Before we start...

- Start downloading Moses:

```
wget http://ufal.mff.cuni.cz/~tamchyna/mosesgiza.64bit.tar.gz
```

- Start downloading our “playground” for SMT:

```
wget http://ufal.mff.cuni.cz/eman/download/playground.tar
```

- Slides can be downloaded here:

```
http://ufal.mff.cuni.cz/~tamchyna/mtm14.slides.pdf
```

Experimenting in MT: Moses Toolkit and Eman

Ondřej Bojar, **Aleš Tamchyna**
Institute of Formal and Applied Linguistics
Faculty of Mathematics and Physics
Charles University, Prague

Mon Sept 8, 2014

Outline

- Quick overview of Moses.
- Bird's eye view of (phrase-based) MT.
    - With pointers to Moses repository.
- Experiment management.
    - Motivation.
    - Overview of Eman.
- Run your own experiments.
    - Introduce Eman's features through building a baseline Czech→English MT system.
    - Inspect the pipeline and created models.
    - Try some techniques to improve over the baseline.

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      create phrase/rule tables from word-aligned data,
      train language models with KenLM
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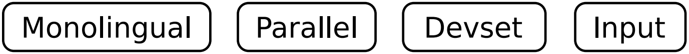
      create phrase/rule tables from word-aligned data,
      train language models with KenLM
    - Tuning translation systems (MERT and others)
- You still need a tool for word alignment:
    - GIZA++, fast_align, ...
- Bundled with its own experiment manager EMS
    - We will use a different one

Bird's Eye View of Phrase-Based MT



Monolingual

Parallel

Devset

Input

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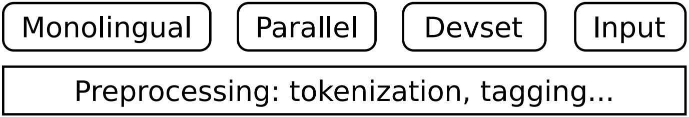

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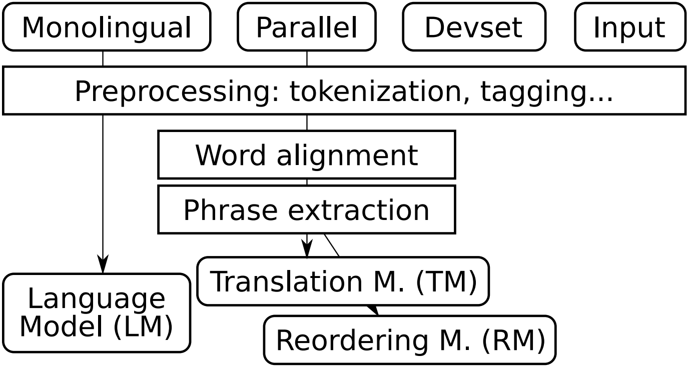

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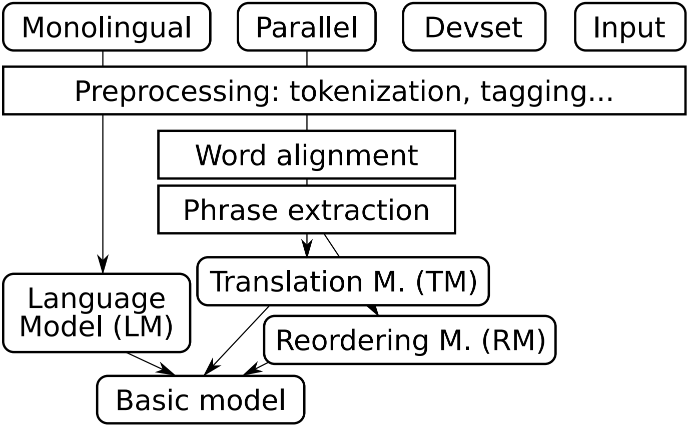

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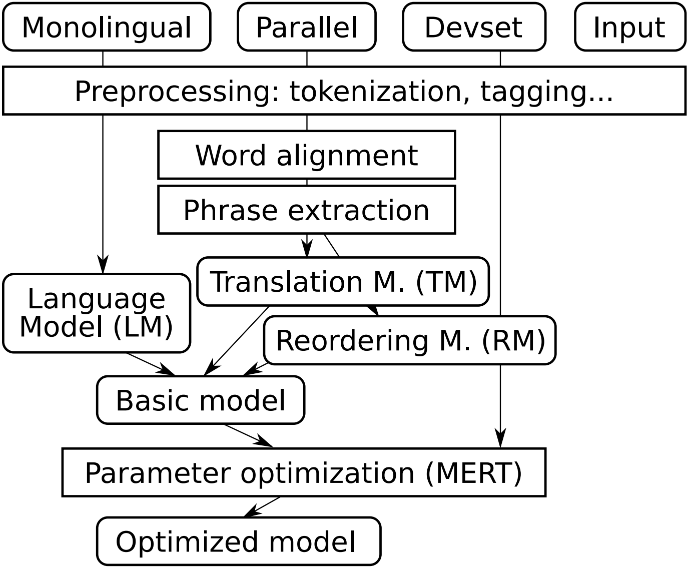

