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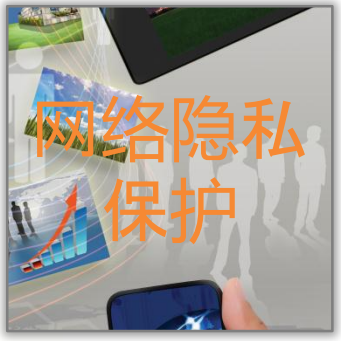

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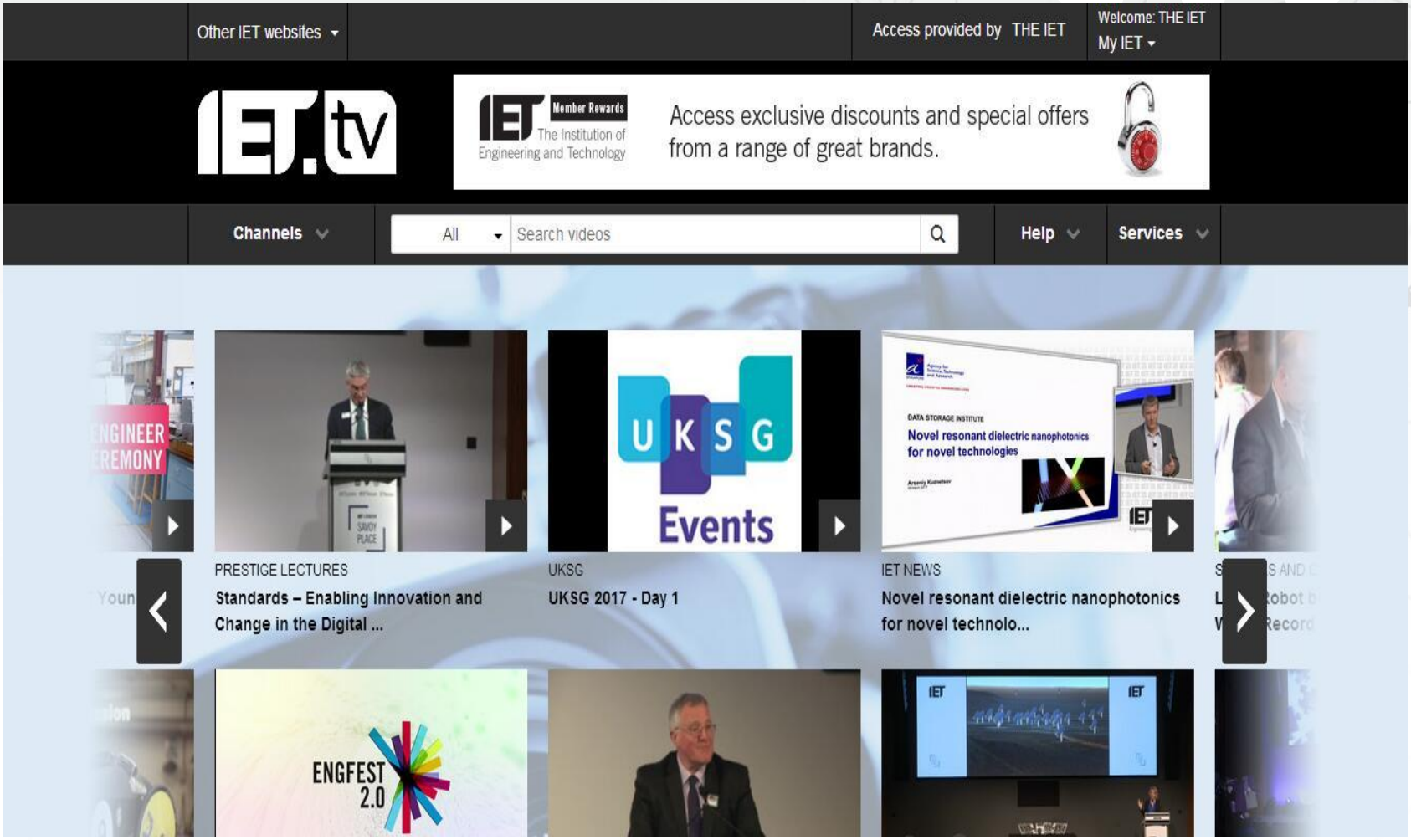

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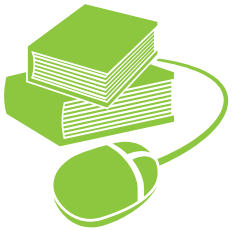

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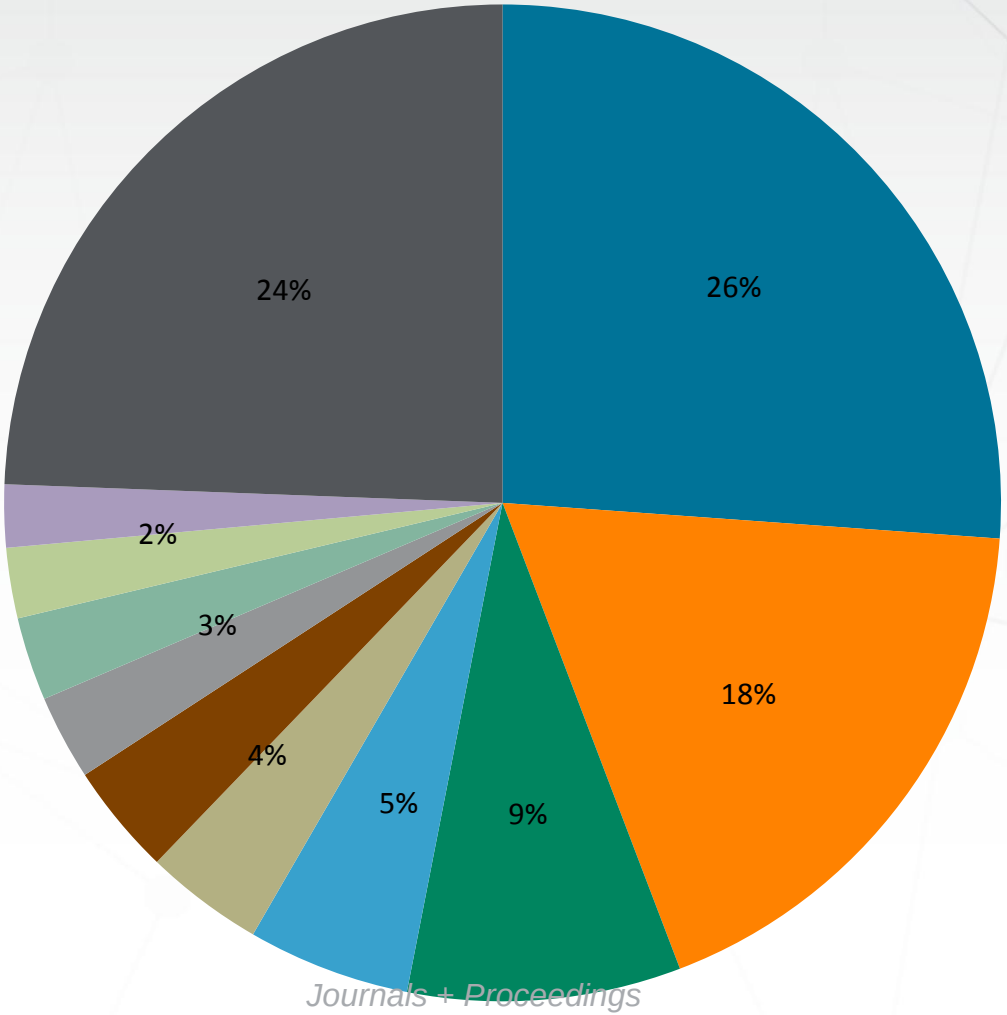

