Workshop - DIDAS

J. R. Cecatto
08/05/2018

Trabalhos atuais

- Previsão de fenômenos: **Explosões solares - “flares**, Ejeções de Massa Coronal - CME, Vento solar, Buracos coronais e jatos de partículas energéticas (MeV / poucos GeV)

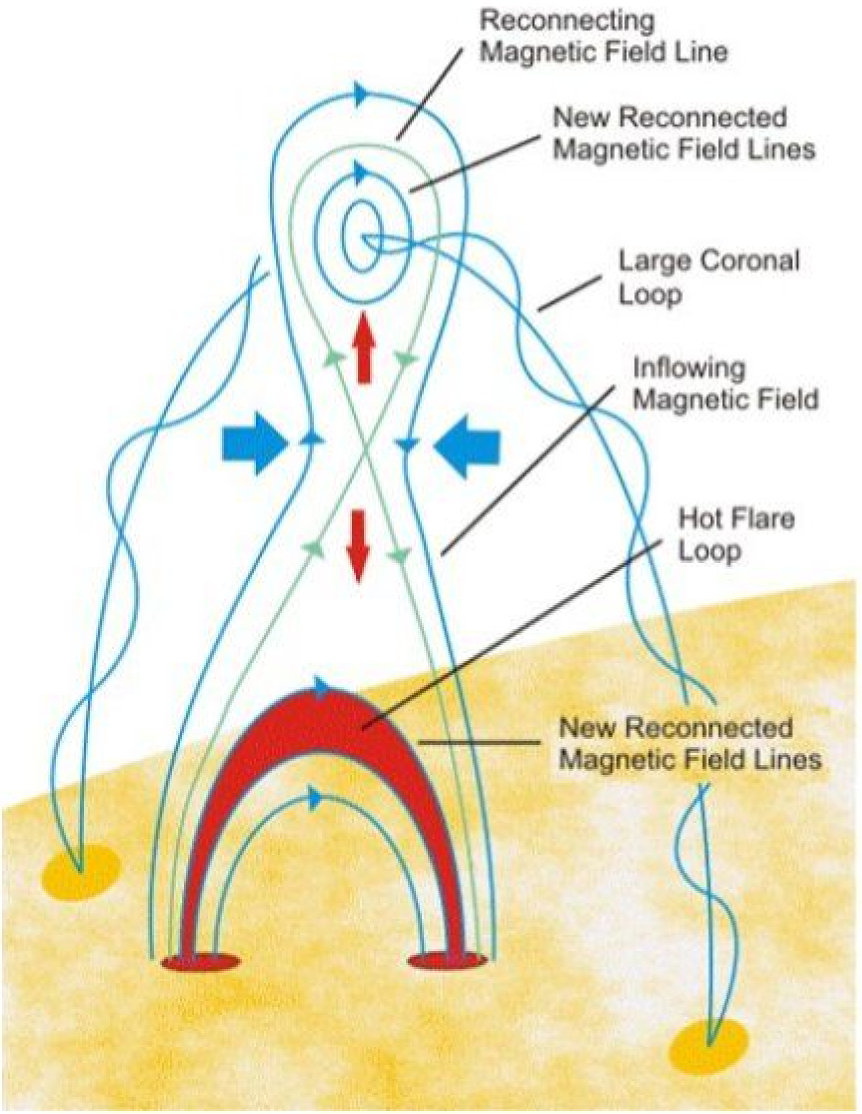
  Colab.: DC-UFSCar, FT-Unicamp, DIDAS:J.E.R. Costa e C.E.F. Lopes, N. Vilmer (O.P. Meudon, França);

- Participação em discussões e artigo sobre astrobiologia

  Colab.: Colegas DIDAS – Alex, Fred, Dinelsa*, Lia, Manoel, Williams, Manoel, Karin;

Motivação

- Melhorar a compreensão processos físicos responsáveis para geração de fenômenos solares que impactam o ambiente terrestre (S.P. Novo modelo);



