality: a term used to describe perfectly rational decision making in the absence of constraint. Mathematically, this is often described by maximum expected utility or maximum likelihood.

Policy: the method or system of principles used by a agent to guide his or her decision process.

Posterior predictive distribution: distribution of unobserved states conditional on observed data, equivalent to the expectation of the probability of the new data point given the model parameters, taken over the posterior distribution.

Precision-weighted prediction error (PWPE): under mild assumptions, Bayesian inference (i.e., inference according to the rules of probability) can be reduced to belief-updating by PWPEs. Hereby, a previous statistic is updated by adding to it the difference between a new observation and the previous statistic, after this difference has been weighted by a ratio of precisions, namely that of the precision of the prediction to the precision of the current belief.

Precision: term used to describe the dispersion of a distribution. The precision is $1/\sigma^2$, where σ is the standard deviation of the distribution.

Predictive Coding: The predictive coding account of perceptual inference assumes that sensory cortex infers the most likely causes of incoming (noisy) sensory inputs. It suggests a hierarchical neural architecture where each level tries to predict the state of the level below (prediction units) and evaluates the discrepancy with the actual inputs from the lower level (prediction error units, PE). Inference corresponds to adjusting neuronal states and learning refers to adjusting connection strengths, both serving to minimize PE at all levels of the hierarchy.

Transition probabilities: the probability with which one state changes into another state. Usually used in the context of state space models, in which a process is described as a set of transitions between a number of states.

LUNCHOPTIONS

On the ETH centre campus…

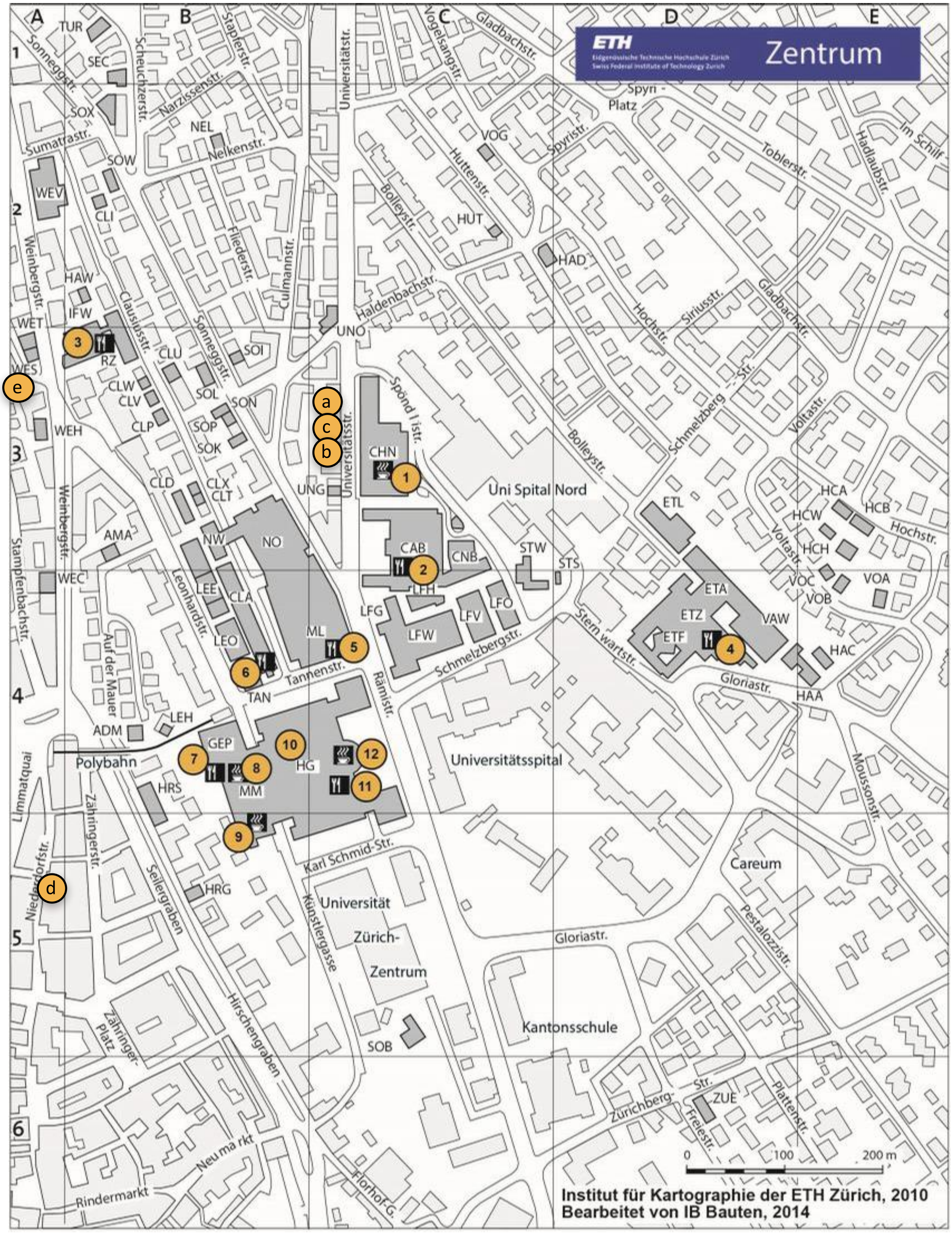
5	Tannenbar	Bistro (Sandwiches, etc.)	Mon-Fri (07:00-17:00)
6	Clausiusbar	Asian food	Mon-Fri (07:30-16:30)
7	Mensa Polyterrasse	Different lunch menus (also vegi), buffet, salade etc. / Dinner	Mon-Fri (11:15-19:15)
8	Cafeteria Einstein	Bistro (Sandwiches, etc.)	Mon-Fri (06:45- 19:45)
9	bQm	Bistro / Student bar	Mon-Thu (11:45-23:00, Fri-22:00)
11	Polysnack	Italian food	Mon-Fri (07:30-17:00)

