Australian Computer Science on the global map

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Abstract

At the time of writing only seven Australian universities had research archives compliant with the Open Access Initiative (OAI) standards. The University of Tasmania proposes a coordinated push by all computer science departments through offering a start-up service that will enable each computer science department in every university in Australia, New Zealand, PNG, East Timor, and the University of the South Pacific to have an OAI presence. Research evidence shows that putting preprints and postprints of research papers on an OAI-compliant server increases the average citation rate by at least 300%, and the readership by a greater factor. 100% coverage in the Australasian region will increase the profile of computer science research in the region. It will also make the same research more accessible to those institutions with smaller budgets, thereby assisting them in their mission.

Keywords: Eprint, open access, OAI, OAI-PMH, archive, research, theses, citation rate, computer science, Australasia.

1 Background

In the 1980s, the Australian computer science departments brought the Internet to Australia, in the form of the ARPANET and via the disused ALOHA satellite above Hawaii. This grew into ACSNET (Australian Computer Science Network), and when it became obvious to most that the Internet was important, the AV-CC took it over as AARNet.

The time has arrived for computer science departments in Australasia to make a similar push, this time in eprint archives. We have the opportunity to

- greatly increase the impact of our own research activity,
- raise the profile of the region in computer science significantly, and
- influence our various universities, with credit accruing to the department.

2 Rationale

2.1 What is an eprint?

An *eprint* is an electronic version of a research paper, article or thesis, preserved in an archive, and searchable or retrievable globally. The word encompasses *preprints* (versions of a research article distributed before refereed publication) and *postprints* or reprints (copies of a published article distributed apart from the journal or proceedings in which they appeared). An *eprint server* is a server on which all or most of the research output of an institution or department is mounted, and which provides search and browse capability to find particular papers. Such a server is a useful addition to a university's or a department's profile, but not particularly valuable by itself. You have to know about it to search it, and few people outside the immediate entity will know of its existence.

To be really value-adding, an eprint server must comply with the standards of the *Open Access Initiative Protocol for Metadata Harvesting* (OAI-PMH), and be registered with global OAI harvesters such as Scirus (2004), myOAI (2004) and OAIster (2004). These provide global search services for research publications from all registered institutions. For example at the time of writing OAIster had data on 3.4M documents from 327 universities and research organizations worldwide. There is small value in institutional searching and only slightly more for national level searching; the Internet is a global medium and global connectivity is the target.

2.2 The impact of eprint archives

There are many benefits of an eprint website for a university. The most significant to academics, research students and other researchers are the following:

- Papers available online are cited on average 300% more frequently than papers available only in paper form (Lawrence, 2001). An ISI citation impact study by Brody *et al* (2004) shows that journal articles that have been made open access by self-archiving are cited 250%–550% more than articles in the same journal that are not self-archived. An even more recent valuable reference is Harnad & Brody (2004). This is by far the most convincing argument.
- The research output of departments (where legally possible) is made publicly available, globally, free, and at the time of creation. It is not restricted to an institution, country, journal, or by ability to pay. Only Internet access is required.
- The self-loading of preprints on the server provides *prima facie* proof of priority of the research findings. This is especially important for research higher degree theses and is a win-win situation for postgraduates working on cutting edge sciences and technologies like computer science for both theses and papers submitted to journals and conferences.

- Global searches through OAI-compatible search engines bring Australasian computer science research and researchers more easily to the attention of other researchers worldwide.
- All of the above increases the research impact of the computer science community in Australasia very significantly.

Besides these, there are many more peripheral or long-range benefits that are unlikely to strongly motivate researchers yet which may resonate with a university senior management. These include:

- No university anywhere has access to the entire world's research. The Open Access Initiative is aimed at making access to research output readily available to all who have Internet access. Working with this initiative incidentally assists in combating the serials pricing crisis.
- Some disciplines are already highly electronic in their dissemination practices; primary examples are Theoretical Physics and Computing. This trend can only be expected to continue.
- The initiative is an operation driven by standards, where global interoperability is seen as vital.

All the above indicate that an eprint server for a university containing a high proportion of its research output would create a major change in the dissemination effectiveness of the university's research. Any university that is not ready to implement such a server is missing out on a major opportunity. The Australian Group of Eight universities have endorsed such an initiative, though only four of them have so far implemented such a server.