- Prevenção / Mitigação efeitos de fenômenos solares nas atividades e sistemas tecnológicos que servem ao ser humano (S.P. Sistema automatizado tempo quase real para previsão de explosões solares);
- Origem da vida no Universo, ...;

Thematic Spatiotemporal Association Rules to Track the Evolving of Visual Features and their Meaning in Satellite Image Time Series

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***Abstract*— Satellite Image Time Series (SITS) is a set of images taken from the same satellite scene at different times. The mining of SITS is challenging task because it requires spatiotemporal data analysis. An example of the need for SITS mining is the analysis of solar flares and their evolving. Thematic Spatiotemporal Association Rules (TSARs) are associations that show spatiotemporal relationships among the values of the thematics attributes. By employing TSARs, we propose an approach to track the evolving of visual features of SITS images and their meaning. Our approach, called Miner of Thematic Spatiotemporal Associations for Images (MiTSAI), considers the data extracting and transformation, the thematic spatiotemporal association rule mining (TSARs), and the post-processing of the mined TSARs, that relate the visual features and their meaning. Our experiment shows that the proposed approach improves the domain expert team understanding of Solar SITS. Moreover, MiTSAI presented an acceptable time performance being able of extracting and processing TSARs using a long period of historical data faster than the period needed for the arrival of new data in the database.**

***Index Terms*— Image Classification, Spatiotemporal Association Classifier, Solar data, Thematic Spatiotemporal Association**

evolution of the sunspots and also the relationship inside the sunspots that happen at the same time.

In our proposed method, a pre-processing access the Solar SITS, processing each image and the image's textual data in parallel. The result of this pre-processing is split according to the sunspots. MiTSAI extracts TSARs from the pre-processed solar SITS considering the visual features, their textual data, and their spatiotemporal features. The extracted TSARs are validated by the domain expert team. The domain expert team is the responsible for defining whether the mined rules are valid and also if the performance of the algorithm is acceptable. The TSARs are post-processed generating rules that relate the visual sunspots features, their evolving and their meaning, producing generalized rules are employed to analysis the sunspot behavior. The performance criterion is that MiTSAI must be able of extracting and processing TSARs using a long period of historical data, at least 8 years, faster than the period needed for the arrival of new data in the database.

https://doi.org/10.1007/978-3-319-77028-4_43 information

Article

SeMiner: A Flexible Sequence Miner Method to Forecast Solar Time Series

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Abstract: X-rays emitted by the Sun can damage electronic devices of spaceships, satellites, positioning systems and electricity distribution grids. Thus, the forecasting of solar X-rays is needed to warn organizations and mitigate undesirable effects. Traditional mining classification methods categorize observations into labels, and we aim to extend this approach to predict future X-ray levels. Therefore, we developed the "SeMiner" method, which allows the prediction of future events. "SeMiner" processes X-rays into sequences employing a new algorithm called "Series-to-Sequence" (SS). It employs a sliding window approach configured by a specialist. Then, the sequences are submitted to a classifier to generate a model that predicts X-ray levels. An optimized version of "SS" was also developed using parallelization techniques and Graphical Processing Units, in order to speed up the entire forecasting process. The obtained results indicate that "SeMiner" is well-suited to predict solar X-rays and solar flares within the defined time range. It reached more than 90% of accuracy for a 2-day forecast, and more than 80% of True Positive (TPR) and True Negative (TNR) rates predicting X-ray levels. It also reached an accuracy of 72.7%, with a TPR of 70.9% and TNR of 79.7% when predicting solar flares. Moreover, the optimized version of "SS" proved to be 4.36 faster than its initial version.