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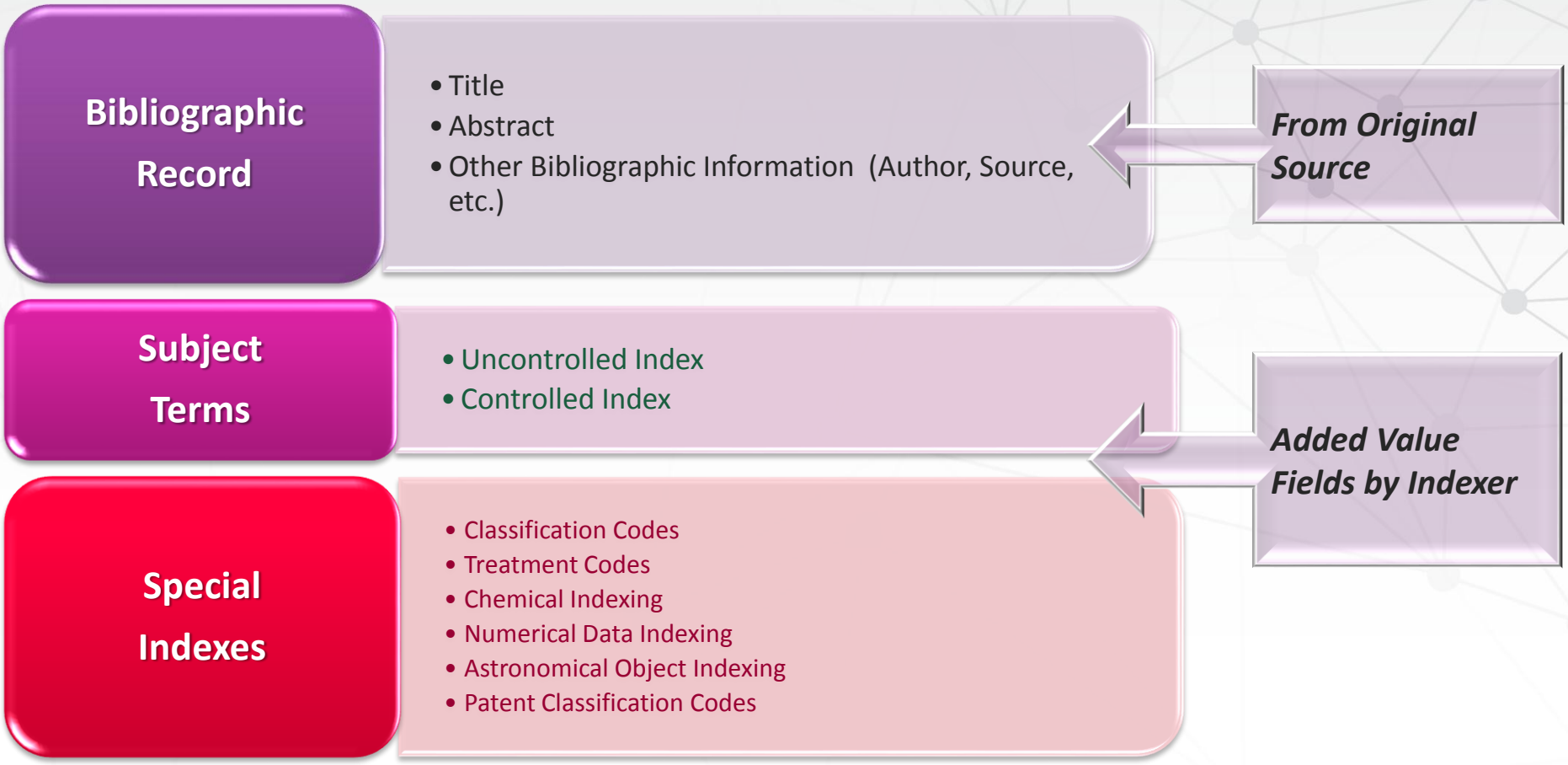
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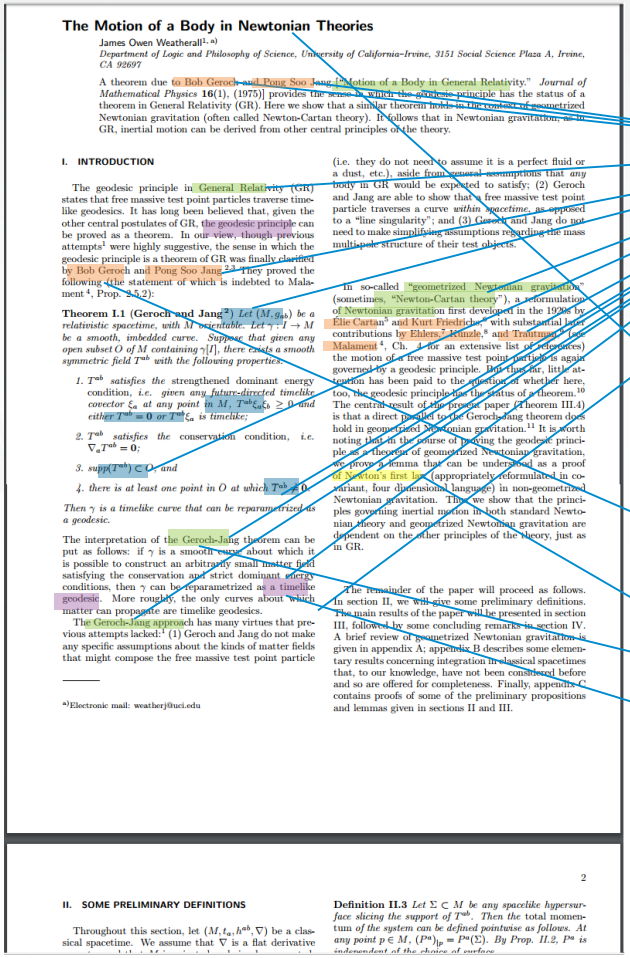

The Motion of a Body in Newtonian Theories

James Owen Weatherall[1, a)]

Department of Logic and Philosophy of Science, University of California–Irvine, 3151 Social Science Plaza A, Irvine, CA 92697

A theorem due to Bob Geroch and Pong Soo Jang ["Motion of a Body in General Relativity." *Journal of Mathematical Physics* **16**(1), (1975)] provides the sense in which the geodesic principle has the status of a theorem in General Relativity (GR). Here we show that a similar theorem holds in the context of geometrized Newtonian gravitation (often called Newton-Cartan theory). It follows that in Newtonian gravitation, as in GR, inertial motion can be derived from other central principles of the theory.

I. INTRODUCTION

The geodesic principle in General Relativity (GR) states that free massive test point particles traverse time-like geodesics. It has long been believed that, given the other central postulates of GR, the geodesic principle can be proved as a theorem. In our view, though previous attempts[1] were highly suggestive, the sense in which the geodesic principle is a theorem of GR was finally clarified by Bob Geroch and Pong Soo Jang.[2,3] They proved the following (the statement of which is indebted to Malament [4], Prop. 2.5.2):

Theorem I.1 (Geroch and Jang[2]) *Let (M, g_{ab}) be a relativistic spacetime, with M orientable. Let $\gamma : I \to M$ be a smooth, imbedded curve. Suppose that given any open subset O of M containing $\gamma[I]$, there exists a smooth symmetric field T^{ab} with the following properties:*

1. *T^{ab} satisfies the* strengthened dominant energy condition, *i.e. given any future-directed timelike covector ξ_a at any point in M, $T^{ab}\xi_a \geq 0$ and either $T^{ab} = 0$ or $T^{ab}\xi_a$ is timelike;*
2. *T^{ab} satisfies the* conservation condition, *i.e. $\nabla_a T^{ab} = 0$;*
3. *$supp(T^{ab}) \subset O$; and*
4. *there is at least one point in O at which $T^{ab} \neq 0$.*

Then γ is a timelike curve that can be reparametrized as a geodesic.

