The SIPTA Newsletter

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Theory and Applications
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Message from the editor

By Fabio G. Cozman, newsletter editor

In this issue of the SIPTA newsletter you will find a discussion of Johannes von Kries's connection to non-numerical probabilities, in our History section. This interesting piece is a contribution by Guido Fioretti, from the University of Modena and Reggio Emilia; I would like to thank Prof. Fioretti for his scholarly contribution, and highly recommend his other writings (that can be found in the site http://www.biblioreggio.unimo.it/fioretti/).

This issue of the newsletter also brings information on the coming 3rd International Symposium on Imprecise Probabilities and their Applications (ISIPTA '03), to occur in Lugano, Switzerland. You will find a word from the conference chairman, Marco Zaffalon, the list of accepted papers, tutorials, and invited talks.

If you have contributions to make to this newsletter, please let me know. Also, if you know of any event or publication that should be of interest to members of SIPTA, send a message about it to fgcozman@usp.br.

Cheers!

History section: The Cognitive Problem of Event Definition Insights from a XIX century logician

By Guido Fioretti
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At the end of the XIX century, a physiologist named Johannes von Kries was attempting at applying probability theory to the evaluation of the effectiveness of new drugs. Similarly to today's developers of expert systems for medical applications, von Kries realized that the main difficulty lied in the very definition of events. What should count as "healing"? That a patient dies one week later than if he did not take the drug? That the patient heals of a disease but takes on another one? Also, in some cases it is not obvious where the border between two or more diseases lies, so classification of symptoms is not obvious.

Von Kries [8, 9] got deeply involved in these issues and, as a side interest to his academic career as a physiology professor, he became a logician. Von Kries viewed probability as a logical relation based on analogy: by drawing analogies between the present and the past, e.g. between present symptoms and past ones, an individual is able to say that a certain event, e.g. a particular disease, is more or less "probable". Von Kries was very much ahead of his time, expecially because he did not think of mental categories — what we may call "events", e.g. diseases — as sets of elements exhibiting certain commonalities but rather as incremental collections where a new element is added because of similarity with a few other ones.

Von Kries stressed that, since similarity is a subjective judgement between phenomena that are objectively different, objective numerical probabilities are not possible for the same reason why one cannot compare apples and pears. Thus, any assessment of a numerical probabil-

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ity is subjective to the extent that it is grounded on a subjective judgement of similarity. In the medical context that von Kries had in mind, the degree of subjectiveness may be very high.

Through Keynes, the idea of non-numerical probability judgements passed on to economics, where evaluating the prospects of an investment involving novel technologies presents similar difficulties in terms of evaluating the similarity of the present situation to the past ones [2, 3, 4]. However, it is doubtful that Keynes read von Kries and, in any case, Keynes admitted to have based his statements on two review articles of von Kries's first book [5]. These review articles added several distortions to the original framework. Furthermore, Keynes forced von Kries's ideas into a foreign philosophical framework, so in the end the issue became quite confused.

The first review, by Alexius Meinong, attempted at transposing von Kries's ideas into the conventional framework of games of chance. Meinong expressed von Kries's ideas in terms of the similarity of the die that one was actually throwing to an ideal, perfectly symmetrical die. Meinong suggested that this similarity judgement spanned a different dimension as probability, so he proposed that two magnitudes should be used to characterise uncertainty. In itself, this was no big step away from von Kries. However Nitsche, a very marginal figure who wrote the second review article, stepped from here to the conclusion that the similarity of the actual die to the ideal one could be assessed by throwing the actual die sufficiently many times. Thus, in the hands of Nitsche all the originality of von Kries was lost and uncertainty evaluation was reduced to the usual pair of probability and sample size. Never forget that von Kries thought of a doctor drawing similarities between symptoms, a situation that cannot be solved by repeating infections sufficiently many times on the same individual.

The issue of non-numerical probabilities passed on from Meinong and Nitsche to the English-speaking literature through Keynes, who added a peculiar distortion of his own. At the time he was writing his *Treatise on Probability*, Keynes was a fervent neo-platonist who conceived of knowledge as arising from direct intuition of Truth. In particular, he was interested in claiming that certain individuals are not bound to following conventional moral values because they are able to grasp the true causal relationships that govern the world [1] (later in his life, Keynes recognized how dangerous his juvenile opinions were, and rejected them explicitly and absolutely [6]). In logical terms, certain individuals would be able to guess the true probability values of causal relationships.

