Robotics Research Review
– RAS Approaches to Research –

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(slides adapted from earlier versions by Alan Bundy, Alex Lascarides, Victor Lavrenko, Stratis Viglas, Mark van Rossum)

Two components of MSc

- Taught component (80 credits)
  - lectures, tutorials, coursework, exams
  - learn established techniques that work
- Research component (100 credits)
  - do something that's never been done before
    - study a new problem, develop a new method, etc.
    - probably the most exciting (and hardest) part of MSc
  - culminates in you writing a dissertation (~50 pages)
  - two courses prepare you:

    RRR: literature review in area of interest

    RRP: write a detailed plan for your MSc project

MSc project timeline

- First teaching block: RRR
  - learn about a relevant area: explore research papers
  - write a 3000-word summary of what you learned
- After FLW:
  - submit robotics research report
  - specify topic
  - talk to supervisors, pick set of topics
- Second teaching block: RRP
  - update RRR and add another 3000 words
  - write a detailed plan for what you're going to do
- Summer (provided your exams went well)
  - work on your project (build, test, analyse results)
  - write a dissertation

RRR: What is it?

- *Compulsory*
- *Survey* of research in targeted area
- Literature review focused at summer project
  - Literature study may affect project definition
  - *choice* of project still *open after* RRR
- Delivered by a Member of staff
  - Knowledgeable about your specialism
  - But generally not about your research project
- Approximately (about 3000 – 4000 words or 10 pages)
  - you can write more, but one would not expect less

Purpose of RRR

1. Learn skills of research reading in order to motivate, formulate, justify and discuss research questions
2. Learn skills of research writing
3. Confirm choice of research area
4. Learn from community rather than from text books or academic teachers

In a nutshell

- Identify relevant papers: (see below)
- Keep notes on each paper
- Attend related seminars: http://www.inf.ed.ac.uk/events/seminars
- Weave the papers into a story
- Write your report
- Submit by 4pm, 25th February 2019: e-mail to supervisor(s) and cc to mherrman@inf.ed.ac.uk
- no extensions

Assessment (out of 100%)

- Your report will be marked by your tutor, you will receive feedback
- Mark is based on:
  - Appropriate coverage: did you hit the important papers in the area?
  - Understanding of sources: are you just parroting back what you read?
  - Critical evaluation and comparison: beyond “A did X, B did Y”?
  - Clarity of expression and presentation: can your friends understand it?
- Cooperation with your Mentor
- We are here to help and RRR is not difficult once you've passed ASR. But if
  - if you don't actively contribute,
  - do not put effort in it, or
  - plagiarize,

  you won't.

Structure of review

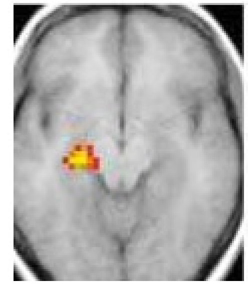
- *Introduction*: identify and motivate topic
- *Main* body
  - *Summarise* each piece of work
  - Give critical *analysis*

    - Big contrast to taught courses: Research is work in progress:
    - *N*ot everything you read is correct or as important as the authors say.
  - *Compare* and *contrast*
- *Conclusion*
  - What is *state* of the field?
  - Where *next*?
- *Bibliography*: list all (and only) papers cited

How to identify papers to read

- Select interesting seed papers based on suggestions of Mentor
- Follow-up the citations in the papers you read (reference list)
- Classical papers and text books: Only if you actually read them (or the relevant parts of them)
- See who cited the paper (easy with Google Scholar)
- Library and online resources
  - Citeseer and ISI Web of Knowledge
  - Google Scholar
  - Library Online http://www.lib.ed.ac.uk/resources

Active attitude



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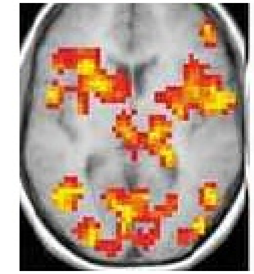

Always have questions in mind when reading (or listening to a talk)

- What are the aims and objectives of the work?
- What was achieved?
- What claims are being made?
- Is the supporting evidence convincing?
- What would I do to extent work / disprove claims.