The interpretation of the Geroch-Jang theorem can be put as follows: if γ is a smooth curve about which it is possible to construct an arbitrarily small matter field satisfying the conservation and strict dominant energy conditions, then γ can be reparametrized as a timelike geodesic. More roughly, the only curves about which matter can propagate are timelike geodesics.

The Geroch-Jang approach has many virtues that previous attempts lacked:[1] (1) Geroch and Jang do not make any specific assumptions about the kinds of matter fields that might compose the free massive test point particle (i.e. they do not need to assume it is a perfect fluid or a dust, etc.), aside from general assumptions that *any* body in GR would be expected to satisfy; (2) Geroch and Jang are able to show that a free massive test point particle traverses a curve *within* spacetime, as opposed to a "line singularity"; and (3) Geroch and Jang do not need to make simplifying assumptions regarding the mass multipole structure of their test objects.

In so-called "geometrized Newtonian gravitation" (sometimes, "Newton-Cartan theory"), a reformulation of Newtonian gravitation first developed in the 1920s by Élie Cartan[5] and Kurt Friedrichs[6] with substantial later contributions by Ehlers,[7] Trautman,[8] and Trautman,[9] (see Malament [4], Ch. 4 for an extensive list of references) the motion of a free massive test point particle is again governed by a geodesic principle. Until now, little attention has been paid to the question of whether here, too, the geodesic principle has the status of a theorem.[10] The central result of this present paper (Theorem III.4) is that a direct parallel to the Geroch-Jang theorem does hold in geometrized Newtonian gravitation.[11] It is worth noting that in the course of proving the geodesic principle as a theorem of geometrized Newtonian gravitation, we prove a lemma that can be understood as a proof of Newton's first law (appropriately reformulated in covariant, four dimensional language) in geometrized Newtonian gravitation. Thus we show that the principles governing inertial motion in both standard Newtonian theory and geometrized Newtonian gravitation are dependent on the other principles of the theory, just as in GR.

The remainder of the paper will proceed as follows. In section II, we will give some preliminary definitions. The main results of the paper will be presented in section III, followed by some concluding remarks in section IV. A brief review of geometrized Newtonian gravitation is given in appendix A; appendix B describes some elementary results concerning integration in classical spacetimes that, to our knowledge, have not been considered before and so are offered for completeness. Finally, appendix C contains proofs of some of the preliminary propositions and lemmas given in sections II and III.

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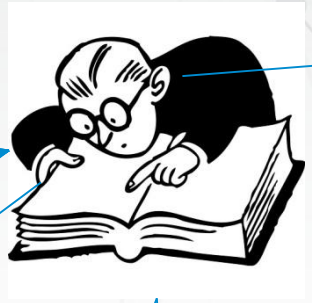
II. SOME PRELIMINARY DEFINITIONS

Throughout this section, let (M, t_a, h^{ab}, ∇) be a classical spacetime. We assume that ∇ is a flat derivative

Definition II.3 *Let $\Sigma \subset M$ be any spacelike hypersurface slicing the support of T^{ab}. Then the* total momentum *of the system can be defined pointwise as follows. At any point $p \in M$, $(P^a)_p = P^a(\Sigma)$. By Prop. II.2, P^a is*



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Title: Branching fraction measurements of $B \to \eta_c K$ decays

Author(s): Aubert, B.; Barate, R.; Boutigny, D.; Couderc, F.; Gaillard, J.-M.; Hicheur, A.; Karyotakis, Y.; Lees, J. P.; Tisserand, V.;

Affiliation(s): BABAR Collaboration, SLAC, Stanford Univ., CA, USA

Journal: Physical Review D

Abstract: We study the decays $B^+ \to \eta_c K^+$ and $B^0 \to \eta_c K^0$, where the η_c is reconstructed in the $K_S^0 K^\pm \pi^\mp$ and $K^+K^-\pi^0$ decay modes. Results are based on a sample of 86 million BB pairs collected with the BABAR detector at the SLAC e^+e^- B Factory. We measure the product of branching fractions $B(B^+ \to \eta_c K^+) \times B(\eta_c \to K\bar{K}\pi) = (7.40 \pm 0.50 \pm 0.70) \times 10^{-5}$ and $B(B^0 \to \eta_c K^0) \times B(\eta_c \to K\bar{K}\pi) = (6.48 \pm 0.85 \pm 0.71) \times 10^{-5}$, where the first error is statistical and the second is systematic. In addition, we search for $B \to \eta_c K$ events with $\eta_c \to 2(K^+K^-)$ and $\eta_c \to \phi\phi$ and determine the η_c decay branching fraction ratios $B(\eta_c \to 2(K^+K^-))/B(\eta_c \to K\bar{K}\pi) = (2.3 \pm 0.7 \pm 0.6) \times 10^{-2}$ and $B(\eta_c \to \phi\phi)/B(\eta_c \to K\bar{K}\pi) = (5.5 \pm 1.4 \pm 0.5) \times 10^{-2}$. (20 refs.)

Free Indexing: B+ decay into etac+kaon+; B0 decay into etac+kaon0; B-antiB pairs; etac decay into kaon+antikaon+pion;
B decay into etac+kaon; etac decay into kaon+-kaon-; etac decay into phi+phi; branching fraction

Controlled indexing: B mesons; eta mesons; kaon production; meson hadronic decay; phi mesons; pion production.

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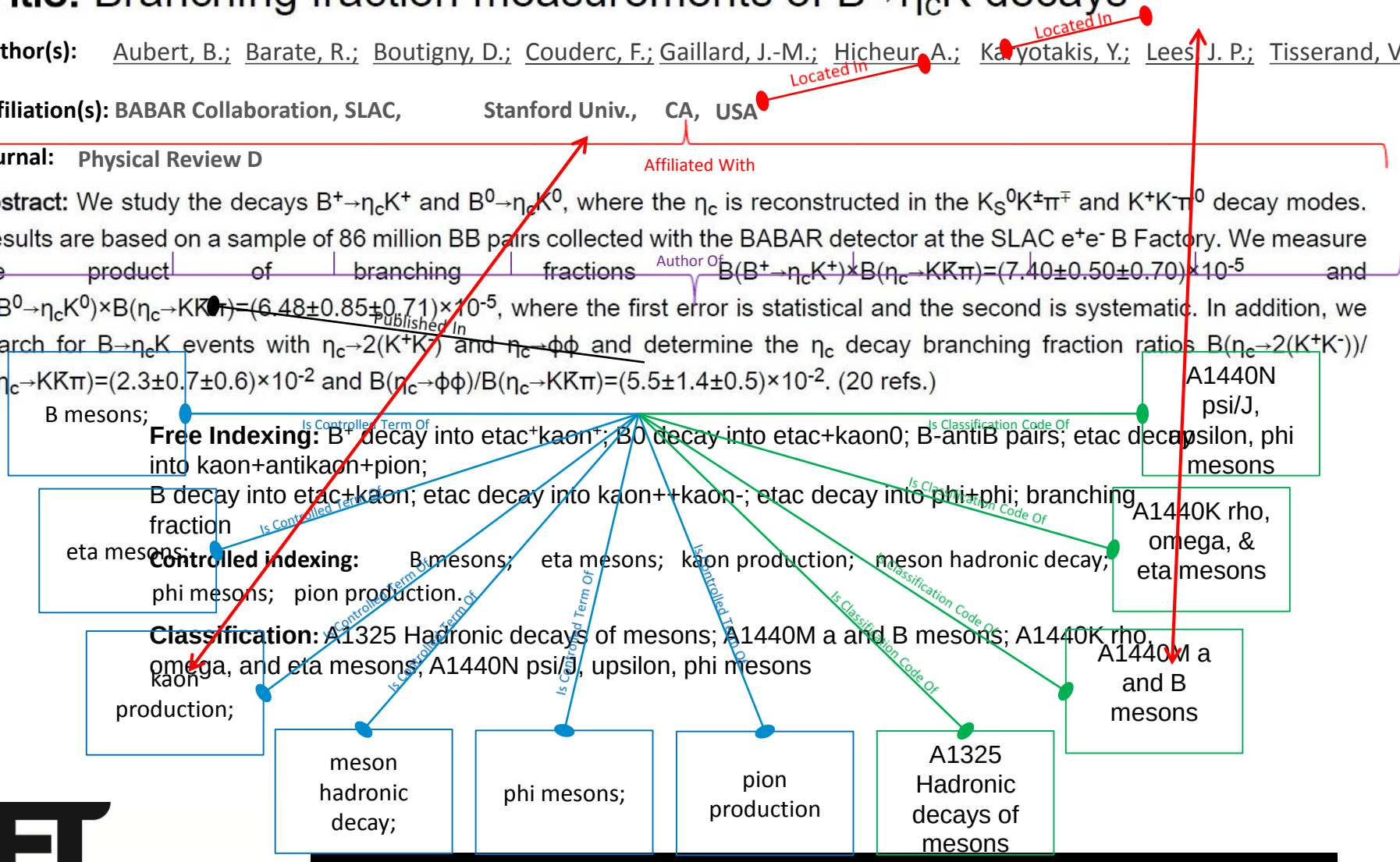