Since the young Keynes thought of probability judgement as of immediately grasping objectively given relationships, the cognitive issues that concerned von Kries could not exist in his framework. On the other hand, Keynes did want to maintain the issue of non-numerical probabilities.

Thus, he ascribed to reality an atomistic character, with every phenomenon arising out of combination of a finite number of "qualities" that are available in infinite amounts. In this framework, uncertainty can arise out of ignorance of the amount of each quality (i.e. probability), as well as out of ignorance about qualities that might be there, but we do not know. The last aspect would be captured by a magnitude that Keynes called "weight".

Keynes's "weight" ultimately descends from Meinong's suggestion of a second magnitude to measure uncertainty, besides probability. However, it entails both qualitative aspects (which "qualities" might be there, of which we are unaware) and quantitative aspects (how many of them, i.e. the sample size). The first aspects is somehow akin to von Kries's original concerns, whereas the second one is, simply, the size of the sample. Consequently, Keynes's account lacks clarity.

Von Kries stands as a prominent figure in the development of probability theory, a very original thinker who has been unduly neglected. His greatest originality lies in explicitely considering the cognitive processes from which the set of events is defined, which is the premise from which every probability theory starts. He did so because, due to his experience as a physician, he was not biased to consider throwing dice or playing roulette as the prototypical situation where uncertainty arises. Incidentally, one can remark that another fundamental development in the mathematics of uncertain reasoning, namely Evidence Theory, originated from the fact that Glenn Shafer thought of a judge evaluating testimonies as the prototypical setting for uncertainty [7]. In effect, a physician evaluating symptoms is quite a similar situation to a judge evaluating testimonies, whereas both of them are conceptually far from playing dice.

References

[1] Bradley Bateman. *Keynes's Uncertain Revolution*. The University of Michigan Press, Ann Arbor, 1996.

[2] Guido Fioretti. John Maynard Keynes and Johannes von Kries. *History of Economic Ideas*, 6:51–80, 1998.

[3] Guido Fioretti. Von Kries and the other "German Logicians": Non-numerical probabilities before Keynes. *Economics and Philosophy*, 17:245–73, 2001.

[4] Guido Fioretti. No faith, no conversion: The evolution of Keynes's ideas on uncertainty under the influence of Johannes von Kries. In Soheji Mizuhara and Jochen Runde, editors, *Perspectives on the Philosophy of Keynes's Economics: Probability, Uncertainty and Convention*. Cambridge University Press, Cambridge, forthcoming 2004.

[5] John Maynard Keynes. *A Treatise on Probability*. MacMillan, London, 1921. Reprinted in *The Collected Writings of J.M.Keynes, vol. VIII*. London, MacMillan 1973.

[6] John Maynard Keynes. My early beliefs. In *The Collected Writings Of J.M.Keynes, vol. X*. MacMillan 1973, London, 1938.

[7] Glenn Shafer. *A Mathematical Theory of Evidence*. Princeton University Press, Princeton, 1976.

[8] Johannes von Kries. *Die Principien der Wahrscheinlichkeitsrechnung*. Verlag von J.C.B. Mohr (Paul Siebeck), Tübingen, 1886. Reprinted in 1927 by the same editor.

[9] Johannes von Kries. *Logik*. Verlag von J.C.B. Mohr (Paul Siebeck), Tübingen, 1886.

Related events and journals

The coming ISIPTA '03 is the most important event to mention in the field of imprecise probabilities; accordingly, we devote the next section entirely to it.

Apart from ISIPTA '03, we note the coming 19th Conference on Uncertainty in Artificial Intelligence (UAI) and the coming tutorial workshop "Beyond Monte Carlo: Introduction to Imprecise Probabilities."