2.3 Accessibility

It has been stated that global accessibility is the prime concern of an eprint server. National repositories that do not link into global search engines, such as the Australian Digital Theses project (2004), are a waste of time and resources until they do. The key to such linkages is conformance to harvesting standards. Search engines such as Google harvest raw HTML pages without any additional help, but the overwhelming number of non-scholarly results they return to all but a very specific enquiry makes them also of little use.

The Open Access Initiative (OAI, 2004) has defined a Protocol for Metadata Harvesting (OAI-PMH, 2004) which is an industry standard. There is a validation tool (OAI Repository Explorer, 2004) which can validate the compliance of a server with the OAI-PMH standard, and an Institutional Archive Repository (2004) which lists all registered OAI-PMH compliant servers in the world. These sites provide basic information for the second tier of eprint services.

This second tier comprises services which harvest from local eprint servers, and provide global search services. Key amongst these is Scirus (2004) which advertises itself as a key portal to scholarly literature, and makes a fair fist of living up to that claim, OAIster (2004) which provides searching only of institutional OAI-PMH compliant archives having a research emphasis, and MyOAI (2004) which has a similar but more restricted aim. Since the Eprint metadata includes references, CiteSeer is another service of great importance to the computer science community. CiteSeer harvests URLs in references and provides citation searches for archived papers. The importance of citation searches should not need elaborating: they provide the ability to go forward in time from a discovered paper of interest, instead of being restricted to the backwards links of references.

2.4 Software

The OAI world is dominated by open source software, and within that by two packages: EPrints and DSpace. EPrints originates from the University of Southampton, UK, while DSpace is a product of MIT, USA. In Australia, EPrints is used by all the existing archives (the seven universities, ALIA, and the National Library), but ANU is also using DSpace. The current market shares are shown in Figure 1. The 'Other' category comprises a number of minor players and archives whose software is not known. The data is derived from the Institutional Archives Registry.

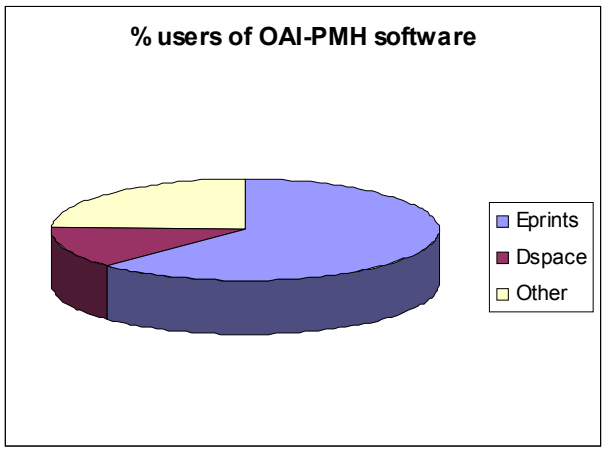

Figure 1 – Software market share

2.5 Current state in Australasia

As previously mentioned, only seven of the Australian universities have OAI-PMH compliant archives. None of the universities in New Zealand or Papua New Guinea have registered archives; neither does the National University of East Timor (*Universidade Nacionál Timór Lorosa'e* UNTL) nor the University of the South Pacific (USP) which serves twelve island nations. Indonesia and Malaysia are also absent from the list of archives.

In the area of digital theses, the situation is only slightly better. 22 Australian universities are participants in the Australian Digital Theses project (2004), which means

(a) that they have commenced to collect theses in electronic form,

(b) they run a local repository which holds full text of research higher degree theses and a web page containing metadata about each thesis,

(c) the central ADT repository harvests the metadata from the local web pages and provides a national search service on the metadata, linking back to the local repositories.

Unfortunately neither the local ADT software nor the central ADT repository are OAI-PMH compliant, and therefore none of the data is retrieved by OAI-PMH harvesters. (Four universities have declined to run the ADT local software but produce web pages with the relevant metadata through other means.) The central ADT repository is harvested by Google and Scirus on a web-page basis. There is an intention to make the central ADT repository OAI-PMH compliant, but apparently not the local repositories.