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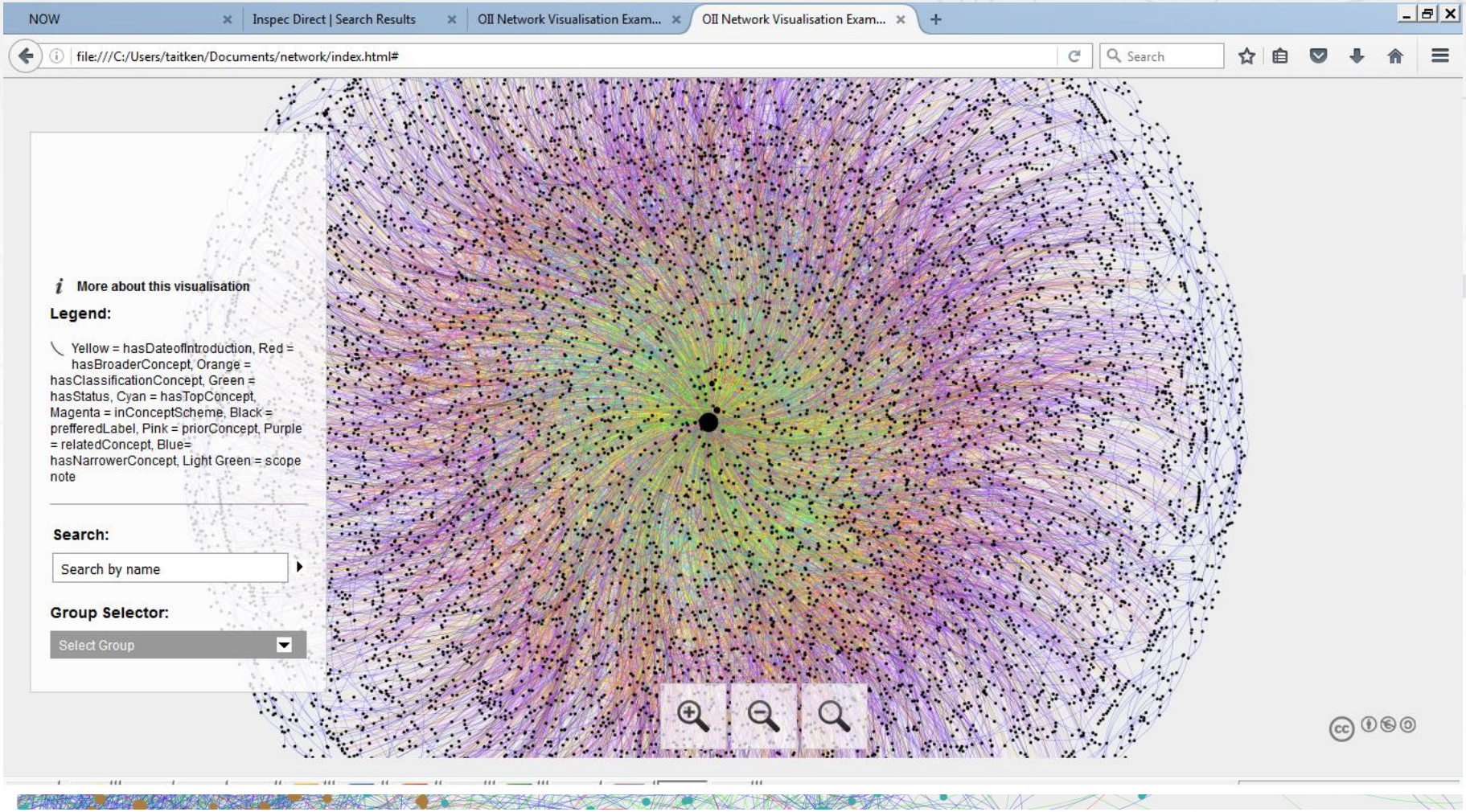

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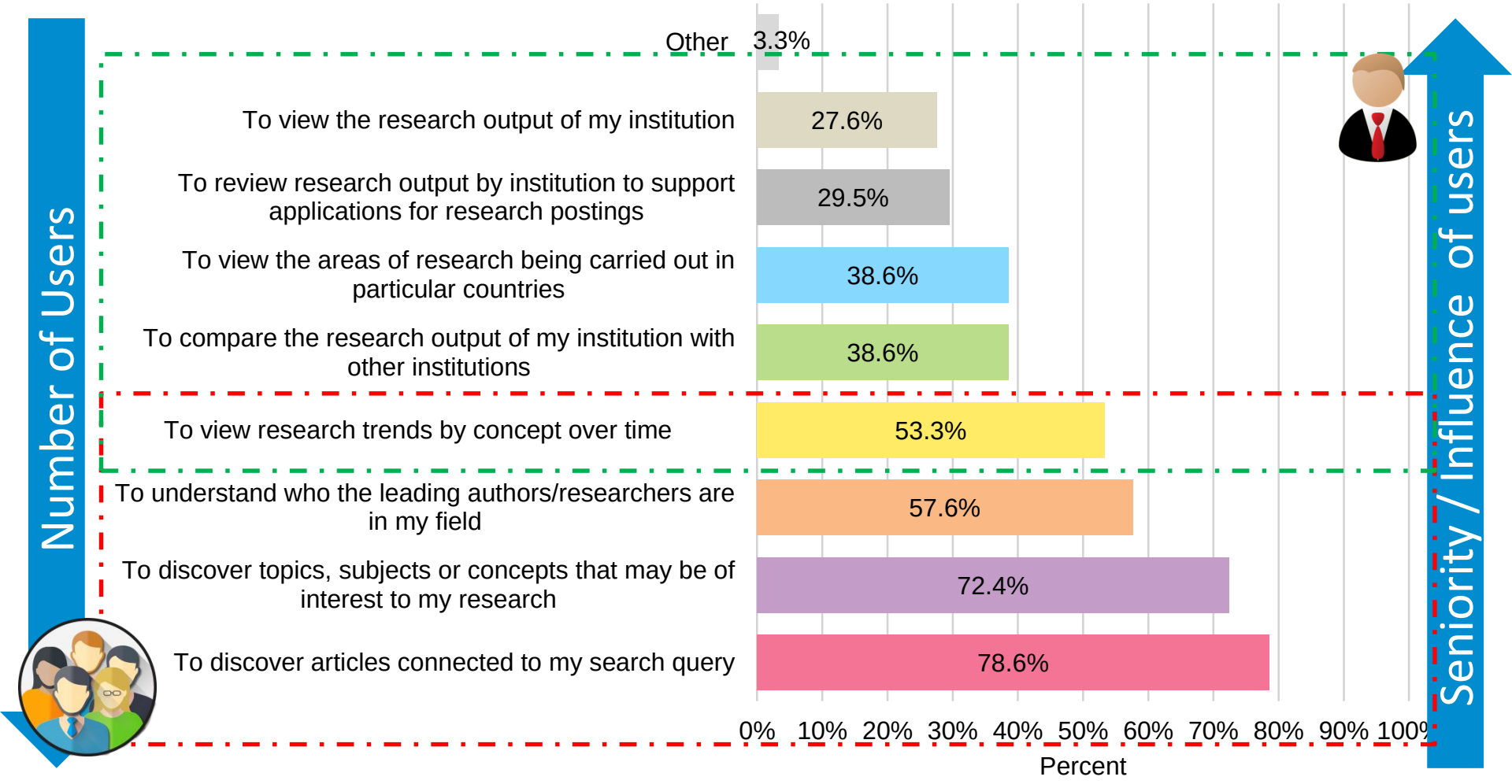

