



美国人文与科学院院士颁授典礼上的演讲辞

A speech for the American Academy of Arts and Sciences

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下月，我将会到波士顿的美国人文与科学院 (The American Academy of Arts and Sciences)，在一年一度的院士颁授典礼上发表约 3-5 分钟的简短演讲。这次演讲有别于以往我做过的科学报告，因为现场并没有投影机、黑板和其它教辅器材，而且，在场的院士有一半是人文学者，一半则是科学家，另外还有一些是工商业界及政界人士。这次的演讲体验想必既新奇又有趣。（我上一次的演讲是在 1985 年。）

我的演讲题目是「网络辅助技术对学术界未来的影响」（题材与我最近就同一主题做的报告有点相似）。以下是演讲辞，虽然这个版本篇幅很长，但是到了真正演讲的时候，内容应该会容大幅删减（10 月 12 日更新：简化版本详见本文末），欢迎读者就演讲的总体内容提出意见与建议。

可参照去年典礼演讲片段（讲者包括詹姆斯·西蒙斯 (Jim

Next month, I am scheduled to give a short speech (three to five minutes in length) at the annual induction ceremony of the American Academy of Arts and Sciences in Boston. This is a bit different from the usual scientific talks that I am used to giving; there are no projectors, blackboards, or other visual aids available, and the audience of Academy members is split evenly between the humanities and the sciences (as well as people in industry and politics), so this will be an interesting new experience for me. (The last time I gave a speech was in 1985.)

My chosen topic is on the future impact of internet-based technologies on academia (somewhat similar in theme to my recent talk on this topic). I have a draft text below the fold, though it is currently too long and my actual speech is likely to be a significantly abridged version of the one below [Update, Oct 12: The abridged speech is now at the bottom of the post.] In the spirit of the theme of the talk, I would of course welcome any comments and suggestions.

Simons), 彼得·金 (Peter Kim), 苏珊·艾希 (Susan Athey), 厄尔·刘易斯 (Earl Lewis) 及卢英德 (Indra Nooyi), 以作比较。顺带一提, 西蒙斯的演讲题目是关于「何谓数学」, 以及「数学家为何要搞数学」。

[11月3日更新: 请浏览学院网页, 观看今年我和其它讲者的演讲片段。其他讲者包括艾米罗·哈里斯 (Emmylou Harris), 詹姆斯·厄尔·琼斯 (James Earl Jones), 伊丽莎白·纳贝尔 (Elizabeth Nabel), 朗奴·马克·乔治 (Ronald Marc George), 及爱德华·维利拉 (Edward Villela)。]

引言

如果说近几十年来世界上最伟大的科技成就, 我会认为是互联网。我所讲的不只是早于1960年代已经在学术及政府机关使用的网络物理结构, 还有所有在网络发展成熟后相继涌现的创新技术, 涵盖了一般网络工具 (如电邮地址列表功能) 到超高效的技术 (如搜索引擎、维基百科等)。

随着互联网逐渐融入现代生活主流, 人类活动陆续受到不同层面的影响和改变。看看新闻, 就知道网络媒体如何因「旧」媒体日渐息微而蓬勃发展起来, 也认识到网上医疗信息如何改变医生与病人之间的关系, 政客如何利用博客、Tweets 讯息和在线影片分享功能, 在争持激烈的选举中争取民意, 诸如此类的报道。

然而, 对于我们这些学术界的人来说, 总想抱着一种比较脱离的态度去看待这些转变。当然, 实力雄厚的大财团相比其它低成本的网络对手, 理应更具竞争优势。在民主社会下, 人民应当有权以不同途径进行在线或非在线的讨论, 透过公众舆论影响政治。相比之下, 我们拥有大学永久聘任的资格、独有的专业知识、以及经得起时间考验的学术成果, 应该可以避免被卷入网络革命的洪流之中。

即使新科技的应用逐步进驻我们的生活——令学术期刊的盈利模式受到威胁, 或是让学生更便捷地抄袭功课 (不过话说回来, 老师可是更容易查出学生作弊的情况)——我们仍然会认为这些发展都只是微不足道的转变而已: 例如电子期刊取代传统纸版期刊; 或是采用更多有效的系统, 查找学生有否涉及抄袭功课的行为。我们还是跟以前一样进行教学、研究、及指导学生等核心学术工作, 只不过现在可能会多些使用互联网。可是无论用甚么方法, 目的都离不开教学, 而不是追求日新月异的互联网科技。毕竟真正的课堂是无法被维基百科所取代, 而网络搜索引擎也不能代替我们的研究, 对不?