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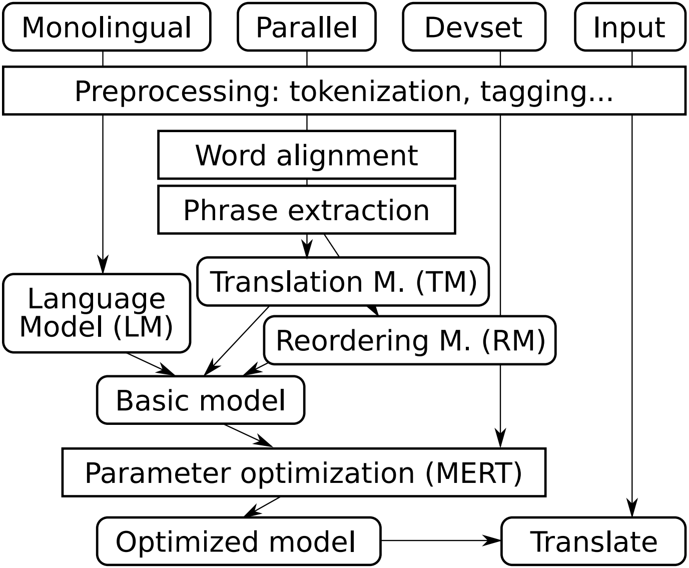

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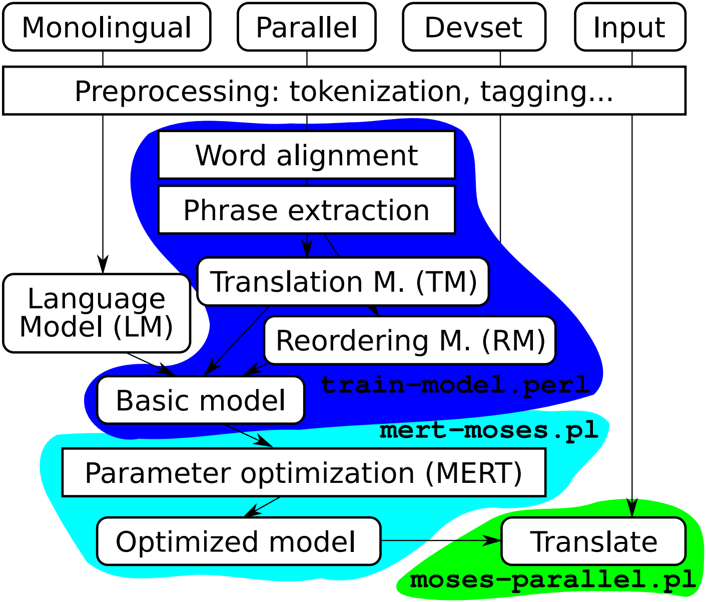