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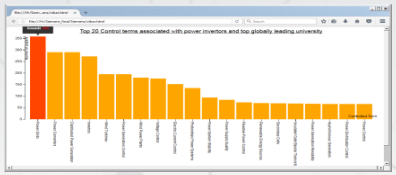

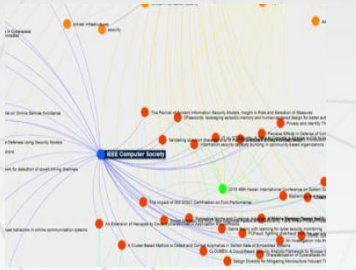

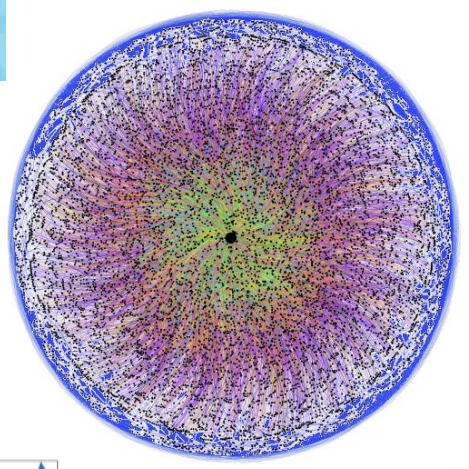

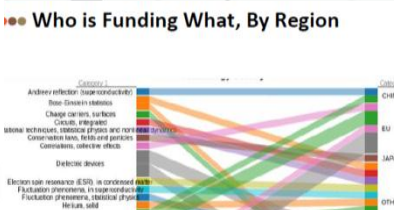

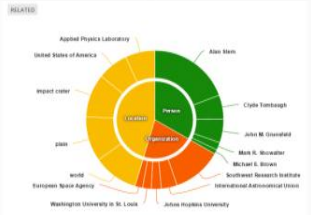

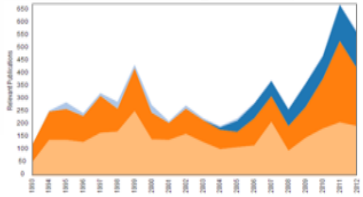

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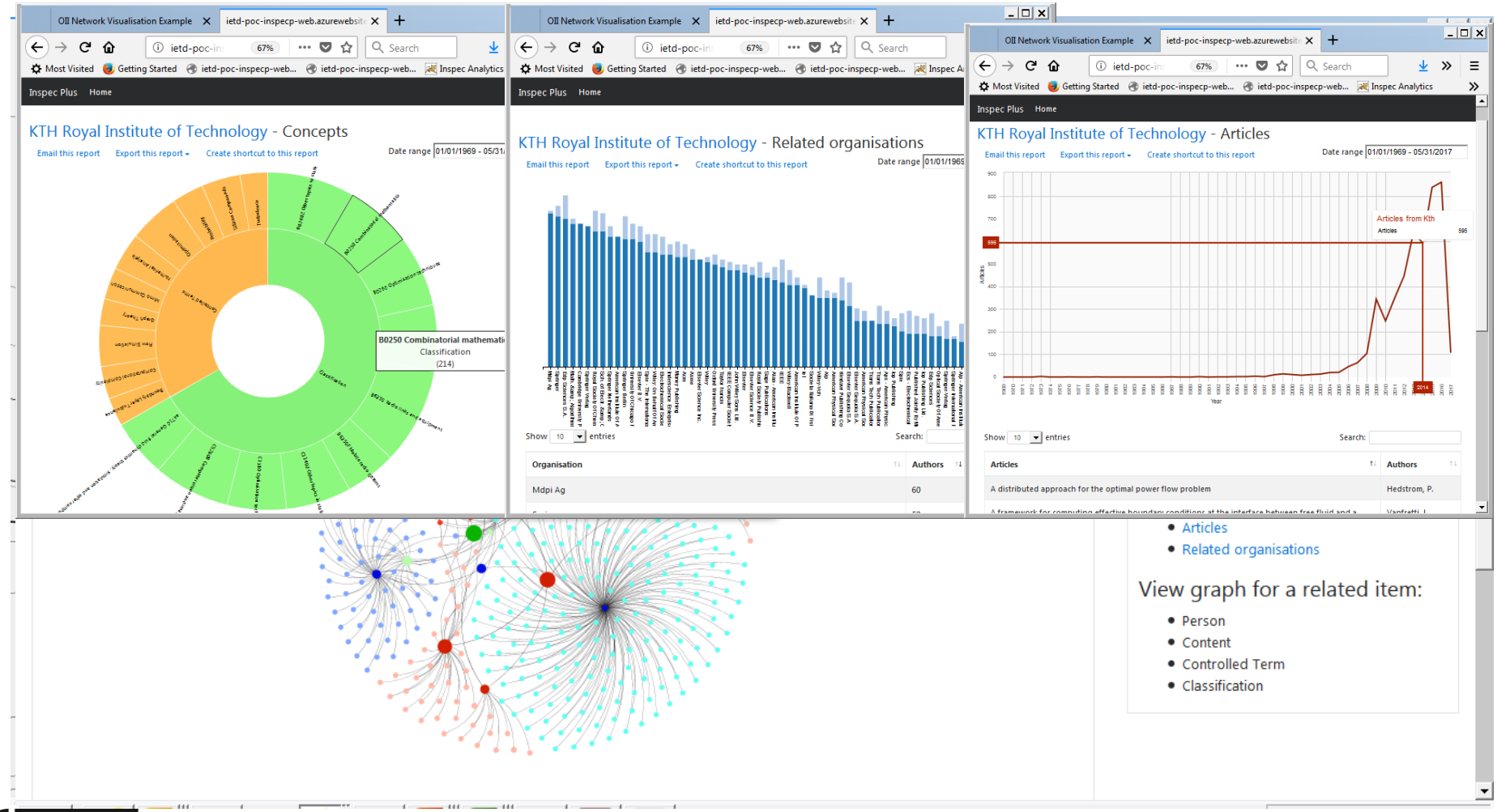

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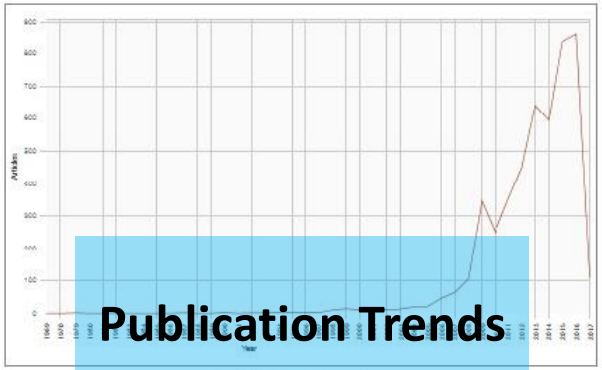
It is the thinnest compound known to man at one atom thick, the lightest material known (with 1 square meter coming in at around 0.77 milligrams), the strongest compound discovered (between 100-300 times stronger than steel and with a tensile stiffness of 150,000,000 psi), the best conductor of heat at room temperature (at (4.84±0.44) × 10^3 to (5.30±0.48) × 10^3 W·m−1·K−1) and also the best conductor of electricity known (studies have shown electron mobility at values of more than 15,000 cm2·V−1·s−1). Other notable properties of graphene are its unique levels of light absorption at πα ≈ 2.3% of white light, and its potential suitability for use in spin transport.