For comparison, the talks from last year's ceremony, by Jim Simons, Peter Kim, Susan Athey, Earl Lewis, and Indra Nooyi, can be found [here](#). Jim's chosen topic, incidentally, was what mathematics is, and why mathematicians do it.

[Update, Nov 3: Video of the various talks by myself and the other speakers (Emmylou Harris, James Earl Jones, Elizabeth Nabel, Ronald Marc George, and Edward Villela) is now available on the Academy web site [here](#).]

Introduction

If I had to name the most significant technological development in recent decades, I would have to say it would be the internet. By this, I mean not just the physical architecture of the internet per se, which was already available to academics and government agencies since the 1960s, but also all the innovative technologies that flourished once the internet matured, from tools as humble as the email mailing list to such unreasonably effective services as modern search engines or Wikipedia.

As the internet has become more integrated into the mainstream of modern life, it has disrupted and revolutionised one sphere of human activity after another. We read in the news about how online media is thriving as "old" media stumbles; how online medical information is transforming patient-doctor relationships; how blogs, tweets, and online videos are tipping the balance in closely fought elections; and so forth.

But to most of us in academia, there is a temptation to view these changes with a certain detachment: sure, established for-profit companies may well face competition (as they ought to) from lower-cost internet-based rivals, and it is only reasonable in a democracy that politics should be influenced by popular debate, both offline and online, but we, by contrast, should be secure in our ivory towers from any internet revolution, with our tenure, our unique expertise, and our time-tested academic traditions.

Even when new technologies do hit close to home – by threatening the profit model of the academic journal system, say, or by greatly facilitating the ability for students to cheat on their homework (and also for professors to detect such cheating!) – we can still rationalise away these developments as requiring only superficial changes to adapt to – switching from physical journals to online journals, perhaps, or placing more safeguards on our homework formats. We still perform our "core" academic activities – teaching, advising, research – much as we have for over a century: classroom by classroom, student by student, and paper by paper. We may do more of these things online now rather than offline, but it is still the academic who is at the center of things, not the internet. After all, it is not as if our classes can be replaced by a Wikipedia entry, or our research by a search engine query, right? Right?

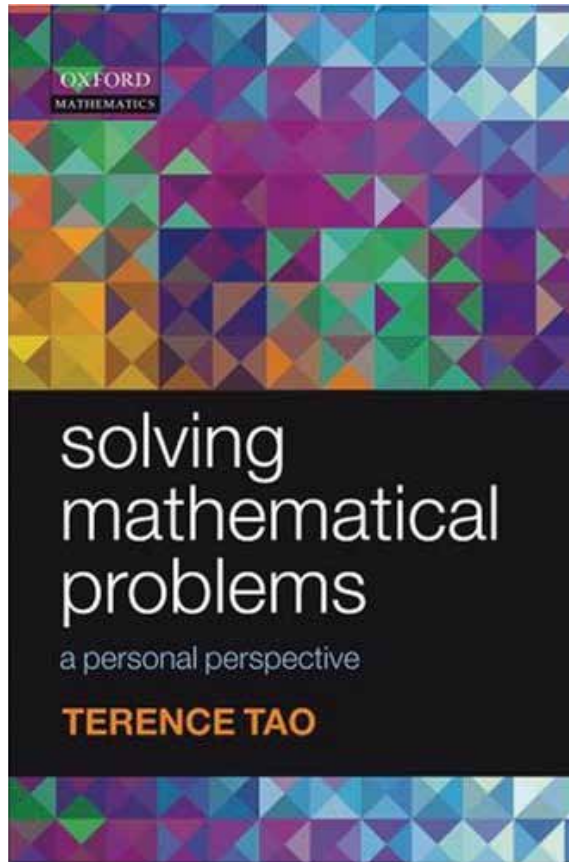
嗯，其实可以说是对，但也可以说是不对。即使使用当今最先进的网络技术，其精密和智能程度也不足以取代我们的学术工作，至少现阶段不行。学术界与其它领域不同，现时还没有受到廉价网络对手的真正威胁。