Keywords: solar flare; X-rays; k-nearest neighbour classifier; sliding window; forecasting; time series; data mining; feature selection; graphical processing unit (GPU); CUDA

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SOLAR FLARE FORECASTING - ORIGIN, EVOLUTION, PERSPECTIVES AND TRENDS

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Abstract. From the discovery of the solar flare and corresponding incidents on Earth, around one and a half century ago, the research gradually evolved up to the current state of its prediction. Until the middle of last century, the solar observations were only permitted by means of optical telescopes. Since then, several frequency bands have gradually been put to observe the Sun, being radio the first of them recording flares and unveiling their characteristics. With the advent of space era using experiments on rockets, satellites, and probes, the observations enlarged the electromagnetic spectrum mainly towards the shortest wavelengths. This improved our understanding about the cosmic phenomena in general, and especially the solar ones. Since then, all those experiments were used to monitor, and observe space phenomena in a systematic way and also measure their physical parameters. In particular, permitted us to observe, and record high-quality data of solar energetic phenomena. This brought us advances in theory and modeling as well as on the own observations. As a byproduct of this evolution, the first attempts of flare forecasting started in a systematic way in the end sixties of century XX. Here, we present a relatively concise revision of solar flare forecasting evolution since the origins. Beyond the methodology, techniques, and algorithms, some results obtained are described. New initiatives as well as perspectives and trends are also presented. In the end, we briefly present a comparison among a good fraction of the methods and also the expectation on solar flare predictions on a glimpse of what can be expected some years ahead.

1 Introduction

On September 1st, 1859, when Carrington and Hodgson, using optical telescopes, discovered the solar flare phenomenon (Carrington , 1859), (Hodgson , 1859), they were not able to imagine the consequences of their discovery in the last decades of century XX. Besides, they had no idea the effects noticed at Earth 18 hours later had a straight relation to their discovery (Muller , 2014). Among the effects, can be mentioned the recordings of electric currents in telegraphic wires, geomagnetic storms, and extremely bright auroras. Later on, these and other pioneers perceived this association of the solar phenomenon with geo-effectiveness and the importance of identifying and attenuating its effects.

Table 1: **Main characteristics of several recent solar flare forecasting methods**

