UE905 EC1 Software Development Project

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University of Lorraine

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Introduction

Main objective: put into practice many of the NLP tools and methodologies acquired throughout the NLP master's program.

This course will consist of bibliographic research, problem analysis, implementing NLP methodologies and machine learning techniques.

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Course Structure

- Session 1: 21 Sep. 2022, 13h30 to 16h30
  Proposed topics, literature survey, proposed approaches
- Online meeting for each group: from start of october to session 2
- Sessions 2–7: Group presentations about ongoing work (see ENT)
- Session 8: 7 Feb. 2023 9h00 to 17h00
  Final project presentations
- Report submission deadline: 27 Jan. and 23h59

Project evaluation

- Weekly presentation 25%
- Project report 25%
- Final presentation 25%
- Project work 25%

Project Guidelines

- Project selection: proposed projects or your own project.
- Literature survey about project work and finalize the possible approaches for implementation w.r.t. dataset, programming language, deep learning libraries and other tools.
- Create schedule for project milestones for each session.
- In each session, the group should present current status of project, issues encountered and future work.
- Each group should create Github repository for project work.

Structure of Github repository I

- Name of the repository must be explicit
  (the project name, or title of your project)
- README.md
  - project title
  - abstract / overall description of project
  - structure of the repository
    (description of the content of the files and folder, where to find what)
  - dependencies and installation instructions
  - usage guide, how to reproduce the experiments if relevant

  Example README.md at `https://gist.github.com/EMarquer/b6dec298d23e82440cf49b69b2d71ebc`

Structure of Github repository II

- Mandatory content
  - `report` folder for project report PDF, may also contain sources at your discretion (TEX, images, etc.)
  - `presentations` folder for all the intermediate presentations as PDF (must be updated before each presentation session)
  - `results` folder for results generated (models trained, performance statistics, etc.)
  - `articles` folder for the PDFs of all the articles used (recommended to make the file names uniform)
- If you integrate some other repository in your work (baseline approach, dependency, etc.) use the `git submodule add repository-to-add-to-my-project.git`

Analogies & analogical reasoning (AR)

Two key cognitive processes: Inference and Creativity

Detecting/mining analogies: Given a, b, c, and d,

- is (a, b, c, d) a valid analogy?

Solving analogies: Given a, b, c

- find x **s.t.** (a, b, c, x) a valid analogy

Reasoning and integrating analogical reasoning:

- Depending on the concrete application and ML&AI task

Different views on Analogical Reasoning (AR)

Axiomatic: As 4-ary relations satisfying certain postulates
Examples: reflexivity, (certain) permutations, etc.

Relational: $R(a, b, c, d) \equiv P(P_1(a, b), P_1(c, d))$, for P, P_1 predicates
Example: $R(wine, France, beer, Germany)$

Functional: $R(a, b, c, d)$ if $b = T(a)$ and $d = T(c)$, for some T
Example: $R(go, went, make, made)$

Model Theoretic: Relying on structural transformations and "rewriting"
Examples: *Structure mapping theory* and *Justifications*

ANR AT2TA 2023-2026: explores both **foundational and applicative** aspects of AR in ML & AI, NLP & NLU, KDD & KRR, real-world & industrial applicat.s, **as well as** bridge gaps with other reasoning and neuro-symbolic frameworks.

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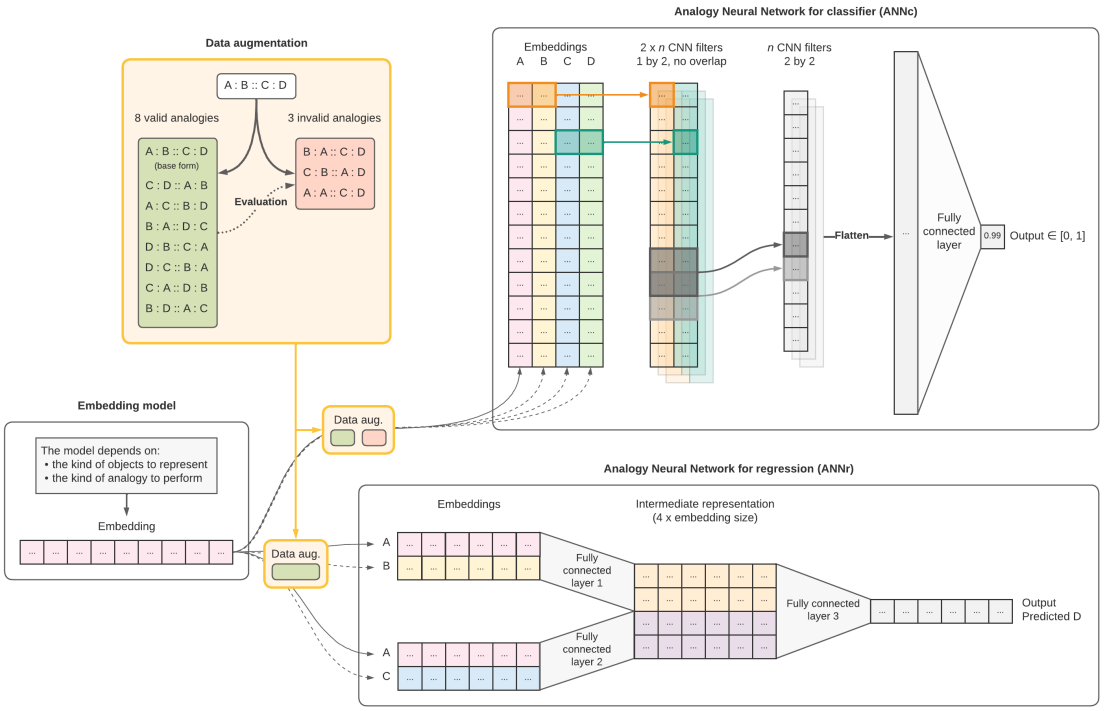
Analogy: some models



