What if.... we could automatically test our textual instructions?

Crash-test-virtual-machines

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Outline

Outline

Branavan et al. (2009)

- This talk is an exercise in brainstorming about how a very interesting paper can be of use within Debian.
  - Reinforcement Learning for Mapping Instructions to Action
  - S.R.K. Branavan, Harr Chen, Luke S. Zettlemoyer, Regina Barzilay
    - Computer Science and Artificial Intelligence Laboratory Massachusetts Institute of Technology
  - Presented at the Annual Meeting of the Association for Computational Linguistics (ACL '2009)
    - Best paper award.

The Problem

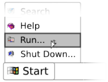
- Instructions from the Microsoft KB (how to remove the “msdownld.tmp” temporary folder).
  - Click start, point to search. and then click for files or folders.
  - In the search results dialog box, on the tools menu. click folder options.
  - In the folder options dialog box, on the view tab, under advanced settings, click *show hidden files and folders*, and then click to clear the *hide file extensions for known file types* check box.
  - Click apply, and then click ok.
  - In the search for files or folders named box, type msdownld.tmp.
  - In the look in list, click my computer, and then click search now.
  - In the search results pane. right-click msdownld.tmp and then click delete on the shortcut menu, a *confirm folder delete* message appears.
  - Click yes.

Output

u: `click` **`Run`**`, and press` **`OK`** `after typing` **`secpol.msc`** `in the` **`open`** `box.`

$\vec{a}$: $\boxed{c\text{: } \textit{left-click} \quad R\text{: [Run...]}}$

$\mathcal{E}$:



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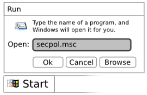

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Type the name of a program, and Windows will open it for you.

Open: secpol.msc

---

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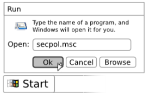

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Results

	Action	Sent.	Doc.	Word
Random baseline	0.128	0.101	0.000	——
Majority baseline	0.287	0.197	0.100	——
Environment reward	∗0.647	∗0.590	∗0.375	0.819
Partial supervision	0.723	∗0.702	0.475	0.989
Full supervision	0.756	0.714	0.525	0.991

The Technology

- Training Data
  - Instructions plus
  - An automatic verifier for step-wise success.
- Output
  - a script (e.g., a shell script) that executes the commands in the text.
- Method
  - Run the OS in a VM, execute first at random, then start informing a model mapping text excerpts into actions.
- Mapping instructions is complicated by out-of-order phrases (“select run after clicking start”), aggregated phrases (“remove everything in the folder”), high level instructions (“start the Web browser”), etc.

Outline

Why Should We Care?

- Users want instructions.
- Maintainers write instructions.
- System changes, instructions become **stale**.
- Debian has a strong tradition in automating as much as possible processes and tests related to the health of the system.
  - E.g., lintian, piu-parts, mini-dinstall and a large etc.
- This new technology might enable continuous testing of instructions related to packages.

Which Instructions?

- Instructions in man pages (hadoop.1)
  The "/etc/hadoop/conf" link is managed by the **alternatives(8)** command so you should not change this symlink directly.
  To see what current alternative(8) Hadoop configurations you have, run the following command:

```
# alternatives --display hadoop
hadoop - status is auto.
link currently points to /etc/hadoop/conf.pseudo
/etc/hadoop/conf.empty - priority 10
/etc/hadoop/conf.pseudo - priority 30
Current 'best' version is /etc/hadoop/conf.pseudo.
```

  (...)
  To activate your new configuration and see the new configuration list:

```
# /etc/init.d/hadoop-namenode restart
```

How Can We Use It?

- Special test target in debian/rules
  - For example, instruction-tests
  - The target produces the training necessary by the system.
  - First upload: debian-wide model is updated.
  - New uploads: if trained model stops working, the maintainer will be informed. This won't happen any time soon. Indeed, first we can
- Add special mark-up to discussion forums.
  - Enrich the mark up of the forums with tags that signal the problem and the instructions to solve it.
  - We can then autommatically warn the readers when a solution no longer works in a newer version of Debian.

More Food For Thought

- `http://forums.debian.net`?
  - Docs, Howtos, Tips & Tricks: 622 topics
- Debian-installer specific instructions?
- Instructions in debconf templates?
- Multi-linguality?
  - Create a model of text into instructions for two languages.
  - In their paper, they show the model can (with some luck) be used to generate text from the actions.
  - For instructions lacking in one, language, they can be generated from the actions a understood in the first language.
    - Hopefully better quality instructions than using machine translation.
    - Instructions are held up-to-date automatically.

About the Speaker

- CU is my graduate school ’alma mater’
  - NLP group
  - PhD CS in 2005
- IBM researcher since then
  - Part of the DeepQA team
- NLP is starting to work, thanks to increased computational power and advances in machine learning.
- Passionate about Free Software and Debian
  - Interested in getting more NLP into Debian
  - Will have plenty of time in the upcoming months, so looking forward to do something useful within Debian.