The ADT is established under CAUL authority, and the UNSW library is the lead institution. The central ADT search page has a woefully bad user interface, and of course is unlikely to be known or searched outside Australia. There are comparable repositories for Canada, France and the UK, but not Japan nor the USA.

A consortium of Australian universities has recently formed the ARROW group (2004) with Monash University as the lead institution. ARROW has secured federal finding to establish a national harvesting repository similar to that of ADT. However, in this case the harvester will be OAI-PMH compliant from the start. If all Australian universities already had OAI-PMH servers, the ARROW project would be speeded up, besides providing the contributing universities an alternate route to global exposure outside ARROW. Such alternate paths are highly desirable, as they limit reliance on a critical resource, and conform to the Internet's distributed nature.

In the absence of retrievable information or links, it is assumed that nothing like these initiatives exists in New Zealand, Papua New Guinea, East Timor, Indonesia, Malaysia, or South Pacific countries. This is however no loss, if a distributed solution is implemented quickly.

2.6 Implementation Barriers

2.6.1 Direct Costs

The direct costs (cash) are minor. A dedicated server with adequate disk space for records for several years and a better response time would cost under $A2000. However, a fully operational server could be mounted initially on an existing web server with adequate disk.

EPrints software (EPrints, 2004) is completely free under a GNU open source licence, as are updates and all the supporting software (Apache, mySQL, Perl, etc). Registration with OAI harvesters is also free. Searches performed on harvesters such as myOAI and OAIster are free apart from Internet traffic costs. The software is widely used by universities for this purpose and there is an active support forum. Over 50% of the world's university repositories use EPrints. Figure 2 shows the rate of growth of global deployment of eprint technology recorded by a key registry.

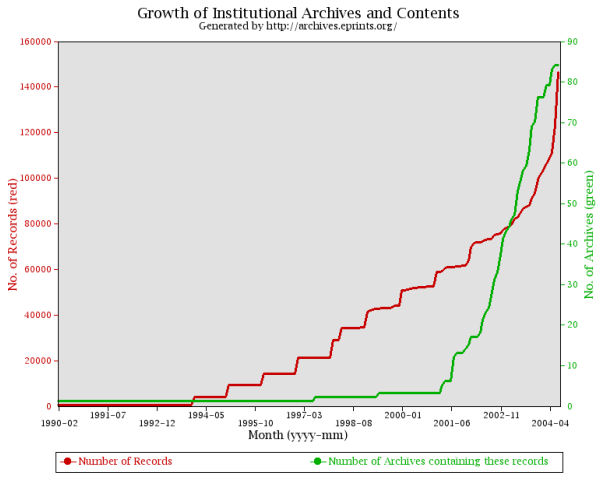

Figure 2
Growth in Archives and Contents 2000-2004

2.6.2 Indirect costs

Indirect costs are more significant and can be broken down into technical support costs, server supervision, and upload costs.

Technical support by ICT personnel

The initial implementation effort for the prototype is relatively small, and consists of downloading the software and documentation, familiarization, installation and customization. The customization is required to suit each department's or university's visual standards and desired user interface, and to provide a custom XML response to OAI-PMH harvesting calls. Probably two person-weeks are sufficient. Ongoing technical support should be minor, and mainly concerned with security, updates and backups. However, the visual appearance of the site may evolve with time as users ask for customization. The EPrints software is highly customizable and easily extended.

Server supervision by information specialists

The server requires supervision by someone with a research or information science speciality, as the moderator and editor (as distinct from the system administrator). Regular monitoring is required to approve uploaded documents, which sometimes need minor changes or referral back. Monitoring the quality of the service and the status of the server is also desirable. Depending on the take-up of the facilities, this should be a light load, with the main work being regular checking of the submission buffer. Documents require ~30s on average to approve.

Uploads

Creation of content is done by the academic staff and RHD candidates themselves. However, now there is the additional step of submitting the content (preprint files and/or postprints) to the server. Two basic self-archiving models are possible for departments, but a combination strategy is of course possible:

- The researcher uploads the file and enters the bibliographic information. Experience suggests that the work may be 2-10 minutes after a small demonstration of what is required. This is a tiny fraction of the work involved in producing the paper, and would seem negligible in order to get

3× increased citations. However in other institutions it has been seen as a barrier because it simply does not get done. It is extremely hard to get academics to do work without deadlines even if it clearly to their benefit.