话虽如此，我相信一个「混合型」学术模式会慢慢形成。在这个模式中，通晓互联网的学者及其所属院校会设法利用网络工具的力量，开展大型研究合作项目，然后广泛迅速地公布研究成果。以我的专业数学为例，虽然这些利用网络为主的活动仍处于起步阶段，不过有迹象显示，相对于惯用的合作及传播信息的模式，网络活动可以大大提高效率（或者更重要的是，有助提升研究开放度、知识累积性、以及回馈反应程度），预料未来会逐步成为主流。网络活动可能会彻底改变我们的工作方式、所追求的目标、甚至是身处的学术文化，但在性质上的转变大概是不明显的。

教学

谈到大学教学，过去历世历代，无论在哪一所学府，老师都是站在讲台，把学科的基本理论同一时间授予班上几十位，甚至过百位的学生。这个做法无疑可以让我们与学生有面对面接触的机会，而且能够操练自己的教学技巧，从而得到满足感。不过，这是最有效率的方法吗？

在数学领域中有一个称为「莫比乌斯变换」(Möbius transformations) 的方程——全世界过千所大学的数学系都把此方程列入复分析 (complex analysis) 的课程中，由老师在课堂上同时向全班约 30-50 名学生讲授，我自己也曾经教过好几次。在影片分享网站 Youtube 里有一段很棒的影片，正好解释了此等变换的几何含义。该影片的点击率达 1,600,000 次，即使上 10000 次课堂，覆盖的人数也远低于这个数字。现在只要在网上搜一下，就能轻易找到影片（一般会出现在常用搜索引擎中的首三个搜索结果之中）。



Well, yes and no. It's true that even the most advanced online resources available today are not nearly "smart" or sophisticated enough to render our academic services obsolete; not yet, at least. Unlike many other industries, academia does not currently face any real threat from a cheap internet-based competitor.

But I believe a "hybrid" form of academic activity is beginning to emerge – one in which internet-savvy academics and their institutions harness the full power of online tools to initiate and organise large research collaborations, and to disseminate and share their results at far more rapid and effective rates than were previously possible. In my discipline – mathematics – this type of net-centric activity is still in its infancy, but it shows signs of potentially being substantially more efficient (and

perhaps more importantly, open, cumulative and responsive) than traditional collaboration and dissemination, and is likely to become increasingly mainstream in the years ahead. It may not totally revolutionise the way we work, the ambition of what we hope to achieve, and the academic culture we work in, but it is likely to transform them significantly.

Teaching

Consider teaching, for instance. Year after year, day after day, and in universities across the world, we stand in lecture halls and present the foundations of our subject to classrooms consisting of hundreds, or even just dozens, of students at a time. This keeps us engaged with our students, hones our skills, and makes us feel useful, but is it the most efficient way to do things?

There is a mathematical topic – Möbius transformations – which is taught routinely in complex analysis classes in a thousand mathematics departments across the world, to classes of perhaps thirty or fifty students in size; I have done so myself several times. On Youtube, there is a beautiful video explaining the geometric interpretation of these transformations which has been viewed one million, six hundred thousand times so far

目前我们当然不能期望要把课堂体验完完整整地复制到 Youtube 影片上, 因为不论是师生互动素质、教材的深度、或是专家的关注度都会大大减低。即使影片揉合更多专业成果, 例如麻省理工学院等知名学府所推出的网上教学影片, 也不足以跟真正课堂教学相比。不过纯粹就互联网的惊人用户人数来说, 便可以知道采用网络辅助教学的未来潜力。