Types of scientific papers

- A new way of doing something (algorithm, analysis, method, technique, construction) [benefits?]
- Discovery of something [importance?]
- Report a correlation/relation “Smokers have higher IQ” [significance, credibility, falsifiability?]
- Linking previously unrelated findings/methods; application to new area [appropriateness]
- Over-arching description/understanding [usefulness]
- Review of the field [any new development?]
- Negative results

Generally: Consistency, clarity, conciseness, strength of evidence, interestingness, impact, ...

Typical claims in Informatics / Robotics

X is better than Y on task Z along some dimension W

- What kind of things are **X** and **Y**?
  - system?
  - technique?
  - parameter?
- What is task **Z**?
- What is the dimension **W**?
  - behaviour, coverage, efficiency, usability, dependability, maintainability

For keyword-based searches in medical databases, Pseudo-Relevance Feedback will provide better search results than Topic Modeling as measured by mean average precision of the ranked list.

Hypotheses in Informatics / Robotics

- *Hypotheses/claims* often not stated
  - *except* in *theoretical* work
  - leads to confusion and misunderstanding
- If *claim not clear* then this should be *criticised*
  - same if claim is *strong* and is *not proven*
- *Evidence* may be *theoretical* or *experimental*
- *Objective* may be to *identify a hypothesis* for subsequent evaluation

Reading to different depths

- *Some work* is *central* to your concerns, *some less so*
- Need to *vary reading depth*
    - some need only *skim*
    - some read *in depth*
    - some *in between*
- Could be *20+ papers in total*, but only *3 or 4 in depth*
    - but you need to *cite everything*

How to skim

- *Read* title, abstract, introduction, conclusion, bibliography, *key sections*
- *Identify* main *contribution* of paper
- How does it *relate* to other work?
- *Identify* key *questions to be addressed* and hunt for answers

How to read in depth

- Make *several passes* over the paper
    - start by skimming
    - then read in increasing detail
- *Apply techniques* to your *own examples (thought experiment)*
- *Try explaining* the ideas to a friend, or even a virtual friend.

Make notes on papers

- What is the key finding? (see abstract and conclusion)
- Why is this research important?
  - How does it relate to earlier work?
  - What perspectives are ensuing?
  - Is the problem elegantly and efficiently treated?
- Critical assessment
  - Is the paper clear and accessible?
  - Is the level of generality appropriately described?
  - Are methods, evaluation and discussion satisfactory?
- How does it relate to your work?
- Write clearly, concisely and to the point such that you can copy into your report.
- Group papers when some of the points coincide, but make sure you have at least one point specifically for each paper.

Telling a story

- Literature survey is part of *motivation*
- How did this field *develop*?
- How did it *start*?
- What are the *rival approaches*?
- How do pieces of work *relate*?
- Where are we *now*?
- What remains *to be done*?
- What are the *hot topics*?

Technical writing

- Your audience: a fellow student: knows some basics, but has not read the papers that you have read.
- Like software writing: there are guidelines, but no recipes for good writing.
  It starts with thinking (away from the computer).
- The reader of a scientific paper will want to *know **exactly** what is going on*
  - it's *not* a *mystery novel*; there is no plot, only facts and (maybe) opinion
  - do *not try* to write *flamboyantly*; it *confuses and irritates* the reader
  - use *terminology*; it's there for a reason
- Strunk & White: The elements of style (available online)
  - read it three times a day, with every meal
- [Richard Dawkins The Oxford Book of Modern Science Writing]

Example of what to avoid

"[…] to enable the advantageous employment of the inherent stratification of the memory infrastructure of modern processors and their interconnected means of communication […]"

"[…] to better use the cache hierarchy and the system bus […]"

Be clear!