- One person in the school is designated as responsible for the uploading. The researchers email the documents to him/her. Entry is smoother, quicker and more reliable, at the expense of some extra liaison with the academic and workload for the responsible person. The person becomes expert in the processes.

2.7 Participation

The implementation of an eprint server is easy; the hard part is getting anywhere near 100% participation by researchers and coverage of research output. This can be readily seen by the performance of Australian institutions with established eprint servers (from less than 40 documents to over 2000). For comparison, MIT has 8000 theses and 4000 papers; Duke University's Historical Sheet Music Archive has 17 000 records. To save rewriting what others have already experienced, here is what the EPrints FAQ says about this problem:

> "How can an institution facilitate the filling of its Eprint archives?
>
> - Install OAI-compliant Eprint Archives .
> - Adopt a university-wide policy that all faculty maintain and update a standardised online curriculum vitae (CV) for annual review.
> - Mandate that the full digital text of all refereed publications should be deposited in the University Eprint Archives and linked to their entry in the author's online CV. (Make it clear to all faculty how self-archiving is in the interest of their own research and standing, maximizing the visibility, accessibility and impact of their work.)
> - Offer trained digital librarian help in showing faculty how to self-archive their papers in their own university Eprint Archive (it is very easy).
> - Offer trained digital librarian help in doing "proxy" self-archiving, on behalf of any authors who feel that they are personally unable (too busy or technically incapable) to self-archive for themselves. They need only supply their digital full-texts in word-processor form: the digital archiving assistants can do the rest (usually only a few dozen keystrokes per paper).
> - A policy of mandated self-archiving for all refereed research output, together with a trained proxy self-archiving service, to ensure that lack of time or skill do not become grounds for non-compliance, are the most important ingredients in a successful self-archiving program. The proxy self-archiving will only be needed to set the first wave of self-archiving reliably in motion. The rewards of self-archiving -- in terms of visibility , accessibility and impact -- will maintain the momentum once the archive has reached critical mass. And even students can do for faculty the few keystrokes needed for each new paper thereafter.)
> - Digital librarians, collaborating with web system staff, should be involved in ensuring the proper maintenance, backup, mirroring, upgrading, and migration that ensure the perpetual preservation of the university Eprint Archives. Mirroring and migration should be handled in collaboration with counterparts at all other institutions supporting OAI-compliant Eprint Archives."

2.8 Copyright

Wherever an eprint server is proposed, many respond 'But I can't do this, because the journal/conference I publish in won't let me.' This is largely untrue, and there is an extensive literature on the reactions and the common objections, which have been canvassed *ad nauseam*. A recent survey indicates that 83% of 10673 scholarly journals (up from ~50% last year) approve self-archiving. Current Publishers Copyright Service (Romeo, 2004) data suggests that 92% of 8613 journals permit some form of self-archiving. IEEE is one of the few exceptions, keeping company with many medical journals.

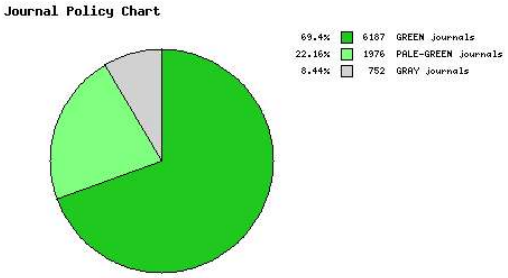

Figure 2 – Journal Policies

In brief, the research and the paper belong to the academic and/or the employing institution prior to publication. At the pre-acceptance stage, the author (or the institution depending on IP policy) is free to do whatever they want with it. Indeed in computer science there was a healthy trade in paper preprints of research articles until electronic archives took over. Regardless of the prior existence of a preprint culture, there is no legal or copyright barrier to mounting preprints on an institutional server, right up to the point where the article is accepted and the publisher asks the author to sign an agreement.

If a publisher states that an article will not be considered if it is mounted on a preprint server, this is simple anti-competitive coercion by that publisher. The author is free to accept the conditions or to publish elsewhere. Such pre-conditions are becoming more and more unusual as publishers adapt to ICT technology impact, but they still exist in some disciplines and with some publishers.