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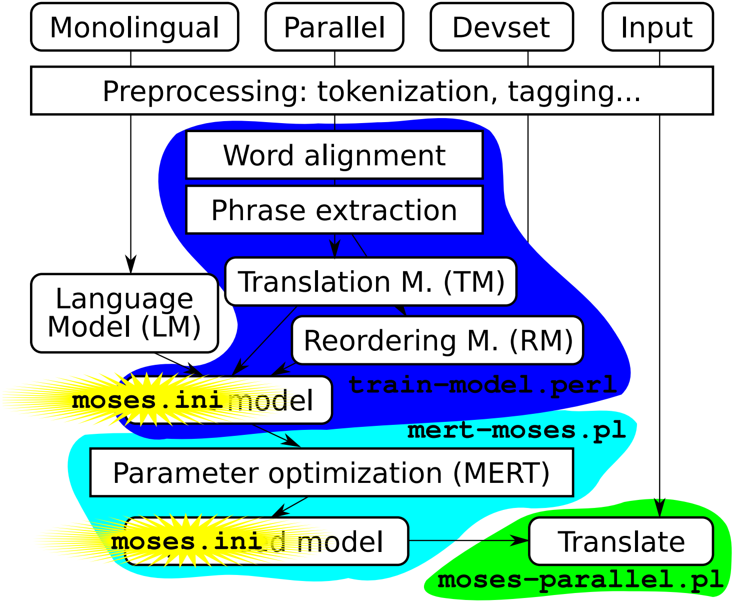
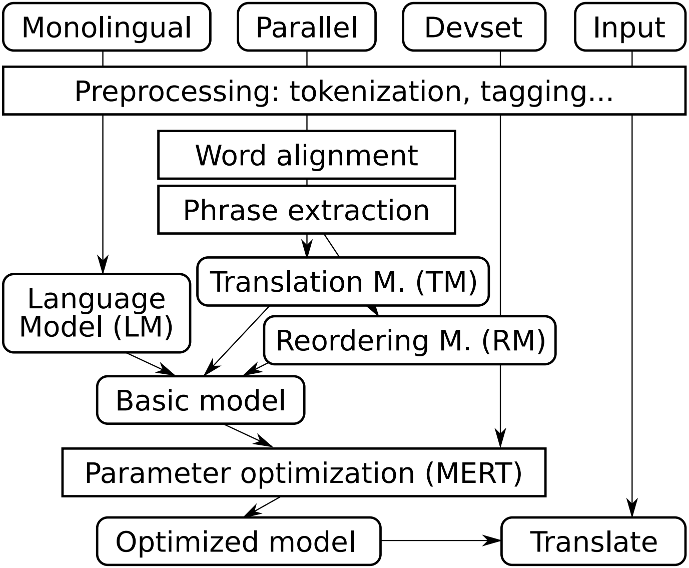
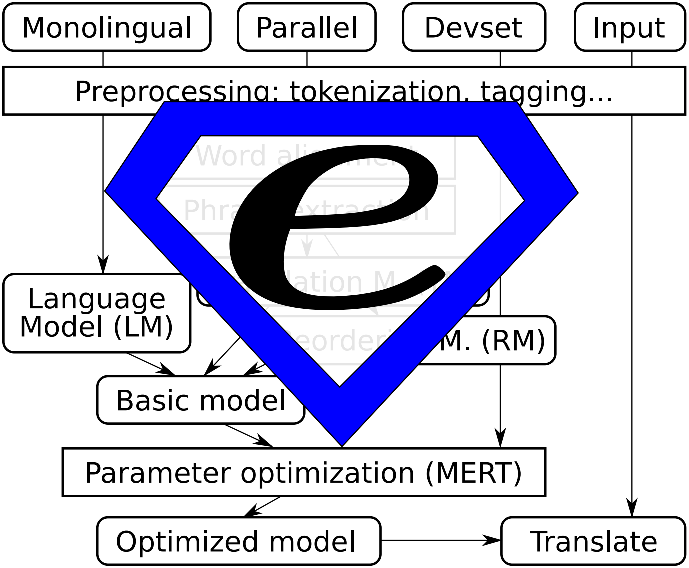


Now, This Complex World...



…Has to Be Ruled by Someone



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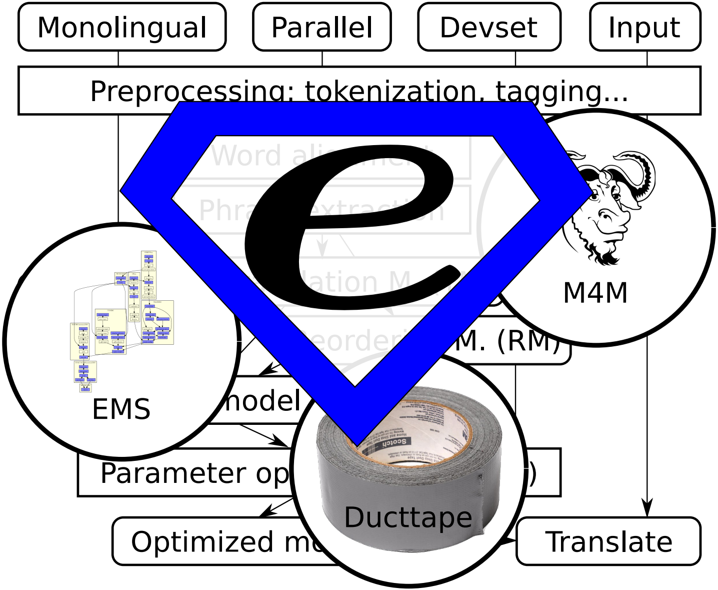

Monolingual

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Preprocessing: tokenization, tagging...