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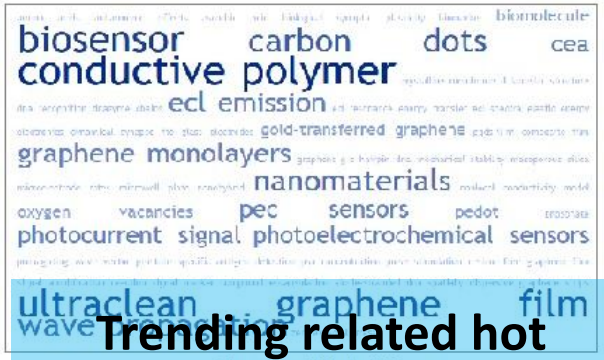

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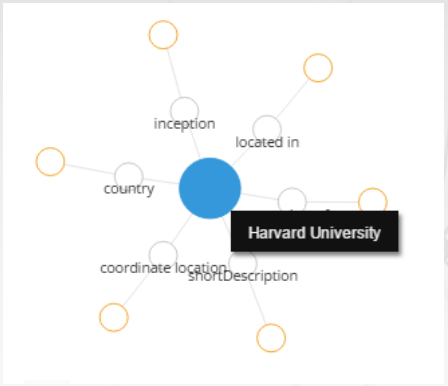

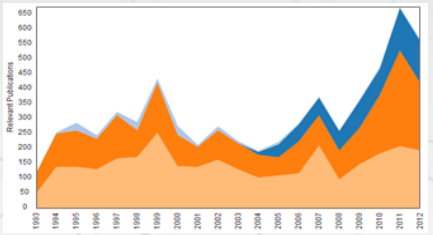

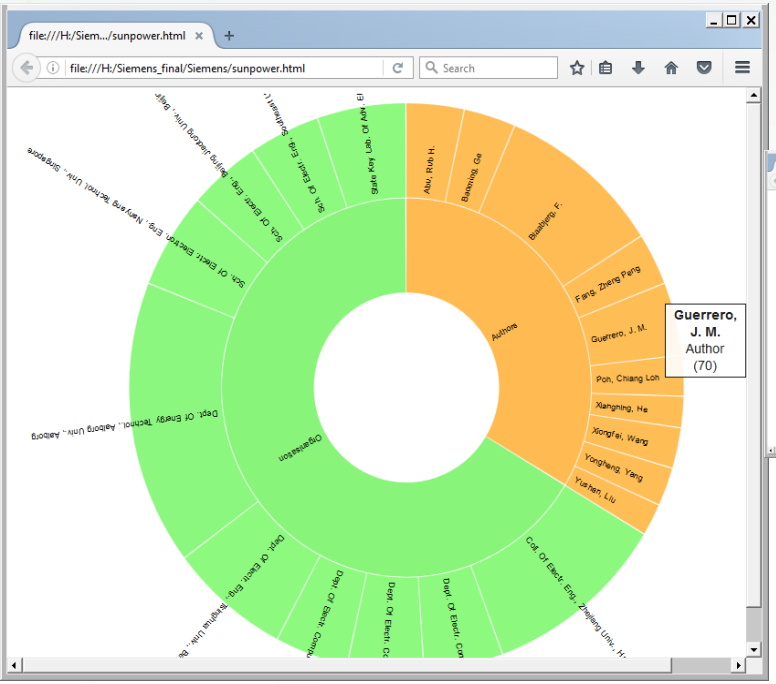

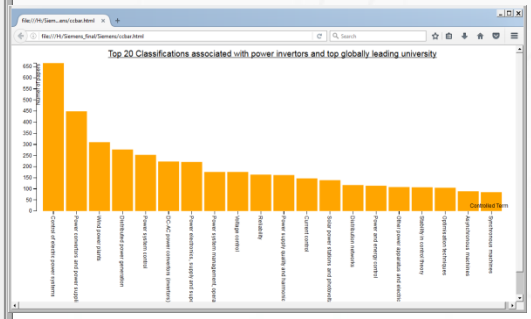

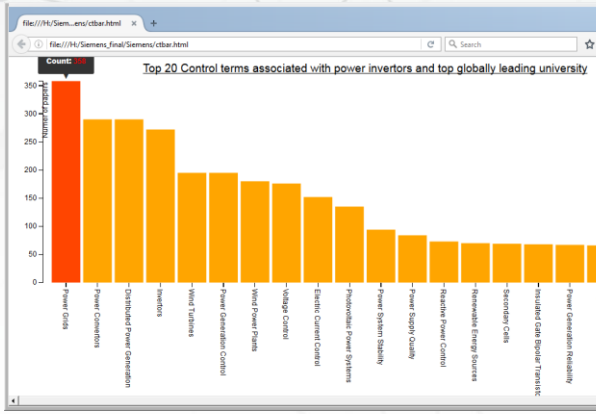

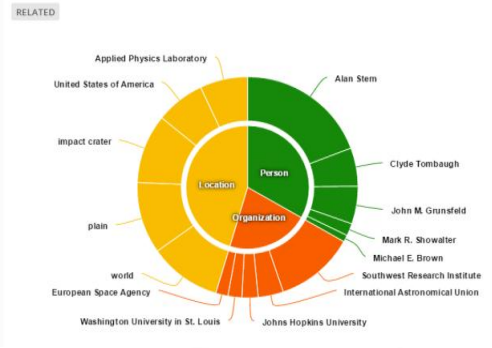

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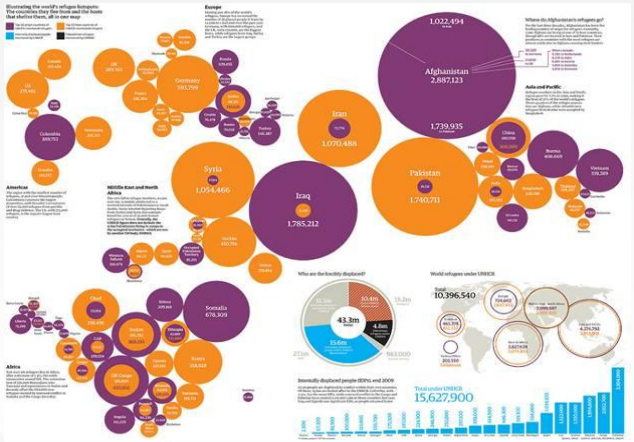
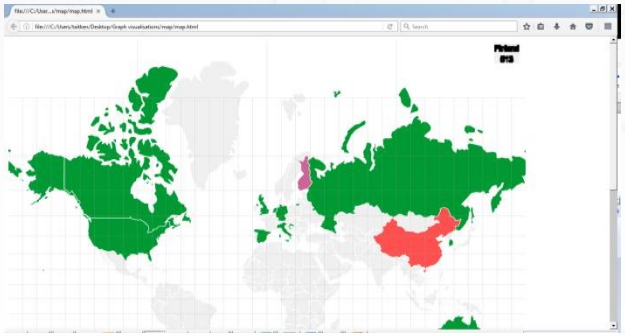
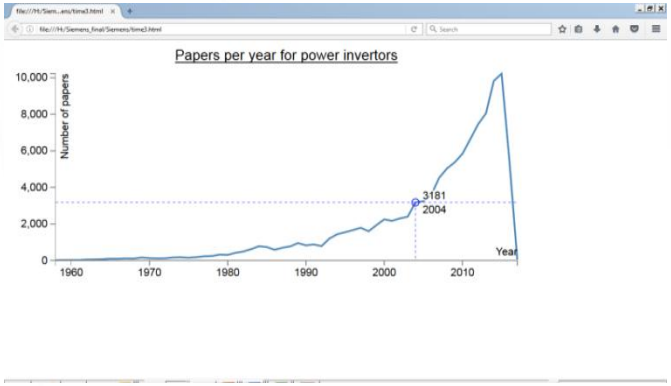
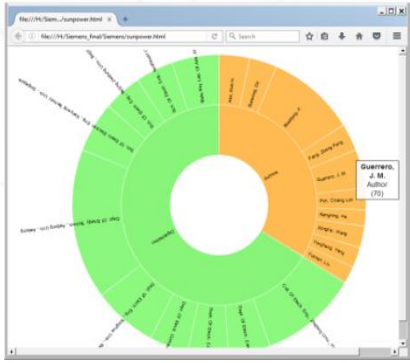
多种度量参数组合，衡量国家或机构科研产出