- What exactly does this mean?
- Be complete on everything essential
- Structure your concepts efficiently
- Provide meta-information when deviating from linear progression
- Get discourse references right
- Avoid malapropisms
- Readability does not imply clarity, but helps to show that your are clear

Avoid plagiarism

- *Quotations* must be *acknowledged*
    - including close paraphrase
    - use quote marks and cite source
      ...Smith (2009) argued that “the Level 2 cache systems are the core to fast database systems in future HPC”....
- *Do not* copy-paste-edit from online sources
- Read School guide on plagiarism
    - http://www.inf.ed.ac.uk/admin/ITO/DivisionalGuidelinesPlagiarism.html
- Plagiarism carries *serious penalties*

In summary, Linked Data is simply about using the Web to create typed links between data from different sources. These may be as diverse as databases maintained by two organizations in different geographical locations, or simply heterogeneous systems within one organization that, historically, have not easily interoperated at the data level.

Technically, Linked Data refers to data published on the Web in such a way that it is machine-readable, its meaning is explicitly defined, it is linked to other external data sets, and can in turn be linked to from external data sets.

While the primary units of the hypertext Web are HTML documents connected by untyped hyperlinks, Linked Data relies on documents containing data in RDF. However, rather than simply connecting these documents, Linked Data uses RDF to make typed statements that link arbitrary things in the world. The result, which we will refer to as the Web of Data, may more accurately be described as a web of things in the world, described by data on the Web.[6]

Berners-Lee outlined a set of 'rules' for publishing data on the Web in a way that all published data becomes part of a single global data space:

1. Use URIs as names for things
2. Use HTTP URIs so that people can look up those names
3. When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL)
4. Include links to other URIs, so that they can discover more things.

These have become known as the 'Linked Data principles', and provide a basic recipe for publishing and connecting data using the infrastructure of the Web while adhering to its architecture and standards.

4

The most visible example of adoption and application of the Linked Data principles has been the Linking Open Data project, a grassroots community effort founded in January 2007 and supported by the W3C Semantic Web Education and Outreach Group. The original and ongoing aim of the project is to bootstrap the Web of Data by identifying existing data sets that are available under open licenses, converting these to RDF according to the Linked Data principles, and publishing them on the Web.

Figure 2: Histogram of the image in Figure 1

Histogram equalization is one of the most commonly used methods for contrast enhancement. It refers to the modification of the image through some pixel mapping such that the histogram of the processed image is more uniform than that of the original image (Arici, 2009). Since it deals with direct manipulation of the pixel intensity values, thus it falls within the category of image enhancement in spatial domain. Histogram equalization method can be achieved by using the cumulative density function of the input image to derive a uniform distributed histogram of the enhanced image (Arici, 2009). Ibrahim & Kong (2007) introduced Brightness Preserving Dynamic Histogram Equalization (BPDHE) method.

1 Brightness Preserving Dynamic Histogram Equalization (BPDHE)

BPDHE is a histogram equalization method, which produces the output image with the mean intensity almost equivalent to the mean intensity of the input image (Ibrahim & Kong, 2007). The steps for BPDHE are as follows:

Method 1: Smooth the histogram with a Gaussian filter

In Figure 2, we can see that the histogram of the digital image is fluctuated and the probability for some intensity values are missing (i.e. intensity values from 0-39 as well as 111-256). As stated by Ibrahim & Kong (2007), it is difficult to detect the local maximums of the histogram without smoothing the histogram. Therefore, the first step is to fill up the disappeared intensity values by using linear interpolation. Linear interpolation is a first degree method that passes a straight line through every two consucutive points of the input signal. If the two known points are given by the coordinates (x_0, y_0) and (x_1, y_1), then the linear interpolant is the straight line between these two points. For a value x in the interval, the value y along the straight line is given by the equation:

$$\frac{y - y_0}{x - x_0} = \frac{y_1 - y_0}{x_1 - x_0}$$

Solving the equation for y gives

$$y = y_0 + (x - x_0)\frac{y_1 - y_0}{x_1 - x_0}$$

Another way to fill up the disappeared intensity values is through the fractal interpolation method as introduced by Kobes & Letkeman (2001). In fractal interpolation, the video frame is encoded into fractal codes via fractal compression, and subsequently decompressed at a higher resolution. For the classic linear Fractal Interpolation Function (FIF), the Iterated Function System (IFS) is used to construct a FIF for a given set of