Do not forget to bring along your **student identification card**. You will get a discount in all **ETH restaurants**.

…and close by:

a	Klara's Kitchen	Bio, vegetarian, vegan, gluten-free, …	Mon-Fri (08:00-18:30)
b	Lilli's Corner	Curry and other South Asian dishes	Mon-Thu (09:00-18:30) Fri & Sat (09:00-16:00)
c	Hot Pasta	Different Italian Pasta	Mon - Fri (08:30-24:00) Sat (09:00-24:00)
d	Migros	Supermarket with a restaurant	Mon-Fri (08:00-21:00) Sat (09:00-21:00)
e	Bäckerei Wüst	Bakery	Mon-Fri (06:30-18:30) Sat & Sun (07:00-17.00)

LUNCHOPTIONS



THETEAM

Organizer

Translational Neuromodeling Unit
Prof. Klaas Enno Stephan, MD Dr. med. PhD
Dr. Frederike Petzschner
Silvia Princz
Gina Paolini

contact: cpcourse@biomed.ee.ethz.ch

Speakers

Aponte	Eduardo
Bach	Dominik
Bogacz	Rafal
Büchel	Christian
Bullmore	Ed
Crane	Huang
Daunizeau	Jean
Daw	Nathaniel
den Ouden	Hanneke
Frässle	Stefan
Friston	Karl
Haker-Rössler	Helene
Heinzle	Jakob
Huys	Quentin
Mathys	Christoph
Montague	Read
Moran	Rosalyn
Paliwal	Saee
Paulus	Martin
Petzschner	Frederike
Rigoux	Lionel
Rosa	Maria
Schmack	Katharina
Schöbi	Dario
Schwartenbeck	Philipp
Series	Peggy
Stephan	Klaas Enno

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