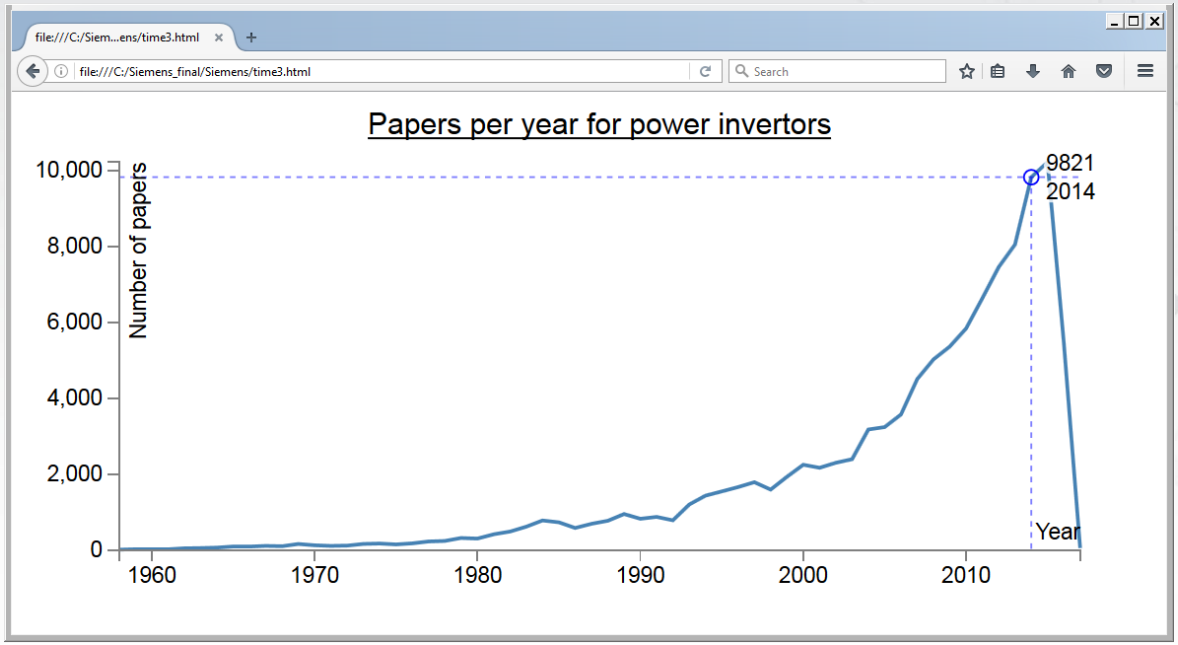








- 环向观察
- 趋势分析
- 研究方向地区分析
- 变化趋势
- 相关主题覆盖范围 (by institution etc)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2,000
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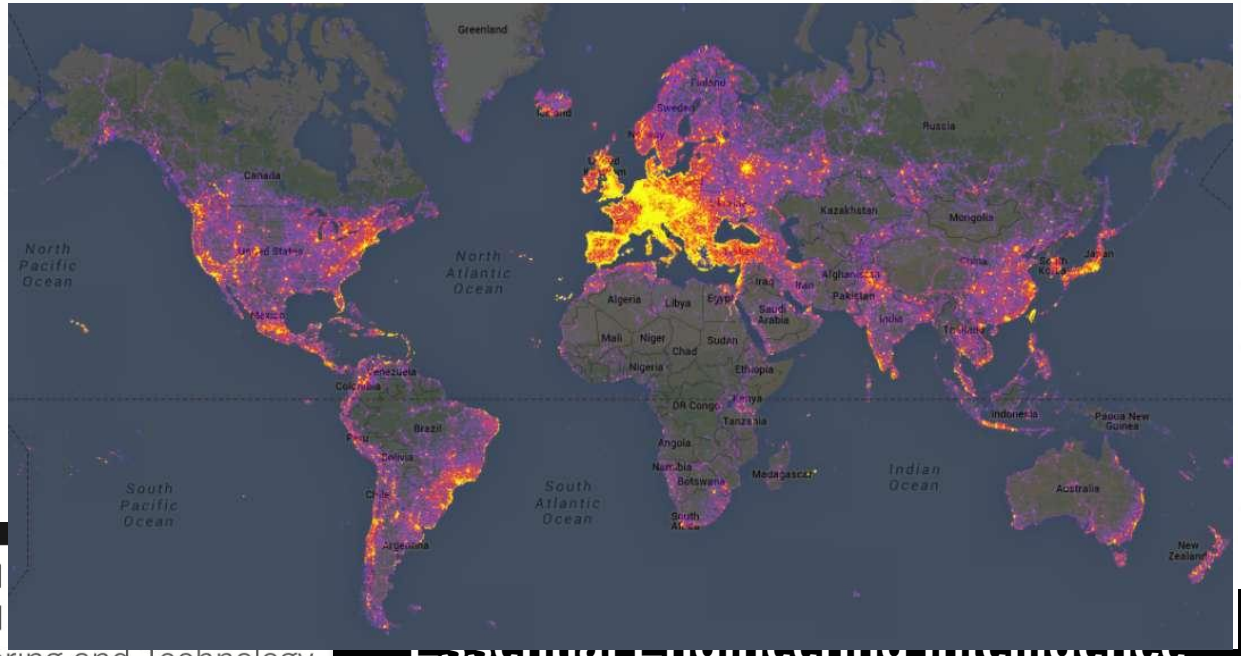
1970
1980
1990
2000
2010
9821
2014
Year