At acceptance stage, *all* publishers of journals or conference proceedings ask for assignment of copyright or some form of copyright license. In the majority of cases the exact form of this is more a matter of tradition than legal requirement, and the publishers (for example *Nature*) are happy for preprints and/or postprints to be mounted on a personal website or institutional eprint server, usually as long as the publisher is acknowledged. Some publishers have actually provided the postprint PDF file exactly as printed in the paper journal or conference proceedings for the author to mount personally (for example the Journal of Research & Practice in Information Technology). These practices increase the profile of

publishers and are a reaction to the increase in electronic access to scholarly literature.

2.9 Other objections

Another common objection is that the Internet is already congested and has too much information, so why add to it? This is nonsense. The Internet does not yet contain as much information as there is in print, yet we do not worry about adding to that body of knowledge. However, everyone would welcome access to more precise and more reliable search tools to find the information that they want on the Internet, and it is precisely this problem that the OAI addresses. Searches of Scirus, myOAI and OAIster are the scholarly equivalent of Google: they search a global and growing database of information restricted to websites that provide scholarly information.

Another objection that is sometimes heard is that preprint files are second-class information; the only thing that should be published on the Internet is the fully refereed paper that which has been validated by experts. Of course, such a criticism cannot be levelled against postprints or RHD theses, which eprint servers also provide. Few editors (of which I am one) of scholarly journals would be so rash as to make this claim; the quality of the refereeing process is well-known to us to be patchy and under increasing stress as more and more experts decline to undertake refereeing tasks. However there are two even more cogent replies.

Eprint servers do not only provide copies of documents, they are surrounded (like e-journals and other electronic media) with other forms of validation and refereeing. For example, many papers are found not through searching but by citations, their inclusion on key papers listings, and links on other websites. All of these are a distributed form of refereeing. Some eprint websites also accumulate comments added to the papers; a form of democratic refereeing similar to book reviews. CiteSeer provides invaluable information to the computer sciences through its analysis of eprint documents, search facilities for citations, and identifying top publications for research impact.

Secondly, the evidence strongly suggests that readers do not have the same view about the uniqueness of a refereed paper that authors and research directors sometimes do. They are often satisfied to read an earlier version of the paper if they can get it more conveniently than a refereed version; even more so if the author mounts a long version of a published paper. Sometimes just the abstract will satisfy them, or surprisingly just a text-only version without diagrams. Enough in any case for the 200-1000 people who actually read the average scholarly paper (the best available estimate) to decide whether they want to study it further or seek/order a journal published version. Both these issues are canvassed with valuable statistics about online usage in Odlyzko (2002); a ‘must read’ for anyone with a view on this topic, positive or negative.

3 Proposal

This paper suggests a coordinated push by all computer science departments and schools in Australasian universities to establish eprint servers as soon as possible, with the initial aim of putting all Australasian computer science research on the global map, and an eventual aim of migrating this sever to the respective university administrations, probably to be operated by the Library.

It is not difficult to establish an eprint server technically. Any computer science department could do it. The direct costs are small, but there is a significant commitment in staff time in learning the details of the software and in interfacing to the global harvesters. The University of Tasmania therefore proposes to cut this effort down and to facilitate the introduction of eprints across all the universities in the region by providing a service:

- A server adequate for the first five or so years would be acquired and preconfigured at the University of Tasmania, using data supplied via email from the target university. When ready, the server would be shipped to the target university with instructions on making the archive live.
- If desired, the University of Tasmania would send one of its technical staff to the target university for up to two days to complete the installation.
- If desired, the author would visit the target university for up to two days, to advise on policies, assist with mounting the first few documents, help develop policies, engage in discussion with senior University executives as required, and to present a seminar or seminars.
- A set of documents would be provided as templates for the target university to modify.

Within Australia, this model could see all universities online in under six months. The target university would commit to meeting the cost of service, including the server, travel, accommodation and other minor expenses, expected to be no more than say $A3000. Given some coordination, travel costs could be shared amongst several universities to keep the cost to any one university as low as possible.

