Can the planets drive the sun into quiescence?

Research group Biomedical Simulation

Dr. Simone Ulzega
Senior Research Scientist,
ulzg@zhaw.ch

Research project
BISTOM – Bayesian Inference for Stochastic Models

Lead:
Dr. Carlo Albert, Eawag

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Partner:
SDSC, Eawag, USI

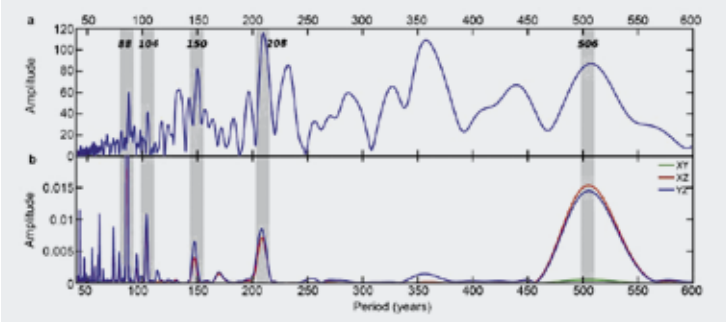
Funding:
SDSC
(Swiss Data Science Center)

Everybody knows that planetary dynamics are driven by the gravitational forces exerted on them by the huge mass of the sun. But can a few tiny planets affect internal solar dynamics to a detectable level?

Understanding the sun's magnetic activity is important because of its impact on the earth's climate and environment. The longest direct record of the solar magnetic activity is provided by sunspots observations, which reveal a well-known 11-year cycle modulated on longer time-scales and a puzzling 70-year-long quiescent period in the 17th century characterized by the nearly total absence of sunspots, known as the Maunder Minimum. Unfortunately, sunspot observations are limited to the past 400 years, since the invention of the telescope. This is obviously an extremely short window on astronomical time-scales, resulting in a substantial lack of information that has left solar astronomers "in the dark": most observed phenomena, including long-term modulations and quiescent phases, have thus remained unexplained. However, recently, new exciting information has become available.

The sun, a noisy system

Sunspots are direct manifestations of strong internal magnetic fields breaking to the surface and releasing huge bursts of energy into space. The *solar wind* thus generated envelopes the earth (we can see it in the form of northern lights!) providing a shielding effect against galactic cosmic rays. Cosmic rays produce in the earth atmosphere radioactive Carbon-14 and Berillium-10 nuclei which are then stored in wood and polar ice cores, respectively. Cosmic rays are modulated by the solar wind and the production rates of radioactive isotopes is thus indirectly modulated by the solar magnetic activity. Time-series of cosmogenic radionuclides thus turn out to be an exceptional proxy for solar activity on unprecedented multi-millennial time-scales, up to hundred thousand years. These time-series exhibit a variety of interesting features such as long stable cycles and many Grand Minima, that is, extended periods of very low solar activity similar to the Maunder Minimum. In a seminal and harshly debated paper by Abreu et al. (Astronomy & Astrophysics 548, 2012), the authors present new evidence (see Figure) that solar magnetic cycles and their minima might be associated with gravitational perturbations exerted by the planets on the sun. In a noisy system like the sun, it is possible that an inherently non-linear physics mechanism called *stochastic resonance* might boost an extremely tiny external periodic forcing to a level where its effects become observable. The question is still open and the debate is lively and vibrant.



The Fourier spectra of the solar magnetic activity (a) and of the planetary torque on the sun (b), calculated under three different conditions (not discussed here), reveal at least 5 matching periodicities. This analogy cannot be a mere coincidence. The solar activity calculation is based on 100k-year time-series of cosmogenic radionuclides. From: Abreu et al., Astronomy and Astrophysics 548, 2012

High performance computing is essential

The SCSC Swiss Data Science Center is funding a 2-year project for applying sophisticated Bayesian inference algorithms to the calibration of stochastic solar dynamo models on time-series of cosmogenic radionuclides. We have extended those methods with Machine Learning (ML) algorithms to compress long time-series into representative summary statistics. The coupling of Bayesian inference and ML methods make the problem computationally extremely expensive and requires an extensive use of the newly established ZHAW HPC (high performance computing) facility in Wädenswil. Among several project goals, we intend to test solar dynamo models including the periodic tidal torque of the planets. A better agreement with the data would substantially contribute to give more weight to the planetary hypothesis. The solar physics community is waiting for new inputs. Our algorithms are running. ■

Einsatz von künstlicher Intelligenz bei der Infektionskontrolle

Stefan Glüge, Wissenschaftlicher Mitarbeiter, glue@zhaw.ch

In Schweizer Spitälern erleiden jährlich 70000 Menschen Healthcare-assoziierte Infektionen (HAI), zirka 2000 sterben daran. Zusätzlich macht die Zunahme von multi-resistenten Erregern HAI zu einem globalen Problem. Infektiologen von Spitälern stehen vor der Herausforderung, eine riesige Menge an Daten schnell zu analysieren, um HAI frühzeitig zu erkennen. Da sie unmöglich sämtliche Infektionsfälle untersuchen können, konzentrieren sie sich auf die Beobachtung hochprioritärer Erreger. Zusätzlich ist die Rekonstruktion des Übertragungswegs eines Erregers, wie eine kontaminierte Dialysestation, aufwändig und kann eine Spezialistin, einen Spezialisten mehrere Wochen beschäftigen. Gleichzeitig werden immer mehr Daten erhoben, z. B. Patientenakten, Behandlungsdaten, Schichtpläne für Pflege-/Reinigungspersonal etc. Auf Basis dieser Daten haben wir ein prototypisches System mit künstlicher Intelligenz entwickelt, welches die Infektionen im Spital überwacht und wahrscheinliche Übertragungen in real-time meldet. Das System stellt der Infektiologie einen Überblick über die «Infektionslandschaft» des Spitals bereit. Dies ermöglicht gezielte Präventionsmassnahmen (Dekontamination, Verlegung usw.) und verhindert eine weitere Ausbreitung. ■