数以百计的学者(包括我自己在内)已经使用博客发布课堂讲义, 鼓励师生及来自世界各地的访客在网上进行全方位讨论。我讲授的班级普遍来说只有约 30 名本地学生, 但是在博客上观看或参与讨论的却多达一百人。他们各自拥有不同的背景, 提出来的问题质量兼备, 大大提升教材内容的质量。通过预备博客的教学素材, 以及阅读学生和参与同事之意见, 我对学科的认识便会更深入。

课堂教学虽然结束了, 但是网上教学依然继续。很多时候, 有些人对某个课题感兴趣, 透过搜索引擎会无意中找到博客里一年前的讲义, 然后重新开始讨论起来。如此一来, 不到几年, 每一个学术专题就会有很有用的网上资源, 任何人只要在网上搜一下就能看见。

在线互动的技术肯定会不断提升, 可想而知会逐渐变成课堂的常规内容, 比如说, 正在收看课堂直播的海外学生用短信把问题发送过来, 这些信息可以透过在线互动技术处理, 即使上完课, 仍可继续在线讨论。其实, 不是所有在线教学的实验都能够达到预期的目标, 有时只需要向前多走一步, 就能给出一个模型, 让世界各地的学府及老师争相仿效。

在我看来, 传统的课堂讲授在未来还是会发挥不可或缺的功能, 只是形式会与现在不同, 结合互联网技术, 成效可望进一步扩展及持续。

交流合作

交流合作研究是另一个有较大转变的范畴。

四十年前, 远隔两地的学者是用书信作为主要通讯方式, 信息传递速度较慢, 妨碍交流合作的发展。时至今日, 现代通讯工具(如电邮)广泛使用, 情况大大改善。远程合作项目已经成为常见的合作模式, 合作伙伴一年中有大部分时间都是进行在线交流, 真正见面的时间只有几天(但很关键)而已。也许因为这个原因, 在数学领域中, 合撰论文的比率急剧上升, 跨学科论文的比例也大幅增加。

近年全球有很多论文作者都使用软件工具, 以便推动交流合作。数学与其它科学领域不同, 这门学科从来都不必动用大型实验室, 为一大批研究生、博士后和高级研究员提供一个

— more people than can be reached than by even ten thousand mathematics lecturers. It can be accessed by just about anyone on the internet through a simple web search on the topic (it is in the top three hits currently on all major search engines).

Now, clearly, one cannot hope to replicate the entire classroom experience as a sequence of Youtube videos — the quality of interactivity, depth of material, and availability of expert attention, in particular, is much poorer. Even more professional organised efforts, such as the online videotaped lectures offered by institutions such as MIT, are an imperfect substitute for physically being present at these lectures. But the sheer numbers of people one can reach by the internet shows the potential of tapping this medium to teach in the future.

Already, hundreds of academics (including myself) use a blog to post their course notes and encourage online discussion (in all directions) between the teacher and students in the classroom, as well as visitors from around the world; I have had classes with perhaps thirty local students but up to a hundred other participants from a variety of backgrounds following (and commenting!) using the blog. There is a much higher quantity and level of questions asked, and the material in my notes is much improved, because of this; and I have learned more about the subject than if I had taught it in a traditional way, both from preparing the blog material, and from obtaining feedback from students and participating colleagues.

Even after the physical class ends, the online class goes on; I have often had people wanting to learn a subject stumble onto one of my online lecture notes on my blog from a year ago through a search engine, and continue the discussion afresh. Within a few years, there may well be valuable online content like this for virtually every commonly taught academic topic, just one search query away from anyone with internet access.

The technological level of online interactivity is certain to increase in the future; one can well imagine it becoming routine in classes to (for instance) field questions by text message from students overseas who are watching the lecture in real time through video, with the discussion continuing online long after the class has ended. Not all experiments in online teaching will achieve their intended objectives, but it only takes one clear success to provide a model that can then be rapidly emulated by institutions and lecturers worldwide.

In my view, the traditional classroom lecture will still play an indispensable role in the future, but in a rather different format than it is today, with its effects being vastly amplified and prolonged through its integration with the internet.