Reference	Algorithm	Data/Input Parameters	Time window	Statistics/Metrics
Ishkov (2001)	method of similar cycles, PFER	evolution of flare activity in the SC23	1-3 day	-
Gallagher et al. (2002)	near realtime active region monitoring	full-disk H-α/MAG, EUV, continuum	24 hour	-
Wheatland (2005)	Bayesian – event statistics flares observed	historical records GOES events (1975-2003)	1 day	climatological SS
Barnes et al. (2007)	discriminant analysis	vector magn field by Imag Vector Magnet	24 hour	climatological SS
Schrijver (2007)	total unsigned flux (R) $\leq$ 15 Mm SFHGPSL	SOHO/MDI, TRACE, GOES (1998-2006)	24 hour	"all clear"
Georgoulis & Rust (2007)	effective connected magnetic field	10-year of SOHO/MDI on the SC23	12 hour	likelihood M/X-flare
Belanger et al. (2007)	set of data assimilation	synthetic energy release TS	-	matches, misses, FAR
Li et al. (2007)	SVM-KNN	sunspots and 10.7 cm radio flux	2 day	-
Wang et al. (2008)	ANN (backpropagation)	MDI/SOHO full disk magnetograms	48 hour	-
Li et al. (2008)	SVM + KNN	SA, Mt.Wilson/McIntosh classes, 10.7cm flux	48 hour	PRED, EQ, HI, Low
Barnes & Leka (2008)	nonparametric discriminant analysis	VM, M-/X-class flares (2001-2004)	24 hour	climatological SS
Yamamoto & Sakurai (2009)	Avg axial / long field strengths, scale length	Vector / LOS magnetograms SFT / MDI	4 hour	-
Yu et al. (2009)	Sequential supervised learning	SOHO/MDI longitudinal magnetograms	48 hour	C4.5 DT and LVQ
Song et al. (2009)	statistical ordinal logistic regression	SOHO/MDI AR magnetograms (1996-2005)	1 day	gen. index R^2_N
Yuan et al. (2010)	statistical (combination of OLR + SVM)	photosp magn measu 230 AR (1996-2005)	24 hour	7 measurements
Mason & Hoeksema (2010)	superposed epoch (SPE) analysis	using 13 years of MDI/SOHO magnetogr	40 hour	G/H skill scores
Yuan et al. (2011)	ordinal logistic regression (OLR)	sunspot group class + photos magn param	-	accuracy, recall, PRE
Falconer et al. (2011)	measures of AR free magnetic energy	40,000 AR SOHO/MDI MAGN + flare history	24 hour	ACEP
Steward et al. (2011)	locate SPIL	LOS magnetograms from GONG	24 hour	PCP, PFA
Bloomfield et al. (2012)	average flare rates & Poisson probabilities	GOES X-ray flares & McIntosh class	24 hour	True Skill Statistics
Falconer et al. (2012)a	free magnetic energy + flare history	LOS magnetogram of 1300 AR	$\geq$ 24 hour	-
Crown (2012)	subjective flare probability	flare look-up table (1996-2008)	24 hour	Brier skill score
Ahmed et al. (2013)	adv feature extr, mach learn, feat selec	MF properties, XRF (Apr/1996-Dec/2010)	24 hour	8 measurements
Li & Zhu (2013)	MLP and learning vector quant	3-day data of SA, Mc/MW, 10.7 cm RF	48 hour	TP + TN + CRR
Jeong et al. (2014)	neural network – one layer MLP model	GOES X-ray flare data (1976-2011)	-	HM of POD & PRE
Winter et al. (2015)	KNN + nearest centroid	~50000 GOES X-ray flares (1986-2014)	24 hour	4 skill scores
Bobra & Couvidat (2015)	machine learning algorithm – SVM	SDO/HMI vector magnetic field data	P/24h, N/48h	True Skill Statistics
Korsós et al. (2015)	based on sunspot group evolution	SDD, peak of XRF (1996-2010)	2-10 hour	-
Guerra et al. (2015)	CPF of 4 methods	13 active regions (2012-2014)	24 hour	Heidke Skill Score
Muranushi et al. (2015)	simulated prediction GXRF 2-year each 1h	6160 combinations of SDO/HMI data	24 hour	True skill statistics
Amaya et al. (2015)	measures magn energ buildup & release AR	2 satellites at L1 & 1AU trailing Earth 80.o	several days	-
Shin et al. (2016)	multiple linear regression and ANN	SA, MFF, WTFF, WMFR of Mc/MW	24 hour	True Skill Statistics
Hada-Muranushi et al. (2016)b	deep learning with Define-by-Run scheme	max. GOES X-ray Flux (1-8 A)	24 hour	True skill statistics
Liu et al. (2017)	random forest algorithm	using SDO/HMI vector magnetic data	24 hour	True Skill Statistics
Murray et al. (2017)	calculate AFR e PM/X by PS	SDO/HMI	AR24h, FD4d	RPS
Nishizuka et al. (2017)	SVM, KNN, extremely randomized trees	UV brightening and vector magnet	24 hour	True Skill Statistics
Raboonik et al. (2017)	SVM	Zhernike moments of magnetograms	48 hour	11 skill scores
Kontogiannis et al. (2017)	unsigned non-neutralized currents in AR	SHARP, XRF (2012-2016)	24 hour	BI probabilities
Sadykov/Kosovichev (2017)	"Sigmoid" SVM on the PIL	LOS/vector magnetograms	-	True Skill Statistics