Conference on Uncertainty in Artificial Intelligence

The 19th UAI is to occur in Acapulco, Mexico, from August 8 to August 10. Information on the UAI conference, including accepted papers, can be found at the site http://research.microsoft.com/uai2003/; as you will find there, "the scope of UAI is wide, including, but not limited to, representation, automated reasoning, learning, decision making and knowledge acquisition under uncertainty." In this coming UAI conference, you will find:

- The invited talk **Some Measures of incoherence: How not to gamble if you must**, by Teddy Seidenfeld, Carnegie Mellon University. Abstract:
  The degree of incoherence, when (one-sided) previsions are not made in accord with coherent (lower and upper) probabilities, is measured by a rate at which an incoherent bookie can be made into a sure loser. We consider each bet from three points of view: that of the gambler, that of the bookie, and a neutral viewpoint. We normalize each bet according to a point of view. The sure losses for incoherent previsions are standardized by a normalization, which leads to a rate of incoherence. Criteria for a normalization are offered and we discuss the range in rates of incoherence that result. We give examples of the measurement of incoherence of some classical statistical procedures. Also, we illustrate how an incoherent bookie might reason about pending gambles from within her/his state of incoherence in order not to increase the rate of incoherence.

- Several accepted papers are related to imprecise probabilities in various ways; the abstracts are not yet available, but a sample of related papers are:

  1. In connection to qualitative representations of probabilities:
     - Janneke Bolt, Silja Renooij, Linda van der Gaag. Upgrading ambiguous signs in QPNs.
  2. In connection to belief functions:
     - Liping Liu, Catherine Shenoy, Prakash Shenoy. A linear belief function approach to portfolio evaluation.
     - Phan H. Giang, Prakash Shenoy. Decision making with partially consonant belief functions.

3. In connection to lower/upper expectations:
   - Gert De Cooman, Marco Zaffalon. Updating with incomplete observations.
   - José Carlos Ferreira da Rocha, Fabio Gagliardi Cozman. Inference in polytrees with sets of probabilities.
4. In connection with fuzzy/possibilistic methods:
   - Richard Booth, Eva Richter. On revising fuzzy belief bases.
   - Francisco Mugica, Angela Nebot, Pilar Gomez. Dealing with uncertainty in fuzzy inductive reasoning methodology.
   - Sylvain Lagrue, Salem Benferhat, Odile Papini. Toward a possibilistic handling of partially ordered information.

For information on previous UAI conferences, go to the site of the Association for Uncertainty in Artificial Intelligence (http://www.auai.org).

Beyond Monte Carlo: Introduction to Imprecise Probabilities

This is a tutorial workshop to be held in conjunction with the World Congress on Risk, June 22 2003 (from 9:00 to 17:30), at the Sheraton Brussels Hotel and Towers, Place Rogier 3, Brussels 1210 Belgium. As you will find in the web site at http://www.ramas.com/ipbrussels.htm, "this tutorial introduces the notions of interval-valued probability and imprecisely specified probability distributions and reviews their uses in risk analysis. It will address the approaches of interval probabilities, probability bounds analysis, Dempster-Shafer theory, robust Bayes methods, and the theory of imprecise probabilities." Gert de Cooman and Scott Ferson will be presenting.

[Send a message to the newsletter editor at fgcozman@usp.br, if you know of an event/call for papers that should be in this section.]

ISIPTA '03

By Marco Zaffalon, conference chairman IDSIA, Istituto Dalle Molle di Studi sull'Intelligenza Artificiale, Switzerland

The 3rd International Symposium on Imprecise Probabilities and Their Applications will be held at the University of Lugano (Lugano, Switzerland). The symposium sessions will be held from July 15 till July 17, and they will be preceded by tutorials on July 14. Detailed information about the conference can be found at http://www.sipta.org/~isipta03/.

The ISIPTA symposia are characterized by the emphasis placed on discussion. This is in part due to the awareness that "imprecise probability" is a generic term for many different models. These models are close in representing uncertainty and randomness without requiring precise probabilities, but they can have different approaches to controversial issues, and they often use different languages. Discussions are a means to exchange ideas on controversial issues and to lean towards a common language and, perhaps, a unifying framework.

ISIPTA '03 will favour discussion primarily through the special format of the symposium: there will be no parallel sessions, and each paper will be presented both in plenary and in poster form. Plenary sessions are intended to introduce the main ideas of the papers in intuitive, non-technical way, and to stimulate general discussion. Poster sessions move the discussion to the technical level by giving the possibility to deepen the details of a paper in an informal way.