Collaboration

Another major area where profound changes are happening is



很大的地方，一起向着同一目标进行研究。然而，发展大规模项目的相关技术正相继涌现。

举例说，利用博客和维基等网络平台，今年首次发起了一个名为“Polymath Projects”的大型合作研究项目，让其它有兴趣的数学家在网上各抒己见，集思广益，从而解决当前的数学难题。

此项目推出不久即成功破解了一个重要的组合数学问题，经过近六星期的时间及许许多多参与者的努力，共给出了一千余个精辟独到的讨论条目。使用网络平台来讨论数学问题，可说是相当新颖的做法，有效地把拥有相同专业和研究方向的学者集中在一起，也许可以作为一种模式，透过在线网络开展交流合作。

网上讨论还有其它意想不到的好处，它可以把所有网上讨论的内容，无论是错误的开始、失败的终结、抑或在问题尚未解决前，逐步形成的每个进展，都一一记录下来，把数学研究的整个过程更全面、更生动、更真实地呈现出来，而非一般在论文或教科书等作品上所见到的研究成果。

进行网上研究与生活息息相关。曾经有一位参与讨论的人士

that of collaboration in research.

It was only four decades ago that the primary mode of communication among academics in distant institutions was by physical mail. This was inconveniently slow, and it discouraged collaboration with anyone who was not in the same physical location. With modern communication tools such as email, the situation today is vastly different; it is completely routine now in mathematics to collaborate over long distances, with months of online communication punctuated by only a few (but crucial!) days of physical contact each year. Perhaps as a consequence, there has been a huge increase in the proportion of papers in mathematics that are jointly authored, rather than singly authored. As a related phenomenon, an increasing fraction of papers are also interdisciplinary rather than specialised to a single subfield.

Very recently, software tools have become available to allow easier collaboration by large numbers of authors from across the world. Unlike the sciences, pure mathematics in academia has never really had the large laboratories in which armies of graduate students, postdocs, and senior researchers work on a single goal; but the technology is just becoming available for such large-scale projects to be possible.

This year, for instance, by ad hoc usage of existing tools such as blogs and wikis, the first “polymath” projects were launched – massively collaborative mathematical research projects, completely open for any interested mathematician to drop in, make some observations on the problem at hand, and discuss them with the other participants.

The very first such project solved a significant problem in combinatorics after almost six weeks of effort, with almost a thousand small but non-trivial contributions from dozens of participants. It was a novel way to do mathematics, but also a novel way to locate the collaborators with the right expertise and interest to solve the problem, perhaps serving as a model to begin collaborations through online networking rather than physical networking.

And there were other unexpected benefits too; the projects have retained a fully available online record of all the discussion, including false starts, dead ends, and incremental progress, that took place while the problem was not yet solved, giving a much richer, more dynamic, and more accurate picture of how mathematical research really takes place than the cut-and-dried presentations one sees in finished products such as papers and textbooks.

By taking research online, it comes to life; one participant compared his anticipation to seeing the latest developments on a polymath project to the suspense one might feel while watching a TV or movie drama. Veteran researchers are familiar with

表示，非常期待看到 Polymath 项目的最新发展，感觉就像追看电视或电影剧集一样。拥有丰富经验的研究人员虽然知道面对压力和成败得失的秘诀，不过要他们向刚踏上研究之路的学生分享这方面的经验，确实不易。也许将来有一天，借助这些开放式网络平台，可以用「摆事实，不空讲道理」的方式来与众人分享经验。

学术文化

采用新技术会导致我们的行为文化产生微妙的变化。在数学方面，搞研究从来都是秘密活动。如果未正式投稿到期刊，学者基本上是不会轻易跟别人提起自己的研究结果，在印刷版面世之前（过程需时几个月，甚至几年），只会把预印本发给少数同行。随着预印本服务器和搜索引擎的应用日益普及，不少学者在正式提交论文前（有的甚至更早），就已经把预印本放上网。从我自身的经验得知，这个做法不但可以提升研究工作的知名度、影响力和关注度，而且（与普通人所想的恰恰相反）有助遏制过度竞争行为，摒除抄袭之风。还有，透过预印本服务器发表的文章都有时间标记，避免出现争位次的情况。