Greenland
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Russia
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Mongolia
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Japan
North Pacific Ocean
North Atlantic Ocean
Algeria
Libya
Egypt
Iraq
Iran
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Pakistan
Saudi Arabia
India
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DR Congo
Tanzania
Angola
Namibia
Botswana
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Australia
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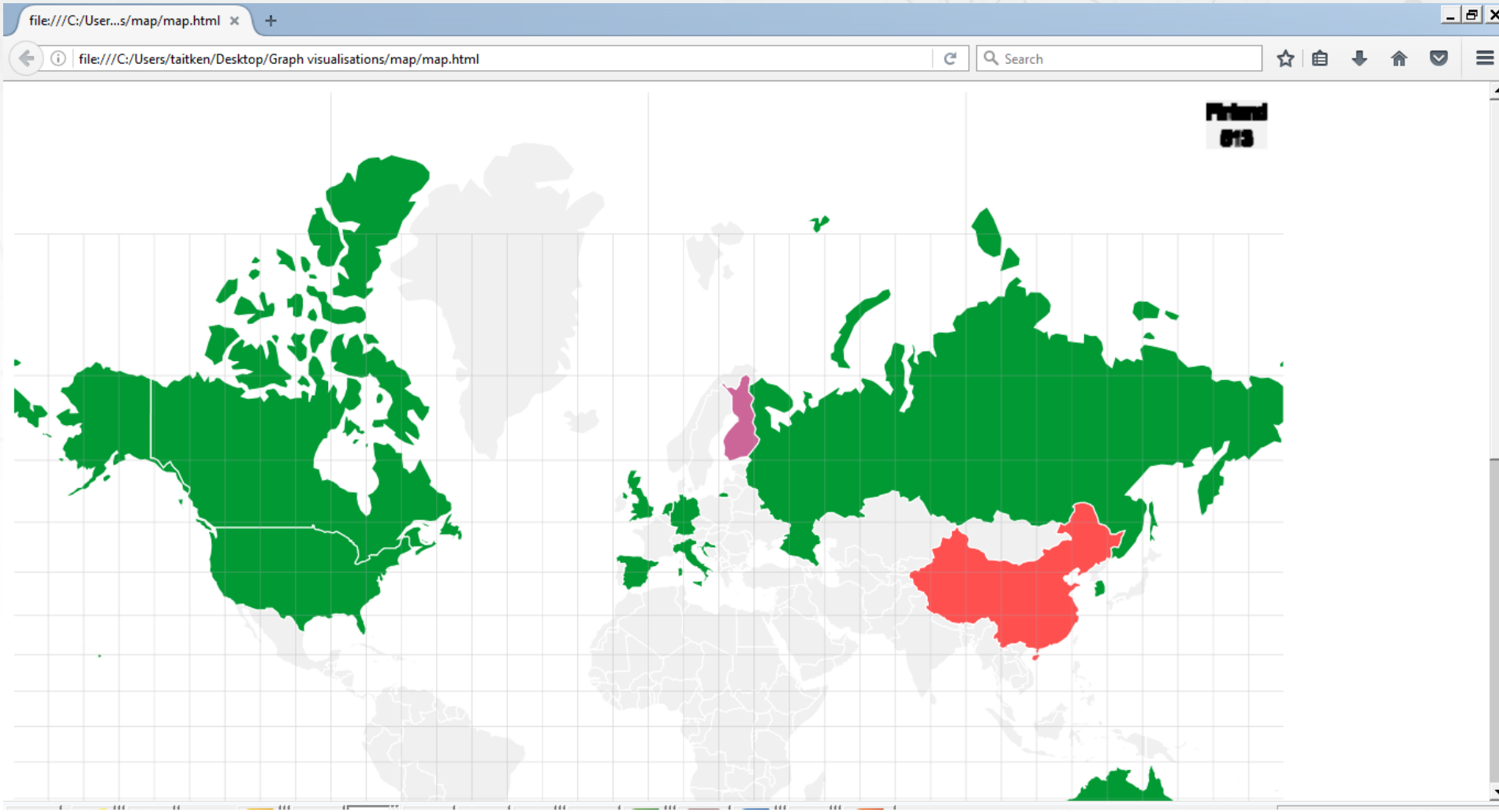

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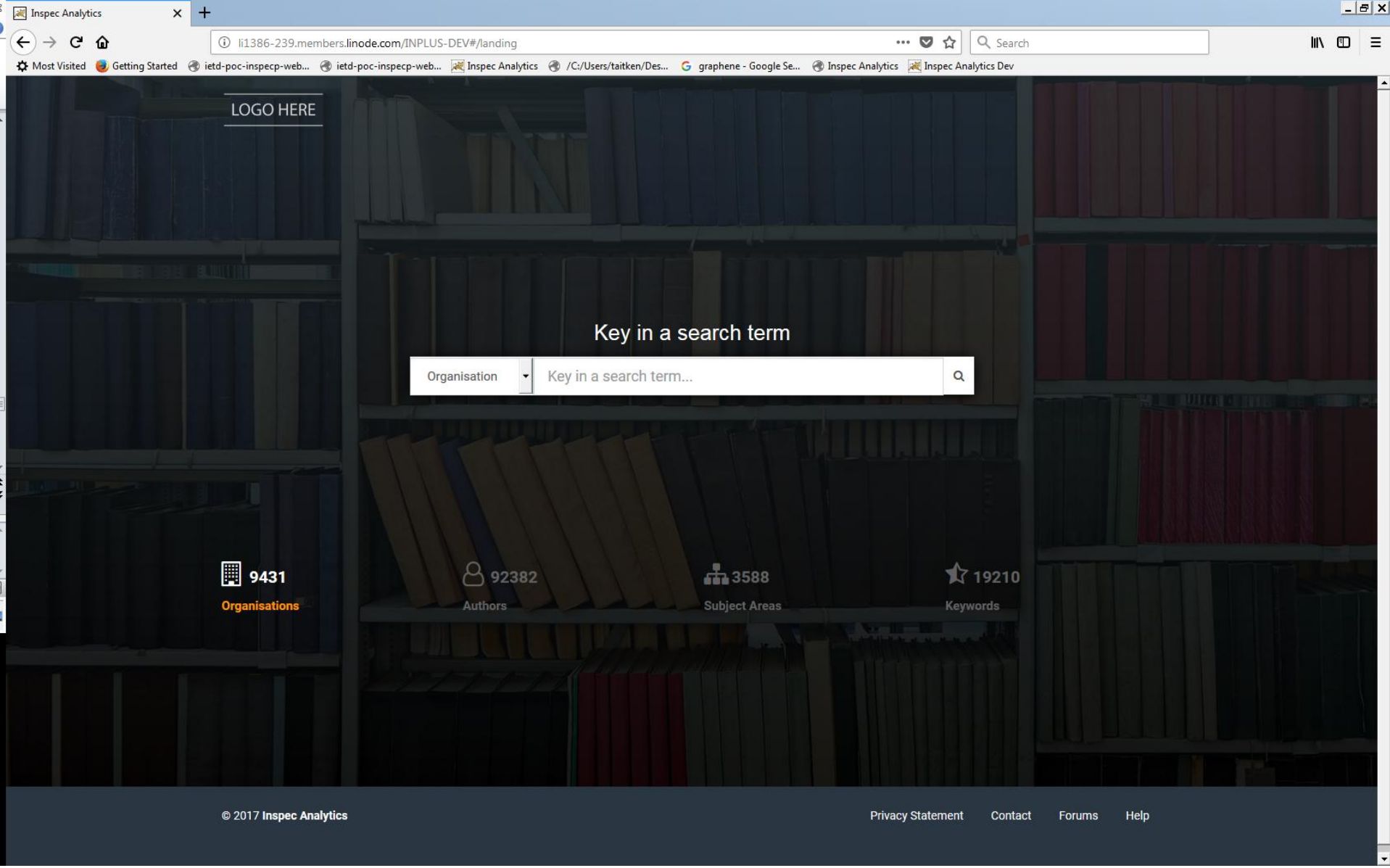
MVP

A Minimum Viable Product (MVP)
我们将在5月推出初级版本，提供基础功能，并根据用户反馈持续对Inspec Analytics进行调试

It is not feature complete, it is not final deliverable. It is a milestone that helps define the future direction of travel, and to whet the appetite or demonstrate capabilities to a limited set of customers



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Working to engineer a better world

总结

- Inspec 包含大量的高质量数据 – 新的数据处理方式可以为用户从数据中提取更多的意义, 多角度全方位进行数据揭示
- IET 知识曲线图
- 基于语义的聚类分析
- 语义搜索 & 可视化
- 为科研机构提供接口，允许第三方开发人员自主开发定制网页和移动端app来调取Inspec数据
- MVP2018年5月即将上线

与IET相连，
使您始终站在科技研究的前沿

谢谢！

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电话：010-6566-4687
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