Discussion will be favoured also by enabling the attendees to share a common background. This is the spirit behind the five tutorials planned on 14 July 2003: tutorials will not only be aimed at students, but at all the people in order to let them share a common view on some basic ideas and models. Finally, discussion will be focused on specific important topics by means of the invited lectures. We are proud of having three distinguished scientists stimulating the debate about foundations and applications of imprecise probabilities.

Invited Tutorials, July the 14th 2003

Prior to the start of the technical sessions, there will be five invited tutorials of 75 minutes each. The tutorials will provide a gentle introduction to a wide range of important subject matters in imprecise probability, from foundational questions to models with potential for great impact on the application side. The tutorials are included in the (regular or student) registration fee.

1. **A gentle introduction to imprecise probability models and their behavioral interpretation**, Prof. Gert de Cooman, Ghent University, Belgium. Abstract:

The tutorial will introduce basic notions and ideas in the theory of imprecise probabilities. It will highlight the behavioural interpretation of several types of imprecise probability models, such as lower previsions, sets of probability measures and sets of desirable gambles; as well as their mutual relationships. Rationality criteria for these models, based on their interpretation, will be discussed, such as avoiding sure loss and coherence. We also touch upon the issues of conditioning, and decision making using such models.

2. **Imprecise Dirichlet model for multinomial data**, Dr. Jean-Marc Bernard, Universit Paris 5 & CNRS, France. Abstract:
The Imprecise Dirichlet Model (IDM) is a model for statistical inference and coherent learning from multinomial data, and, more generally, for categorical data under various sampling models. The IDM was proposed by Walley (1996, JRSS B, 58 No. 1, 3–57) as an alternative to other objective approaches to inference, since it aims at modeling prior ignorance about the unknown chances θ of a multinomial process. The IDM is an imprecise probability model in which prior uncertainty about θ is described by a set of prior Dirichlet distributions. The set of priors is updated, by the means of Bayes' theorem, into a set of Dirichlet posterior distributions, so that the IDM can be viewed as a generalization of Bayesian conjugate analysis. As in any imprecise probablity model, inferences can be summarized by computing upper and lower probabilities for any event of interest. The IDM induces prior ignorance (characterized by maximally imprecise probabilities) about θ and many other derived parameters. The IDM has many advantages over alternative objective inferential models. It satisfies several general principles for inference which no other model jointly satisfies: symmetry, coherence, likelihood principle, and other desirable invariance principles. By conveniently chosing its hyperparameter s (which determines the extent of imprecision), the IDM can be tailored to encompass alternative objective models, either frequentist or Bayesian. After presenting the IDM, both from the parametric viewpoint (inferences about θ) and the predictive viewpoint (inferences about future observations), we shall review its major properties, and then focus on applications of the IDM for various statistical problems.

3. **Partial identification of probability distributions**, Prof. Charles F. Manski, Northwestern University, USA. Abstract:
This tutorial exposits elements of the research program presented in Manski, C., Partial Identification of Probability Distributions, Springer-Verlag, 2003. The approach is deliberately conservative. The traditional way to cope with sampling processes that partially identify population parameters has been to combine the available data with assumptions strong enough to yield point identification. Such assumptions often are not well motivated, and empirical researchers often debate their validity. Conservative analysis enables researchers to learn from the available data without imposing untenable assumptions. It also makes plain the limitations of the available data. Whatever the particular subject under study, the approach follows a common path. One first specifies the sampling process generating the available data and ask what may be inferred about population parameters of interest in the absence of assumptions restricting the population distribution. One then asks how the (typically) set-valued identification regions for these parameters shrink if certain assumptions (e.g., statistical independence or monotonicity assumptions) are imposed. Major areas of application include regression with missing outcome or covariate data, analysis of treatment response, and decomposition of probability mixtures.

4. **Graph-theoretic models for multivariate modeling with imprecise probabilities**, Prof. Fabio G. Cozman, University of Sao Paulo, Brazil. Abstract:
Markov chains, Markov fields, Bayesian networks, and influence diagrams are often used to construct standard probability models. These models share the property that they are based on graphs. We ask, how do these models behave when probability values are imprecise? What are the independence concepts at play, and what are the computational tools that we could use to manipulate the resulting models? This tutorial will describe results that have been obtained in recent years, mostly in the field of artificial intelligence, concerning graphical models and imprecise probabilities. Most results have focused on directed acyclic graphs, with interesting applications ranging from classification to sensitivity analysis in expert systems.