AU - Astronomical Unity; AR - Active Region; LOS - Line-of-Sight; SFT - Solar Flare Telescope; MAG - ; SFHGPSL - Strong Field, High-Gradient Polarity-Separation Lines; G/H - Gilbert/Heidke; GOES - Geostationary Operational Environmental Satellite; SC22-23 - Solar Cycles 22 e 23; PFER - Period of Flare Energy Release; GONG - Global Oscillation Network Group; PF - Peak Flux; FH - Flare Heliolongitude; SOHO/MDI - Solar & Heliospheric Observatory/Michelson Doppler Imager; SDO/HMI - Solar Dynamics Observatory/Helioseismic and Magnetic Imager; SPIL - Strong-Gradient Polarity Inversion Lines; MLP - Multi-Layer Perceptron; ANN - Artificial Neural Network; DT - Decision Tree; LVQ - Learning Vector Quantization; OLR - Ordinary Logistic Regression; PRED - Prediction; EQ - Equal; HI - High; SDD - SOHO/MDI + Debrecen Data; SVM - Support Vector Machine; KNN - K-Nearest Neighbour; Mc/MW - McIntosh/Mount Wilson classification; RF - radio flux; ASSIM - Assimilation; CPF - Combined Probabilistic Forecast; P - Positive Active Region; N - Negative Active Region; SA - Sunspot Area; PCP - Probability for Correct Prediction; PFA - Probability of False Alarms; TP - True Positive; TN - True Negative; CRR - Correctness; MFF - Maximum Flare Flux; WTFF - Weighted Total Flare Flux of previous day; WMFR - Weighted Mean Flare Rates; SS - Sill Score; HSS - Heidke Skill Score; GXRF - GOES X-Ray Flux; TSS - True Skill Score; MOSWOC - Met Office Space Weather Operations Centre; FD4d - Full Disk four day; GWILL - Gradient-Weighted Inversion-Line Length; PIL - Polarity Inversion Line; AFR - Average Flare Rate; PM/X - Probability of M/X-class flare; PS - Poisson statistics; RPS - Ranked Probability Score; HM - Harmonic Mean; POD - Probability Of Detection; PRE - Precision; FAR - False Alarm Rate; MF - Magnetic Feature; XRF - GOES X-ray Flare; TS - Time Series; SHARP - Space weather HMI Active Region Patches; BI - Bayesian-inferred; MAGN - Magnetogram; ACEP - All-Clear Event Probability

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Review

Habitabilidade Cósmica e a Possibilidade de Existência de Vida em Outros Locais do Universo

Cosmic Habitability and the Possibility of Life Existence in other Places of the Universe

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Este artigo aborda alguns aspectos relacionados ao conceito de vida como a conhecemos e explora a relação entre a evolução química do Universo e a produção dos elementos básicos da química prebiótica. Baseando-se no Modelo Cosmológico Padrão, são descritas as condições cosmológicas que levaram ao surgimento desses elementos e são mostradas evidências de que o Universo, em seus estágios primordiais, dispunha de elementos capazes de produzir substâncias orgânicas. É feita uma breve abordagem de como a química em ambientes astrofísicos leva à formação de compostos que fazem parte da cadeia de reações que conduz à formação dos "tijolos da vida". Finalmente, levantamos a hipótese que o universo poderia ter zonas habitáveis a partir dos primeiros 30 milhões da anos e que a condição de habitabilidade tem estreita relação com a sua evolução química, mesmo quando se leva em consideração a hipótese de diferentes universos.
Palavras-chave: Habitabilidade Cósmica, Astrobiologia, Astroquímica

This article discusses some aspects related to the concept of life as we know it and explores the relationship between the chemical evolution of the Universe and the production of the basic elements of prebiotic chemistry. Based on the Standard Cosmological Model, the cosmological conditions that led to the appearance of these elements are described and evidences are shown that the Universe, in its primordial stages, had elements capable of producing organic substances. Next section gives a short overview on how chemistry in astrophysical environments leads to the formation of compounds that are part of the chain of reactions that leads to the formation of the "bricks of life." Finally, we mention that the universe could have habitable zones from the first 30 million years and that the habitability condition has a close relation with its chemical evolution, even when one takes into account the hypothesis of different universes.
Keywords: Cosmic Habitability, Astrobiology, Astrochemistry

1. Introdução

A existência de vida no Universo tem permeado o pensamento humano desde os primórdios da civilização. Os avanços científicos do século XX, particularmente constituída de prótons, nêutrons e elétrons) que deu origem às estrelas e galáxias, observadas principalmente através da emissão de radiação eletromagnética. Uma cronologia da evolução do modelo padrão, bem como uma descrição atualizada e didática do "status"da cosmologia atual pode ser encontrada em

FIM

Obrigado !