Word ali men

Phra extraction

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eorderi M. (RM)

nodel

Parameter op)

Optimized m

Translate

EMS

M4M

Ducttape

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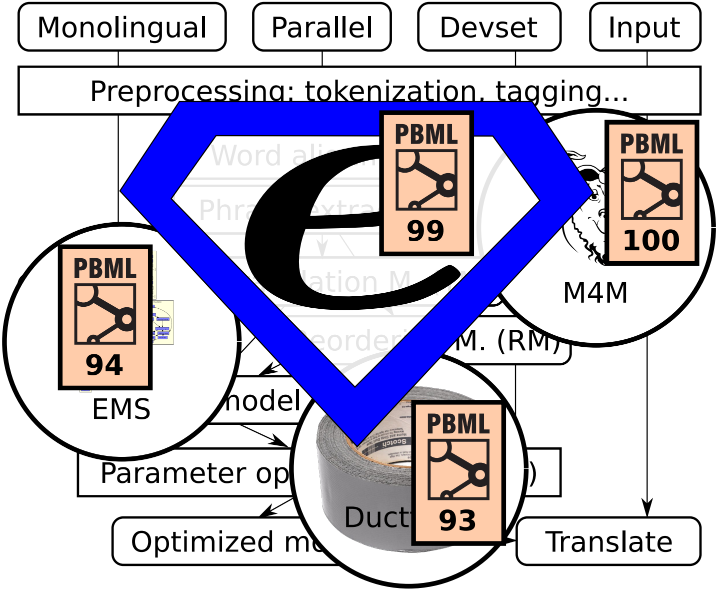

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  - easily run many experiments in parallel
- Re-use of intermediate files
  - different experiments may share e.g. the same language model

Features of Eman

- Console-based ⇒ easily scriptable (e.g. in bash).
- Versatile: "seeds" are up to the user, any language.

- Support for the manual search through the space of experiment configurations.
- Support for finding and marking ("tagging") steps or experiments of interest.
- Support for organizing the results in 2D tables.

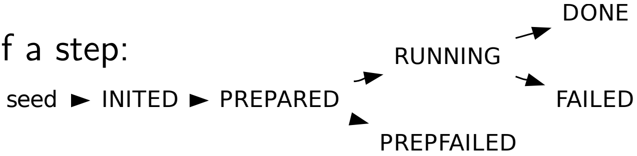
- Integrated with SGE
  ⇒ easy to run on common academic clusters.

eman --man will tell you some details.
http://ufal.mff.cuni.cz/eman/ has more.

Eman's View

- Experiments consist of processing STEPS.
- Steps are:
  - of a given type, e.g. **align**, **tm**, **lm**, **mert**,
  - defined by immutable variables, e.g. **ALISYM=gdfa**,
  - all located in one directory, the "**playground**",
  - timestamped unique directories, e.g. **s.mert.a123.20120215-1632**
  - self-contained in the dir as much as reasonable.
  - dependent on other steps, e.g. first **align**, then build **tm**, then **mert**.

Lifetime of a step:



Why INITED→PREPARED→RUNNING?

The call to **eman init** *seed*:

- Should be quick, it is used interactively.
- Should only check and set vars, "turn a blank directory into a valid eman step".

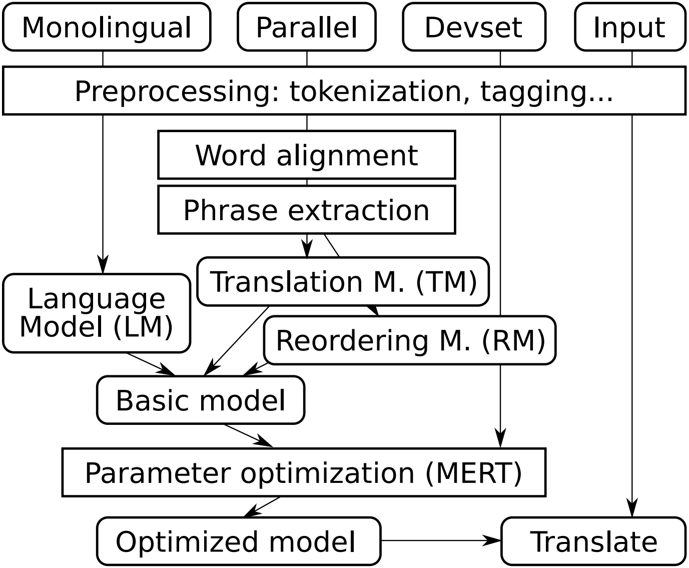
The call to **eman prepare** *s.step.123.20120215*:

- May check for various input files.
  - Less useful with heavy experiments where even corpus preparation needs cluster.
- Has to produce **eman.command**.
  ⇒ A chance to check it: are all file paths correct etc.?

The call to **eman start** *s.step.123.20120215*:

- Sends the job to the cluster.

Our Eman Seeds for MT



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Preprocessing: tokenization, tagging...