其实，在许多数学的分支中都拥有同一个「社会期望」，也就是说，希望不用大费周张就能轻易地在网上取得某学者的研究结果，同时期刊在刊登文章时，不会造成垄断的情况。因此，现今研究发展的传播速度比过去几十年要快得多。

我能预料未来会出现更多同类型的文化转向。目前，在数学研究中，解决困难的过程往往都是充满疑惑，直至问题圆满解决写出一篇质量符合出版要求的文稿。随着 Polymath 等开放式合作项目的兴起，今后的学术文化会有所改变，正如今次我预先把这篇演讲辞放上来，希望得到大家的宝贵意见，让我可以继续努力，写得更好。如果在几年前，我大概只会把文稿发给一两位值得信任的朋友，然后最多做一次修改。

同样地，数学博客和其它半正式论坛的兴起，带动了现时数学界的风气——某一数学题目背后蕴含的涵义和启示，就如其定义、定理与证明一样，都是被人看重的。有些学者在比较专门的数学专业中，可能会面对越来越多由同行所造成的压力，致使他们毫不保留地公开自己的研究成果。

目前的数学教学都是采用「老师讲、学生听」的单向模式，单凭班上少数勇于发问的学生所提出的问题，要不就从学生在课堂结束几天、甚至几星期后，在功课、评估及考试中的表现，才可以得到他们对教学的回馈。

在不断改善技术的情况下，人们对于课堂及课外网上论坛的互动教学成效的期望会越来越高，而接近同步的实时反馈系

these tensions, frustrations, and joys, but it used to be quite difficult to convey these experiences to the graduate students entering the field; perhaps these open internet projects, with their “show, don’t tell” nature, may succeed in doing so in the future.

Academic culture

As we adopt new technology, our culture of doing things subtly changes. In mathematics, for instance, research used to be a secretive activity; one would often not discuss what one was working on before it was ready for submission to a journal, and would only give out preprints to a select few colleagues before the publication process was complete (which takes months or even years). With the rise of preprint servers and search engines, it is nowadays quite customary to put a preprint online as soon as it is submission-ready (or sometimes even sooner!); experience has shown that doing so greatly increases the visibility, impact, and influence of one’s work, and (perhaps counterintuitively) discourages excessively competitive behaviour and even plagiarism, as the timestamps given by preprint servers can help defuse arguments over precedence.

Indeed, in many parts of mathematics there is now a social expectation that one’s work should be readily available online, and journals have largely abandoned attempts to enforce a (counterproductive) monopoly on the dissemination of their authors’ work. As a result, research developments propagate at a significantly faster speed than in previous decades.

In the future, I can imagine further cultural shifts of this type. Currently, the actual problem-solving process in mathematical research is usually obscured from view until the problem has been solved and a polished, publication-quality draft is available; with the rise of open collaborative projects such as polymath, this culture may begin to change in the future. (For instance, I circulated a draft of this talk on my blog weeks in advance, both to obtain valuable feedback and to encourage me to continue working on the text. A few years ago, I might only have shown a draft to one or two trusted friends, with perhaps a single round of revisions.)

Similarly, the advent of mathematical blogs and other semi-formal outlets for discussion is reinforcing an existing trend in mathematics in which the intuition and motivation behind a mathematical topic is emphasised as much as the definitions, theorems, and proofs; some of the more technical and specialised subfields of mathematics may well encounter increasing societal pressure in the future from their peers to make their work more accessible and transparent to wider audiences.