The model would be modified for universities outside Australia. Export of a computer may be more bother than it is worth. In these cases it is suggested that the University of Tasmania technical staff visit the country and instal the software on a suitable server. In the case of New Zealand, coordination between the several universities could again reduce costs. Alternatively, a remote installation process might be possible. It would be important to keep the load on UTas staff low.

4 Content Policies

It is important to develop a policy as to what content is to go into an eprint archive. The following policies have been suggested for UTas, and may be adopted by other universities as a model.

1 All legally allowable documents falling into the following categories should be uploaded as metadata and with full text versions.

2 If the full text of the document cannot be legally uploaded for copyright or sponsored research reasons, it is recommended that just the metadata be loaded (eg title, author, abstract, etc).

3 Academics are encouraged to develop their home pages with hyperlinks to the eprint server, rather than remount copies of their papers. This may lead to discovery of other research undertaken at the university or by the academic.

4 The following content categories should be uploaded.

(a) Preprints of research papers submitted to journals or refereed conferences.

(b) Postprints of research papers accepted by journals or refereed conferences. Full papers, short papers, poster presentations, etc are all acceptable.

(c) Long versions of research papers (particularly relevant to papers shortened for publication or presentation).

(d) Commissioned reports, if in the public domain.

(e) 'Slide presentations' in a format such as PowerPoint which accompany one of the above.

(f) Research higher degree theses (PhD and Research Master) accompanied by ancillary materials such as developed software, etc.

(g) Honours and Coursework Master theses, accompanied by ancillary materials such as developed software, etc. However only First Class and Upper Second Class theses will be public; theses with lower Classes of pass will be confined to viewing by registered users (*ie* on-campus).

Category (e) deserves some comment. Even if the university has a mandatory or voluntary Australian Digital Thesis project, it is still worth encouraging PhD graduates to upload their theses to an eprint server. At the present time ADT does not provide OAI-PMH global exposure and an eprint server does. In addition, and equally important to computer science, the thesis is not restricted to a pdf file (as is ADT policy) but can have accompanying software, raw data, multimedia, etc. Multiple formats in one upload are also possible, such as PDF, Postscript, Word, HTML, XML, LaTeX, etc.

5 Extension university-wide

In this paper, the concentration has been on establishing an eprint server in the computer science department in every Australian university, and linking this server into the global OAI community. The benefits are joint and individual – with all computer science departments as participants, Australian CS achieves a higher global profile and all benefit; individual departments also achieve access to each others' research, as well as learning about the open access initiative, and contributing to it. Extension to nearby countries in the region has also been suggested, with corresponding benefits to the region.

However there are also optional extensions that any department should seriously consider. The easiest and simplest arises if the university has an information systems department or a computer systems engineering department as well as a computer science department. It is a minor matter to extend the invitation to them to participate, with mutual benefit.

More significant is the possibility of convincing the university itself to take over the server and make it a university-wide one. The University of Tasmania is headed down this path, and should have made the decision before the end of 2004 (agreement is anticipated). Tackling this extension will win the computer science department credit for proposing an activity which has fallen under the radar of the Pro Vice-Chancellor (Research) and the Library, but precisely because of that is a ticklish one to tackle. In addition, the success of an eprint archive depends mostly on the participation rate by academics, not on technical issues. This means that the computer science department has to convince the university community at large, and especially its opinion-makers, that an eprint archive is not only a good thing, but a gift of inestimable value.

The author faced exactly this problem in the University of Tasmania, and determined to take a paper direct to Academic Senate, concurrently carrying on a proselytizing campaign amongst opinion leaders. The paper was very well received and was referred to all and sundry in the University for comment and action at the next meeting of Senate.

Key to this outcome was getting the Library onside, since they do not appreciate being blindsided. The Library (or a Resource Centre) is the logical entity in most universities to operate an eprint server. The only other options worth considering are a Research Office or an ICT service section.

The School of Computing at UTas is willing to provide advice, assistance and draft documents to assist others to go down this path.

6 Conclusion

This paper has outlined a scheme for putting the research of all Australian computer science departments into globally accessible standards-compliant servers, making Australian CS research more visible in the world community, and making it have more impact. The scheme will be put to the heads of schools and departments in the latter part of 2004.

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