Word alignment

Phrase extraction

Translation M. (TM)

Language Model (LM)

Reordering M. (RM)

Basic model

Parameter optimization (MERT)

Optimized model

Translate

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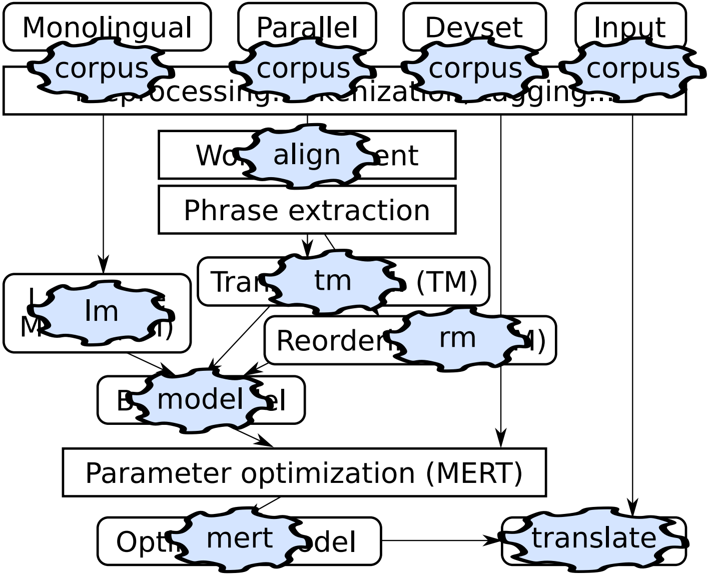

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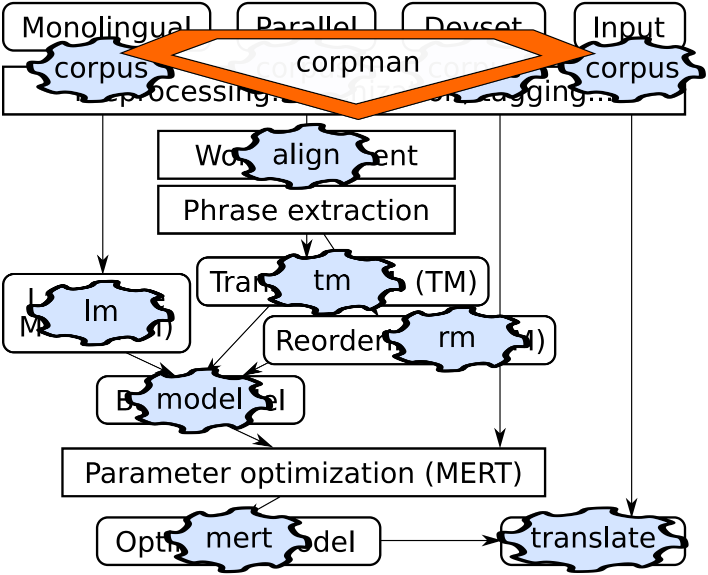

Eman's Bells and Whistles

Experiment management:

- **ls**, **vars**, **stat** for simple listing,
- **select** for finding steps,
- **traceback** for full info on experiments,
- **redo** failed experiments,
- **clone** individual steps as well as whole experiments.

Meta-information on steps:

- **status**,
- **tag**s, autotags,
- **collect**ing results,
- **tabulate** for putting results into 2D tables.

Whole Experiment = **eman traceback**

eman traceback s.evaluator.8102edfc.20120207-1611

```
+- s.evaluator.8102edfc.20120207-1611
|  +- s.mosesgiza.b6073a00.20120202-0037
|  +- s.translate.b17f203d.20120207-1604
|  |  +- s.mert.272f2f67.20120207-0013
|  |  |  +- s.model.3e28def7.20120207-0013
|  |  |  |  +- s.lm.608df574.20120207-0004
|  |  |  |  |  +- s.srilm.117f0cfe.20120202-0037
|  |  |  |  +- s.mosesgiza.b6073a00.20120202-0037
|  |  |  |  +- s.tm.527c9342.20120207-0012
|  |  |  |  |  +- s.align.dec45f74.20120206-0111
|  |  |  |  |  |  +- s.mosesgiza.b6073a00.20120202-0037
|  |  |  |  |  +- s.mosesgiza.b6073a00.20120202-0037
|  |  +- s.mosesgiza.b6073a00.20120202-0037
```

Options: **--vars --stat --log ... --ignore=***steptype*

Finding Steps: **eman select**

- Step dirs don't have nice names.
- You need to locate steps of given properties.

What language models do I have?