Outline

Interesting Idea Beyond NLP

- How reinforcement learning works.
  - Build over time a model of the mapping between actions and the way the environment is affected by the actions.
  - Sample the actions at a given point and see how the environment reacts.
- When mapping instructions into actions:
  - The instructions guide the sampling of actions and compute rewards.
- A sequence of actions that maximizes rewards is expected to be the sequence of actions corresponding to the instructions.

Formally

- Input is a document $d = (u_1, ..., u_l)$, a sequence of sentences (and each sentence is a sequence of words).
- Output is a sequence of actions $\vec{a} = (a_0, ..., a_{n-1})$. Actions are predicted and executed sequentially (and each sentence is consumed in order, but its words are in any order).
- An action $a = (c, R, W')$, contains a command c, its parameters R and the words it encompasses W'
  - The parameters refer to object in the environment and/or words in the document.
- The environment ε contains the objects and their properties.
  - The env. ε changes with a command c with params R according to a transition distribution $p(\varepsilon' | \varepsilon, c, R)$.
- The state of the mapping at a given point is given by a mapping state s, a tuple (ε, d, j, W).

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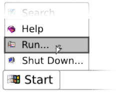

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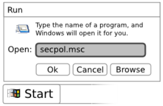
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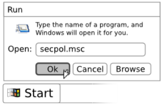
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Reward Function

- After each sentence, check whether any of the words in the remaining of the instructions appear in the screen.
    - If you were expected to open the control panel up to this point, then the label “control panel” should be visible.
    - If none is visible, reward is -1
    - If some are visible, the reward is weighted between 0 to 1 depending on how many matches appear in the screen.
- The main drawback of the technique, without this approximation it will require unreasonable human intervention.

Environment

- The environment are the UI objects in the screen and object properties such as label, location, and parent window.
- Commands include click (left, right, double) and type-into
    - Take a UI object as a parameter
    - type-into also takes as a parameter the input text.
- A total of 4,000+ features represent the environment.

Training Data

Total # of documents	128
Total # of words	5562
Vocabulary size	610
Avg. words per sentence	9.93
Avg. sentences per document	4.38
Avg. actions per document	10.37

Training Algorithm

```
Input: A document set $D$,
       Feature representation $\phi$,
       Reward function $r(h)$,
       Number of iterations $T$

Initialization: Set $\theta$ to small random values.

1   for $i = 1 \dots T$ do
2     foreach $d \in D$ do
3       Sample history $h \sim p(h|\theta)$ where
          $h = (s_0, a_0, \dots, a_{n-1}, s_n)$ as follows:
3a      for $t = 0 \dots n-1$ do
3b        Sample action $a_t \sim p(a|s_t;\theta)$
3c        Execute $a_t$ on state $s_t$: $s_{t+1} \sim p(s|s_t, a_t)$
        end
4       $\Delta \leftarrow \sum_t \left( \phi(s_t, a_t) - \sum_{a'} \phi(s_t, a')p(a'|s_t;\theta) \right)$
5       $\theta \leftarrow \theta + r(h)\Delta$
      end
    end

Output: Estimate of parameters $\theta$
```

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Where To Go From Here

- Throw me tomatoes (save them for lunch!)
- Forget NLP and use reinforcement learning for something else.
- Let's talk about where we can tinker with these within Debian.
- Other NLP tech I been considering:
  - Mailing lists summaries (GoogleNews style)
  - Automating meetbot "info" entries
  - Indexing the source code of Debian packages (deb-source-index is an IRCbot interface to a proof-of-concept index)

Mailing Lists Summaries

- Some teams (e.g., debian-java) have high traffic mailing lists.
  - Supplement the mailing list with a page with summaries and information relevant to the reader (e.g., automatic messages filtered to only certain packages).
- Debian-devel mailing list would profit from summaries in the style of the (now defunct) kernel-traffic summaries.
  - Been using the kernel-traffic as training material.
  - Can help complement the submitter-driven news services in the project, like Debian-News.

Automating MeetBot #info Entries

- MeetBot is an excellent bot to conduct meetings in IRC.
    - Written by Richard Darst in pure python.
    - Used heavily by the DebConf-team.
- MeetBot has a number of commands.
    - Many of these commands are used to make a succint summary of what topics were discussed through the meeting, which action items were assigned and which topics were agreed upon.
        - It is possible to include extra information into these summaries by issuing a general '#info' command, but many times the participants forget to do so, producing lower quality summaries.
- I am interested in producing a summary including “also of note” items, in the vein of “an automatic model believes this messages should have been #info”.

NLP and Free Software

- NLP requires many, many eyes.
  - Plenty of errors in current systems.
  - But perfection is possible, just painful.
- I am hoping to contribute to the maintenance of NLP tools within Debian
- And also to get other contributors interested in NLP.
  - Considering offering an on-line course on NLP for Free Software contributors (ping me if you would be interested).

Summary

- Some cool new tecnology is becoming available.
  - Debian can take advantage of it quickly
- Doing reinforcement learning over full O/S VMs worked for some particular problem with some particular data.
  - Yes, it is a particular case, but it should tempt others to try similar things.
- Let's add some NLP goodies to the Debian tooling.
- Keep in touch!
  - DrDub in OFTC / pablo.duboue@gmail.com