5. **Imprecise probabilities and ambiguity aversion in economic modeling**, Prof. Sujoy Mukerji, Oxford University, UK. Abstract:
   The talk will have, roughly, two parts. The first part will give an introductory account of decision theoretic frameworks, useful in economic modeling, that incorporate the hypothesis that cognitive limitations may imply that decision makers' beliefs are represented by imprecisie probabilities. The second part will discuss some examples of economic modeling that apply such frameworks.

Accepted Papers

- Joaquín Abellán, Serafín Moral. Maximum of entropy in credal classification.
- Thomas Augustin. On the suboptimality of the generalized Bayes rule and robust Bayesian procedures from the decision theoretic point of view — a cautionary note on updating imprecise priors.
- Jean-Marc Bernard. Analysis of local or asymmetric dependencies in contingency tables using the imprecise Dirichlet model.
- Veronica Biazzo, Angelo Gilio, Giuseppe Sanfilippo. Some results on generalized coherence of conditional probability bounds.
- Andrew Bronevich. The maximal variation of fuzzy interval.
- David V. Budescu , Tzur Karelitz. Inter-personal communication of precise and imprecise subjective probabilities.
- Andrea Capotorti. Relevance of qualitative constraints in diagnostic processes.
- Marco Cattaneo. Combining belief functions issued from dependent sources.
- Frank Coolen, Ke-Jian Yan. Nonparametric predictive comparison of two groups of lifetime data.
- Fabio Gagliardi Cozman. Computing lower expectations with Kuznetsov's independence condition.
- Fabio Cuzzolin. Geometry of upper probabilities.
- James M. Dickey. Convenient interactive computing for coherent imprecise prevision assessment.
- Serena Doria. Independence with respect to upper and lower conditional probabilities assigned by Hausdorff outer and inner measures.
- Pablo Ignacio Fierens, Terrence Fine. Towards a chaotic probability model for frequentist probability: The univariate case.
- Peter Gillett, Glenn Shafer, Richard Scherl. Subjective probability and lower and upper prevision: A new understanding.
- Minh Ha Duong. Bounding the risk of lung cancer attributed to other environmental pollutants.
- Javier Hernández, Jacinto Martín, José Pablo Arias, Alfonso Suarez-Llorens. Bayesian robustness with quantile loss functions.
- Marcus Hutter. Robust estimators under the imprecise Dirichlet model.
- Jean-Yves Jaffray, Meglena Jeleva. How to deal with incomplete acts? A proposal.
- Radim Jirousek. On approximating multidimensional probability distributions by compositional models.
- George J. Klir. An update on generalized information theory.
- Igor Kozine, Victor Krymsky. Reducing uncertainty by imprecise judgements on probability distributions: Application to system reliability.
- Elmar Kriegler, Hermann Held. Climate projections for the 21st century using random sets.
- Aron Larsson, Mats Danielson, Love Ekenberg, Jim Johansson. The DecideIT decision tool.
- Radu Lazar, Glen Meeden. Exploring a collection of priors arising from an imprecise probability assessment based on linear constraints.
- Sebastian Maass. Continuous linear representation of coherent power previsions.
- Fabio Maccheroni, Massimo Marinacci, Erio Castagnoli. Expected utility with multiple priors.
- Enrique Miranda, Inés Couso, Pedro Gil. Study of the probabilistic information of a random set.
- Darryl Morrell, Wynn Stirling. An extended set-valued Kalman filter.
- Robert Nau. The shape of incomplete preferences.
- Renato Pelessoni, Paolo Vicig. Convex imprecise previsions: Basic issues and applications.
- Gerd Peschl. Reliability analysis in geotechnics with finite elements - Comparison of probabilistic, stochastic and fuzzy set methods.
- Erik Quaeghebeur, Gert de Cooman. Game-theoretic learning using the imprecise Dirichlet model.
- Huguette Reynaerts, Michèle Vanmaele. A sensitivity analysis for the pricing of call options in a binary tree model.
- José Carlos Ferreira da Rocha, Fabio Gagliardi Cozman. Inference in credal networks with branch-and-bound algorithms.