- **eman ls lm**
- **eman select t lm**

If we need just the finished ones:

- **eman stat lm | grep DONE**
- **eman select t lm d**

And just 5-gram ones for English:

- **eman select t lm d vre ORDER=5 vre CORPAUG=en**

Deriving Experiments using **clone**

The text form of traceback allows to tweak the experiment:

- **eman tb** *step* | **sed 's/cs/de/'** | **eman clone** replicates our experiment on German instead of Czech.

The regex substitution is available in eman itself:

- **eman tb** *step* **-s '/cs/de/' -s '/form/lc/'**
  shows the traceback with the substitutions highlighted.
  - A good chance to check if the derivation does the intended.
- **eman tb** *step* **-s '/cs/de/' -s '/form/lc/'** \\
  | **eman clone --dry-run**
  - Last chance to check if existing steps get reused and what vars will new steps be based on.
  - Drop --**dry-run** to actually init the new steps.
  - Add --**start** if you're feeling lucky.

Hacking Welcome

Eman is designed to be hacking-friendly:

- Self-contained steps are easy to inspect:
  - all logs are there,
  - all (or most of) input files are there,
  - the main code (**eman.command**) is there,
  - often, even the binaries are there, or at least clearly identifiable.
- Step halfway failed?

  ⇒ Hack its **eman.command** and use **eman continue**.
- Seed not quite fit for your current needs?

  ⇒ Just init the step and hack **eman.seed**.

  ⇒ Or also prepare and hack **eman.command**.

Always mark manually tweaked steps, e.g. using eman's tags.

Fit for Cell-Phone SSH ☺

- Experiments run long but fail often.
- You don’t want to be chained to a computer.

Most eman commands have a short nickname.

- How are my last 10 merts?

  ```
  eman sel t mert l 10 --stat
  ```

Specify steps using any part of their name/hash or result:

- `s.foobar.`**a0f3**`b123.20120215-1011` failed, retry it:

  ```
  eman redo a0f3 --start
  ```

- How did I achieve this great BLEU score of 25.10?

  ```
  eman tb 25.10 --vars | less
  ```

Fit for Team Work

Playgrounds can be effectively merged:

- **eman add-remote** */home/fred/playground freds-exps*
- You can re-interpret Fred's results.
- You can clone Fred's experiments.
- You can make your steps depend on Fred's steps.
  - Only a shared file system is needed.

Caveat: we don't bother checking for conflicts yet.

Getting Started

“Install” eman in your home directory:

```
git clone https://redmine.ms.mff.cuni.cz/eman.git
```

Make sure eman is in your PATH: Bad things happen if not.

```
export PATH=$HOME/eman/bin/:$PATH
echo "export PATH=$HOME/eman/bin/:\$PATH" >> ~/.bashrc
```

Get our SMT Playground (with all the seeds):

```
git clone \
https://redmine.ms.mff.cuni.cz/ufal-smt-playground.git
```

Fix Perl Dependencies

Set up a local Perl repository.

```
 wget -O- http://cpanmin.us \
| perl - -l  /perl5 App::cpanminus local::lib
eval ‘perl -I  /perl5/lib/perl5 -Mlocal::lib‘
echo ’eval ‘perl -I  /perl5/lib/perl5 -Mlocal::lib‘’ >>  /.bashrc
```

You can copy the answer from:

`http://stackoverflow.com/a/2980715`

(just replace `.profile` with `.bashrc`)

Install the required packages:

```
cpanm YAML::XS
```

Confirm that `eman` runs:

```
eman --man
```

Setup Corpora

- Czech→English translation
- Training data: roughly 0.1% of CzEng 1.0 (15k sentence pairs)
- Dev set: 10% of WMT 2012 (300 sentence pairs)
- Test set: 10% WMT 2013 (300 sentence pairs)

Download the data:

```
http://bit.ly/mtm13corpora
```

Extract it into a subdirectory your playground, e.g.:

```
mkdir ~/ufal-smt-playground/playground/corpora
```

Importing the Corpora

- Every corpus has to “enter the world of eman”.
- This can be done using the seed `corpus`.

“`eman init corpus`” requires the following variables:

- `TAKE_FROM_COMMAND` command which produces the corpus
- `OUTCORP` corpus name
- `OUTLANG` corpus language
- `OUTFACTS` description of factors
- `OUTLINECOUNT` number of lines that we are expecting to get, used as a sanity check

Importing the Corpora

E.g. for training data, the Czech side:

```
TAKE_FROM_COMMAND="cat ../corpora/train.cs" \
OUTLINECOUNT=15000 \
OUTCORP=train OUTLANG=cs \
OUTFACTS=lc+lemma+tag \
eman init --start corpus
```

✎ Inspect the step directory. Where is the corpus stored?
✎ Create a bash script/“one-liner” to import all corpora: train/dev/test, cs/en (loop over sections and languages).