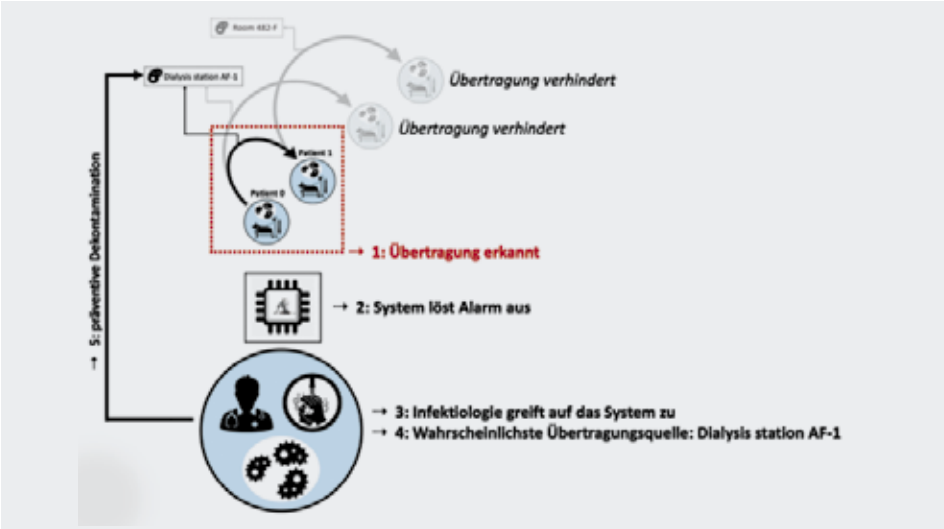


Abb. 1: Workflow KI-basierter Infektionskontrolle

Neue Projekte

FH Lohnstudie 2019
Leitung: daniel.vonfelten@zhaw.ch
Dauer: 1.10.18 – 30.6.20
Beteiligte Institute: IFM, IAS
Projektpartner: FH Schweiz, Zürich

FM Salär- und Branchenstudie 2019
Leitung: daniel.vonfelten@zhaw.ch
Dauer: 1.10.18 – 31.12.20
Beteiligte Institute: IFM, IAS
Projektpartner: fmpro Schweizerischer Verband für Facility Management und Maintenace, Wallisellen

An integrated modelling and learning framework for real-time online decision assistance in Swiss agriculture
Leitung: martin.schuele@zhaw.ch
Dauer: 1.12.18 – 30.11.21
Beteiligte Institute: IAS, IUNR
Projektpartner: Hydrolina Sàrl, Villaz-St-Pierre; Universität Neuenburg, Neuenburg; mitfinanziert durch Innosuisse (KTI), Bern

Weitere Projekte
zhaw.ch/ias/projekte

Weiterbildung

1.6.2019
Python Online Introduction

15.8.2019
R Online Introduction

13. + 16.9.2019
Artificial Intelligence for Managers

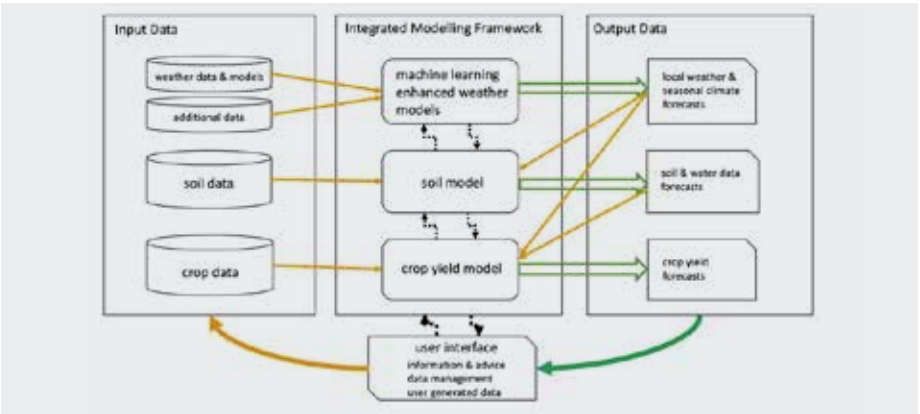
September 2019 – Februar 2020
Deep Learning Fundamentals

Infos und Anmeldung
zhaw.ch/ias/weiterbildung

Agrolina – An Online Decision Assistance for Swiss Agriculture

Martin Schüle, Wissenschaftlicher Mitarbeiter, scli@zhaw.ch

Climate change is putting pressure on agriculture. Harvest losses due to droughts, changing climatic conditions or other extreme weather conditions are constantly increasing. Swiss agriculture, for example, was affected by crop losses in the dry year of 2018. In response to the demand of the local actors facing challenges in food production, the Institute of Applied Simulation and the Institute of Natural Resource Sciences established with the industry partner Hydrolina the Innosuisse project “Agrolina” to develop an information and data platform for agriculture. We are developing an app and online information platform that assesses and visualises risks in agriculture developing an integrated model coupling reliable weather and seasonal climate forecasts, soil data and crop yield forecasts. Based on real-time and historical weather, climate, soil and crop data and machine learning algorithms, the system calculates expected weather and climate conditions and crop yields and supports agriculture with its real-time and online data in terms of production costs, irrigation management and required resources. By including users, who can manage and analyse their own data, the app provides a true information platform for agriculture. The information and data platform will thus help to plan ahead, to enable stable agricultural production, to mitigate the effects of climate change and to promote resource-saving and sustainable agriculture. ■



Overview data and information processing platform