In teaching mathematics, the current model is that of a nearly one-way street; the lecturer does almost all of the talking. Apart from a few questions from the more bold students, one only receives feedback days or weeks after the class has ended, from

统将成为大势所趋。

如此改变肯定会受到一定的拦阻，例如学界一直为「老师应否允许学生在课堂上使用笔记本计算机」闹得热哄哄。事实上，许多类似的建议都不可能百分百成功，而我们对于在线实验的成功关键仍然一知半解。尽管如此，在技术发展和变迁的过程中，我怀疑我们是否可以一直保持现状。

结语

试试把前网络时代的学术界比喻作前工业时代的制造业：工业革命前，制造业是由个别工匠或秘密同业公会来构成。工人各自为自己的工作辛苦劳碌，师傅们则把多年来累积的珍贵经验和技艺仅仅传授予为数不多的徒弟。其实在学术界中，也不难找到相似的地方。

工业革命发生后，专业化和大规模生产成为制造业的主导趋势，生产成效和信心增加了，不过也意味着业内人士之间的关系变得不再如从前那么紧密。有人会哀叹工匠独特的创造力和个性失去了，可是随着工业革命发展进入新纪元，创意产物最终能够渗透进更广泛的群众。由于有生产、设计、研发、企业、制造、市场推广、培训、管理等细分工序，才能把最佳的人才安排在最合适的工作岗位上，不必单靠一己之力去承担整个生产销售的过程。此外，每一个范畴中的最佳做法都得到行内广泛采用，而非局限于始创人和少数追随者之中。

自印刷机发明以来，学术界还没有经历过像工业革命般的大规模转变，然而随着互联网（现代版的印刷机）的出现，学术界会再一次面临一场革命吗？

简化版

今天我很高兴获颁院士，也很荣幸能够在此发表讲话。我必须承认，虽然之前做过超过一百次科学报告，但是这次可说是我第二次正式做演讲，而第一次发生在九岁的时候。我会尽量把讲话内容整理得好一点，希望听起来不要像九岁小孩的话。有甚么不好的地方，请各位多多包涵。

接下来，我会谈谈互联网的影响力、以及其有效的应用，从现代搜索引擎到维基百科。

我们都知道互联网在娱乐、新闻、政治等方面，都造成了前所未有的改变。然而，在这场网络革命中，我们总希望希望可以置身事外，凭着自己的大学永久聘任资格、独有的专业知识、丰富的学术成果，应该可以避免卷入网络革命的洪流之中。毕竟，真正课堂无法被维基百科所取代，而搜索引擎

the assignments, evaluations and exams the students turn in.

With improvements in technology, there may be a greater expectation in the future for such classes to be significantly more interactive, both during the “actual” class, as well as the online discussions before and afterwards, and with near-instant feedback becoming the norm.

Such changes will certainly encounter resistance; consider for instance the ongoing debate on whether to allow laptops in classrooms. Many such initiatives will not be fully successful; we still have a very partial understanding of what makes one online experiment flourish and another one fail. Nevertheless, I doubt that we will keep the status quo indefinitely in the presence of such technological and social changes.

Conclusion

One can draw an analogy between pre-internet academia and pre-industrial manufacturing. Before the industrial revolution, manufacturing was the province of individual craftsmen or of secretive guilds, working painstakingly on each individual piece of work, with each master passing down their carefully hoarded insights and tricks to just a handful of disciples. It is not hard to find parallels to each of these phenomena in academia.

But after the industrial revolution, specialisation and mass production became the paradigm in manufacturing; less intimate, surely, but also vastly more efficient and reliable. One might bemoan the loss of creativity and individuality that each craftsman exhibited, but eventually, as the industrial revolution matured into the modern era, the outlets for creativity became dispersed to a wider group of people. Thanks to division of labour, design, invention, entrepreneurship, manufacturing, marketing, training, or management could now be performed by whoever was best qualified to do each, rather than by the same individual; and the best practices in each of these areas could be adopted widely, rather than being confined to their originator and a select number of followers.

Academia has not experienced change on the scale of the industrial revolution since the invention of the printing press. With the advent of the internet – the modern day analogue of the printing press, among other things – could it be revolutionised once again?

Abridged version of speech

It's a great honour, both to be inducted to the Academy and to address you all today. I must confess that while I have given over a hundred scientific talks, this is only my second speech; and the first one was when I was nine. So I please bear with me; I'll try not to sound like a nine-year-old.