Did it work? Find out:

```
eman ls --stat
```

Frequent mistake: wrong OUTLINECOUNT for dev and test.

Listing and Printing Corpora

Corpman links symbolic names with `corpus` steps:

```
./corpman ls # show all registered corpora
```

Corpman ensures uniform pre-processing:

```
./corpman train/cs+lemma --dump
 # (Construct and) print the corpus as lemmas.
```

✎Bonus: Calculate the OOV (out-of-vocabulary) rate of the test data given the training data for:

- English vs. Czech and lowercase forms vs. lemmas

Use `ufal-smt-playground/scripts/count-oov.pl` or `oov.pl` from Moses. (Or write your own.)

Compiling Moses

In eman's philosophy, software is just data.

- Binaries should be compiled in timestamped step dirs.
- . . . so we know the exact code that was used.

Compile Moses and GIZA++:

```
eman init --start mosesgiza
```

✎ Examine the step dir. Where is the compilation log?
✎ Bonus (hard): Make another `mosesgiza` step where Moses prints "OOV" every time it encounters an out-of-vocabulary word.

Getting Moses binaries

- In your playground, download the binary:

```
wget http://ufal.mff.cuni.cz/~tamchyna/mosesgiza.64bit.tar.gz
```

- Extract it:

```
tar xzf mosesgiza.64bit.tar.gz
```

- Some hacking:

```
./fix-symlinks.sh
```

- Let eman know what we did:

```
eman reindex
```

Baseline Experiment

In your playground:

```
wget http://ufal.mff.cuni.cz/~tamchyna/baseline.traceback
eman clone --start < baseline.traceback
```

✎ While the experiment runs:

- Make a copy of the traceback
- Modify it to train word alignment on **lemmas** instead of **lc**. (But preserve the translation lc→lc!)
    - Note that `ALILABEL` is somewhat arbitrary but has to match between `align` and `tm`.

✎ Bonus: do the required edits using substitution in `eman`.

Hint: `eman --man`, look for the “`traceback`” command.

Looking Inside the Models

- Go to one of your baseline `model` steps, look at files:
- Language model: `lm.1.corpus.lm.gz`

  ✎ What is more probable: “united kingdom” or “united states”?

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  ✎ How do you say “hi” in Czech?

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  ✎ Why are longer n-grams more probable than short ones?
- Phrase table: `tm.1/model/phrase-table.0-0.gz`

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  ✎ Phrase scores are $P(f|e), lex(f|e), P(e|f), lex(e|f)$.
  Given that, what do the counts in the last column mean?

  (Let’s look e.g. at the phrase “`ahoj ||| hi`”.)

Tuning

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- Standard Unix tool:

  ```
  eman du -sh s.mert.*
  ```

- Eman status:

  ```
  eman eman ls mert --dus --stat
  ```

Results

Let's compare MT quality (BLEU) of 2 systems:

- alignment on lowercase forms
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  ```
  eman tb --vars s.evaluator.xyz | grep ALIAUG
  ```

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- Trace back + grep:

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  ```

- Trace forward from the alignment step:

  ```
  eman tf $(eman sel t align vre 'SRC.*lc')
  ```

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BLEU is in the "`s.evaluator.../scores`" file.

Wild Experimenting

✎ Run word alignment on `lcstem4`, `lcstem5`.

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✎ Try different orders of the language model (3, 4, 6).

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✎ Try the opposite translation direction: English→Czech.

✎ Set up a factored system:

- lc→lc (baseline path), and
- lemma→lc (alternative path).

Summary

Hopefully, you now understand:

- within (PB)MT:
  - the structure of a (PB)MT experiment,
  - what is the language model and the translation model,
- meta-level:
  - eman's organization of the experimentation playground,
  - the idea of cloning of experiments.

Extra Slides

Eman is Versatile

What types of steps should I have?

- Any, depending on your application.

What language do I write steps in?

- Any, e.g. bash.

What are the input and output files of the steps?

- Any, just make depending steps understand each other.
- Steps can have many output files and serve as prerequisites to different types of other steps.

What are measured values of my experiments?

- Anything from any of the files any step produces.

What the User Implements: Just Seeds

Technically, a seed is any program that:

- responds to arbitrary environment variables,
- runs **eman defvar** to register step variables with eman,
- produces another program, **./eman.command** that does the real job.

The seed is actually run twice:

- At "init": to check validity of input variables and register them with eman.
- At "prepare": to produce **eman.command**.

The user puts all seeds in **playground/eman.seeds**.

- Eman runs a local copy of the seed in a fresh step dir.

eman redo

On cluster, jobs can fail nondeterminically.

- Bad luck when scheduled to a swamped machine.
- Bad estimate of hard resource limits (RAM exceeds the limit ⇒ job killed).

Eman to the rescue:

- **eman redo** *step* creates a new instance of each failed step, preserving the experiment structure.
- **eman redo** *step* **--start** starts the steps right away.

To make sure eman will do what you expect, first try:

- **eman redo** *step* **--dry-run**

eman clone

CLONING is initing a new step using vars of an existing one.

Cloning of individual steps is useful:

- when a step failed (used in **eman redo**),
- when the seed has changed,
- when we want to redefine some vars:
  ORDER=4 eman clone s.lm.1d6f791c...

Cloning of whole tracebacks:

- The text of a traceback gets instantiated as steps.
- Existing steps are reused if OK and with identical vars.
- **eman traceback** *step* | **eman clone**
- **eman traceback** *step* | **mail bojar@ufal**
  followed by **eman clone** < **the-received-mail**.

eman tag or **eman ls --tag** shows tags

TAGS and AUTOTAGS are:

- arbitrary keywords assigned to individual steps,
- inherited from dependencies.

Tags are:

- added using **eman add-tag** *the-tag steps*,
- stored in `s.stepdir.123/`**eman.tag**.

⇒ Use them to manually mark exceptions.

Autotags are:

- specified in `playground/`**eman.autotags** as regexes over step vars, e.g.: **/ORDER=(.*)/$1gr/** for LM,
- (re-)observed at **eman retag**.

⇒ Use them to systematically mark experiment branches.

eman collect

Based on rules in **eman.results.conf**, e.g.:

```
BLEU  */BLEU.opt                  BLEU\s*=\s*([^\s,]+)
Snts  s.eval*/corpus.translation  CMD: wc -l
```

eman collects results from all steps into **eman.results**:

```
# Step Name                        Status  Score Value Tags and Autotags
s.evaluator.11ccf590.20120208-1554 DONE     TER  31.04 5gr DEVwmt10 LMc-news towards-
s.evaluator.11ccf590.20120208-1554 DONE     PER  44.61 5gr DEVwmt10 LMc-news towards-
s.evaluator.11ccf590.20120208-1554 DONE     CDER 33.97 5gr DEVwmt10 LMc-news towards-
s.evaluator.11ccf590.20120208-1554 DONE     BLEU 12.28 5gr DEVwmt10 LMc-news towards-
s.evaluator.11ccf590.20120208-1554 DONE     Snts  3003 5gr DEVwmt10 LMc-news towards-
s.evaluator.29fa5679.20120207-1357 OUTDATED TER  17.66 5gr DEVwmt10 LMc-news
...                                ...      ...    ...
s.evaluator.473687bb.20120214-1509 FAILED   Snts  3003
```

- Perhaps hard to read.
- Easy to grep, sort, whatever, or **tabulate**.

eman tabulate to Organize Results

The user specifies in the file **eman.tabulate**:

- which results to ignore, which to select,
- which tags contribute to col labels, e.g. **TER**, **BLEU**,
- which tags contribute to row labels, e.g. **[0-9]gr**, **towards-[A-Z]+**, **PRO**.

Eman tabulates the results, output in **eman.niceresults**:

```
                 PER   CDER  TER   BLEU
5gr towards-CDER 44.61 33.97 31.04 12.28
5gr              44.19 33.76 31.02 12.18
5gr PRO          43.91 33.87 31.49 12.09
5gr towards-PER  44.44 33.52 30.74 11.95
```

Related Experiment Mgmt Systems

Eman is just one of many, consider also:

- LoonyBin (Clark et al., 2010)
  - ⊖ Clickable Java tool.
  - ⊕ Support for multiple clusters and scheduler types.
- Moses EMS (Koehn, 2010)
  - Experiment Management System primarily for Moses.
  - Centered around a single experiment which consists of steps.
- Pure Makefiles
  Yes, you can easily live with fancy Makefiles.
  - You will use commands like **make init.mert**
    or **cp -r exp.mert.1 exp.mert.1b**
  - You need to learn to use **$***, **$@** etc.
  - You are likely to implement your own eman soon. ☺

There are also the following workflow management systems: DAGMan, Pegasus, Dryad.

References

Jonathan H. Clark, Jonathan Weese, Byung Gyu Ahn, Andreas Zollmann, Qin Gao, Kenneth Heafield, and Alon Lavie. 2010. The Machine Translation Toolpack for LoonyBin: Automated Management of Experimental Machine Translation HyperWorkflows. Prague Bulletin of Mathematical Linguistics, 93:117–126.

Philipp Koehn. 2010. An Experimental Management System. Prague Bulletin of Mathematical Linguistics, 94:87–96, September.