- Mark Schervish, Teddy Seidenfeld, Joseph Kadane, Isaac Levi. Extensions of expected utility theory and some limitations of pairwise comparisons.
- Damjan Skulj. Products of capacities derived from additive measures (Extended abstract).
- Matthias Troffaes, Gert de Cooman. Dynamic programming for discrete-time systems with uncertain gain.
- Lev Utkin. A second-order uncertainty model of independent random variables: An example of the stress-strength reliability.
- Lev Utkin, Thomas Augustin. Decision making with imprecise second-order probabilities.
- Barbara Vantaggi. Graphical representation of asymmetric graphoid structures.
- Jirina Vejnarova. Design of iterative proportional fitting procedure for possibility distributions.
- Anton Wallner. Bi-elastic neighbourhood models.
- Kurt Weichselberger, Thomas Augustin. On the symbiosis of two concepts of conditional interval probability.

Invited Talks and Contributions

The following are the invited talks and contributions at ISIPTA '03. These are included in the registration fee.

- **Theories of probability: Some questions about foundations** (banquet talk), Terrence L. Fine, Professor of Electrical & Computer Engineering and Statistical Science, School of Electrical and Computer Engineering and Center for Applied Mathematics, Cornell University, USA. Abstract:
  We consider some of the following questions and offer some thoughts but no answers. How do we recognize probabilistic reasoning and its armature of probability theory? How is the study of probabilistic reasoning distinguished from study of other forms of indeterminacy, imprecision, and vagueness? Methodology or theory? What counts as a theory of probability and what does not? Is there a unified concept of probability? Is probability fundamental or is it merely a convenient placeholder for a more detailed account? Can we judge "adequacy" (satisfaction, success) outside of the very methodology/theory of probability we are using? Is a pragmatic stance sufficient or merely defeatist? Is self-consistency sufficient or at most necessary? What are examples of domains, however small, and probability theories for them that are unproblematic? What are examples of conceptual frameworks or spaces within which to have this discussion?

- **The accumulation of imprecise weights of evidence**, Irving J. Good, University Distinguished Professor Emeritus, Virginia Tech., USA. (Unfortunately, Prof. Good will be unable to come to Lugano for ISIPTA '03, but he should be available to reply to questions the attendees will raise on his contribution.) Abstract:
  A familiar method for modeling imprecise or partially ordered probabilities is to regard them as interval valued. It is proposed here that it is better to assume a Gaussian form for the logarithm of the probabilities. To fix the hyperparameters of the Gaussian curve one could make judgements for the quartiles for example. The same comment applies for weights of evidence. The reason for this proposal is that when the pieces of evidence are statistically independent one has additivity and the addition of Gaussian curves is easy to perform. When the pieces of evidence are dependent, there is a more general additivity, or one might be able to allow for interactions of various orders. Possible applications would be to legal trials and to differential diagnosis in medicine, or even for distinguishing between two hypotheses in general.

- **Application of nonmonotonic upper probabilities to quantum entanglement**, Patrick Suppes, Lucie Stern Professor of Philosophy, Emeritus, Stanford University, USA. Abstract:
  A well-known property of quantum entanglement phenomena is that random variables representing the observables in a given experiment do not have a joint probability distribution. The main point of this lecture is to show how a generalized distribution, which is a nonmonotonic upper probability distribution, can be used for all the observables in two important entanglement cases: the four random variables or observables used in Bell-type experiments and the six correlated spin observables in three-particle GHZ-type experiments. Whether or not such upper probabilities can play a significant role in the conceptual foundations of quantum entanglement will be discussed.

Banquet and Lunches

The conference banquet will be offered at the restaurant of Castelgrande castle in Bellinzona, the capital of the Ticino canton. Castelgrande is a 13rd century castle placed on top of a huge cliff and it provides an incredible view up and down the valley. The castle is one of the most important historical monuments of Ticino. In 2000, Castelgrande and two other castles in Bellinzona (Montebello and Sasso Corbaro) were awarded the UNESCO's prestigious international status of world heritage sites, a honor shared only by three other Swiss monuments: the old town of Bern, the Abbey of St. Gallen and the Mstair convent.

The registration fee includes four lunches on the days 14–17 July. The lunches will be offered at the restaurant of the Lugano 1 high school, in the middle of the beautiful Ciani park.

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