也不能替代我们的研究，至少现在不行。

不过，我相信重大的改变已经展开。

以教学为例，在数学领域中有一个称为「莫比乌斯变换」(Möbius transformations) 的方程——全世界过千所大学的数学系都把此方程列入复分析 (complex analysis) 的课程中，老师在课堂上同时向全班约 30-50 名学生讲授，我自己也曾经教过好几次。

可是，如果在网上搜一下「莫比乌斯变换」(Möbius transformations)，就会得出一段很棒的 Youtube 影片，该影片的点击率达 1,600,000 次，即使上 10000 次课堂，覆盖的人数也远低于这个数字。

数以百计的学者（包括我自己在内）已经开始使用博客去推动教学。我讲授的班级一班大约只有 30 名本地学生，但是在博客中参与讨论的人士却多达一百人。课堂教学结束了，网上教学依然继续。通过搜索引擎，偶尔会有些新访客发现某个课堂的资料，开始参与讨论。

这些网络工具都有意想不到的用处，几星期前我把这篇讲稿放上网，结果得到许多宝贵的意见。

研究方面，比如说，通过使用博客和维基等现有的网络平台，今年首次发起了一个名为“Polymath Projects”的大型合作研究项目，开放给所有有兴趣的数学家在网上进行公开讨论，发表意见。

此项目推出不久即成功破解了一个重要的组合数学问题，经过近六星期的时间及许许多多参与者的努力，共给出了一千余个精辟独到的讨论条目。

通过网络平台讨论数学问题，可说是相当新颖的做法，有效地把拥有相同专业和研究方向的学者集中起来，也许可以作为一种模式，利用在线网络开展交流合作。

用这种方式展开讨论、研究数学，真是既新颖又有趣。有一位参与讨论的人士更表示，非常期待看到 Polymath 项目的最新发展，感觉就像追看电视或电影剧集一样。（要是当时你也在场便好了！）

自印刷机发明以来，学术界还没有经历过像工业革命般的大规模转变，然而随着互联网（现代版的印刷机），学术界会再一次面临一场革命吗？

致谢：感谢陶哲轩教授允许本刊连载他的博客译文。

I would like to talk about the impact of the internet, and all the unreasonably effective services it has spawned, from modern search engines to Wikipedia.

We know that the internet has revolutionised area after area: entertainment, journalism, politics will never be the same again. But those of us in academia like to feel protected in our ivory towers from the internet revolution, with our tenure, our expertise, and our academic traditions. After all, our classes can't be replaced by a Wikipedia entry, and our research can't be replaced by a search engine – not yet, anyway.

Nevertheless, I believe major change is already underway.

Consider teaching, for instance. There is a mathematical topic – Möbius transformations – which is taught in a thousand mathematics departments across the world, to perhaps thirty or fifty students at a time. I've done so myself many times.

But if you do a web search for Möbius transformations, you'll find a beautiful video on Youtube explaining this concept clearly, which has been viewed one million, six hundred thousand times – more people than can be reached by ten thousand mathematics classes.

On a smaller scale, hundreds of academics (including myself) have actively pushed their classes onto the internet, using such tools as blogs. I have had classes with perhaps thirty local students but up to a hundred online participants. Even after the physical class ends, the online class goes on, with new visitors stumbling onto the class via a search engine and continuing the conversation.

These tools can have unexpected uses; for instance, I posted a draft of this talk online a few weeks ago, and got a tremendous amount of valuable feedback in return.

Or consider research. This year, for instance, by ad hoc usage of existing tools such as blogs and wikis, the first “polymath” projects were launched – massively collaborative mathematical research projects, completely open for any interested mathematician to drop in.

The very first such project solved a significant problem in combinatorics after almost six weeks of effort, with almost a thousand small but non-trivial contributions from dozens of participants. It was a novel, transparent, and lively way to initiate and then do mathematics. One participant even compared his anticipation to seeing the latest developments on a polymath project to the suspense one might feel while watching a TV or movie drama. (You had to be there, I guess.)

Academia has not experienced massive change – on the scale of the industrial revolution – since the invention of the printing press. With the advent of the internet – the modern day analogue of the printing press, among other things – could it be revolutionised once again?