8.2.2.1 Methods

The goal of CRM model is to learn the joint distribution $P(r, w)$ over regions r of an image and the words w in its annotation (Lavrenko, Manmatha, & Jeon, 2003). As stated by Lavrenko, Manmatha and Jeon (2003), T is the training set of annotated images, J is an element of T, $r_A = \{r_1, ..., r_{n_A}\}$ is the regions of some image A, that is in the testing set of unannotated images and $w_B = w_1, ..., w_{n_B}$ is some arbitary sequence of words, we can compute a joint probability, $P(r_A, w_B)$ by:

$$P(r_A, w_B) = \sum_{J \in T} \prod_{b=1}^{n_B} P_v(w_b \mid J) \prod_{a=1}^{n_A} \int_{\mathbb{R}^k} P_R(r_a \mid g_a) P_G(g_a \mid J) dg_a$$

The estimation parameters are:
1. $\boldsymbol{P_T(J)}$ which is a uniform prior, is the probability of selecting underlying model of image J to generate some new observation r, w (Lavrenko, Manmatha, & Jeon, 2003).

$$P_T(J) = \frac{1}{N_T},$$

where N_T is the size of the training set.
2. $\boldsymbol{P_R(r \mid g)}$ is a global probability distribution used to map generator vectors, $g \in \mathbb{R}^k$ to actual image regions $r \in R$ (Lavrenko, Manmatha, & Jeon, 2003).

$$P_R(r \mid g) = \begin{cases} \frac{1}{N_g} & \text{if} G(r) = g \\ 0 & \text{otherwise} \end{cases}$$

where N_g is the number of all regions r' in R such that $G(r') = g$.
3. $\boldsymbol{P_G(. \mid J)}$ is a non-parametric kernel-based density function used to generate the feature vectors $\{g_1, ..., g_n\}$, that are later mapped to image regions r_J according to P_R (Lavrenko, Manmatha, & Jeon, 2003).

$$P_G(g \mid J) = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{\sqrt{2^k \pi^k |\sum|}} exp\{(g - G(r_i))^\top \sum^{-1} (g - G(r_i))\},$$

where $r_J = \{r_1, ..., r_n\}$ is the set of regions for image J, $\sum$ is the feature covariance matrix with equation $\sum = \beta.I$, where I is the identity matrix and β plays the role of kernel bandwidth that determine the smoothness of P_G around support point $G(r_i)$.
4. $\boldsymbol{P_v(. \mid J)}$ is the multinomial distribution that is assumed to have generated the annotation w_J of image $J \in T$ (Lavrenko, Manmatha, & Jeon, 2003).

Self-plagiarism

- You cannot get credits twice for the same work
- You will need to quote your own work outside the RRR just like other literature
- Reference to work outside RRR may help the marker to appreciate your project
- Referring to your own work may not count as a reliable scientific evidence
  - find additional support in other literature
  - use in less critical places (e.g. delimitation of area)
- Keep self-references at a reasonable level

Bibliography

- List *all* and only *papers cited*
  - [Hacker 2000] Hacker, A., "A model of free will", *Journal of Computational Theology*, pp 1-42, Vanity Press, 2000.
- There are *several styles* and publication types
  - LaTeX/LyX supports several
- Provide the following:
  - *author(s) name(s), paper title, journal/book/conference title, year*, pagination, volume/number, editor(s), publisher

Pacing Yourself

- Work out *timetable* for reading/writing
- Leave *plenty of time for feedback* and correction
- Read at a *steady pace*
- Keep notes
- ***Write as you go***

Including your own work

- Report of own work should not be on the cost of the coverage of the literature
- Extraction, justification and structuring of a good research question is already own work
- Beyond this don't aim for more than a Proof of Principle
- Will have a relatively weak effect on the mark

Summary

- Make thoughtful and thorough search for sources
- Papers and seminars
- Study each in appropriate depth
- Keep notes
- Critically evaluate and compare
- Weave into story
- Write ~4000 word report
- Reflect story and relevance in report
- Leave time for feedback and correction

More information

- Read the MSc project guide

http://www.inf.ed.ac.uk/teaching/courses/diss/guide.html

  most of your questions are answered there

- If you have questions
    - ask your supervisor
    - make an appointment to see me