Deep Visual Analogy-Making, Scott E. Reed, Yi Zhang, Yuting Zhang, Honglak Lee, NIPS 2015

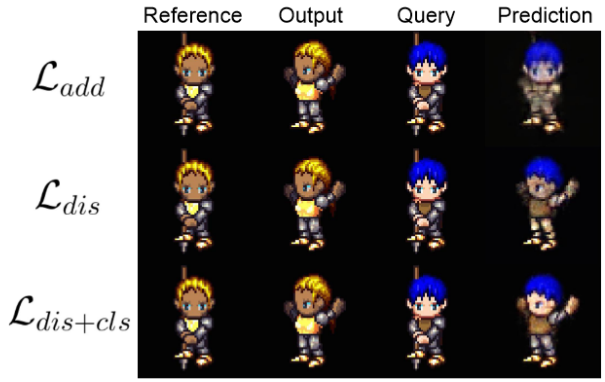
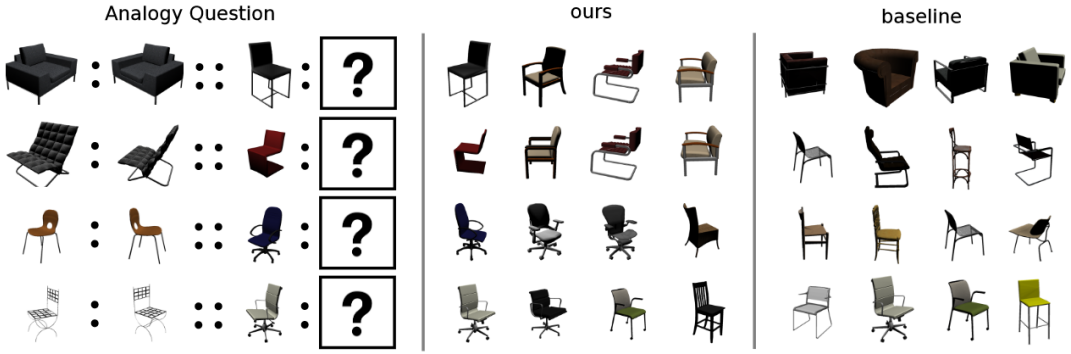


Figure 7: Few shot prediction with 48 examples.

VISALOGY: Answering Visual Analogy Questions, Fereshteh Sadeghi, C. Lawrence Zitnick, Ali Farhadi, NIPS 2015



Proposed Project I – Analogy agreement

Analogy, agreement between generation and detection: Morphological analogies make for an interesting benchmark for developing models of analogy: it is sequential data involving both simple and complex structural changes, and many languages are available [8]. In previous years, deep learning approaches were developed to detect (ANNc [1]) and solve (ANNr [7], ANNg [4]) morphological analogies. ANNc has significantly higher performance than other methods on analogy detection, and could be leveraged to improve analogy solving models. A potential track is to use an architecture inspired from Generative Adversarial Networks [5].

Project goal: measure the agreement between on one side ANNc and on the other side ANNr and ANNg models to determine the benefits of a combined approach, design and train such an approach.

Proposed Project II – Multi-modal analogy

Analogy based approach for caption generation: Analogy can be used to select images from other images [12, 11] or by manipulating their captions [10]. Analogy should be usable for image captioning or image generation from a caption, by relying on existing examples in the data. In that way, analogy could be used to improve existing image generation or image captioning models.
A similar work can be done on other modalities, as long as two different modalities are involved (tabular & text, image & triples, ...).

Project goal: design and learn an image captioning/text summarization or generation model using analogical principles; design the dataset necessary for the experiments.

Multiple modality pairs = multiple possible groups!

Proposed Project III – CBR and transfer settings

Case-Based Reasoning (CBR) approach using analogy: CBR is a research domain aiming to solve problems using examples with known solutions. Given a set of problems and associated solutions called a case-base, CBR methods propose a solution for an unseen problem by selecting similar problems from the case-base and adapting their solutions.
This is related to transfer learning where the idea is to take advantage of what has been learned on a source domain in order to improve the learning process in a target domain related to the source domain. It is also the basis of analogy based classification that relies on the *analogy inference principle* (AIP): if $A : B :: C : D$ is an analogy, then so is $f(A) : f(B) :: f(C) : f(D)$.

Project goal: develop a selection algorithm for cases in a case base using analogy, develop a solving approach to obtain the solution, and apply the approach on data. Explore the transfer and classification potential.

Proposed Project IV – Multilingual analogy

A model to rule them all: Morphological analogies make for an interesting benchmark for developing models of analogy: it is sequential data involving both simple and complex structural changes, and many languages are available. Deep learning approaches were developed to detect morphological analogies (ANNc [1]), and in a recent work [9], clusters of languages behaving similarly with regards to analogy have been identified. This opens the door to using a single model for each of the clusters, and forms a first step to universal models of analogy.

Project goal: develop a single model for analogy detection in multiple languages using ANNc, and implement an ensemble approach to cover all the clusters.

Proposed Project V – Cross-lingual analogy

Clustering of Semantic Analogies for Inter-Language Similarities:
Recent works have allowed to retrieve language families from the transfer of morphological analogies between languages [9].
We wonder if we can find similar emerging patterns from multilingual or cross-lingual semantic analogies.

Project goal: use clustering methods to explore, visualize and analyze the latent space of deep learning models of morphological analogy.

Proposed Project VI – Analogy for puns

Morphological Word Embeddings for Semantic Analogies: Deep learning models of analogy have been successfully developed for both morphology [1, 2] and semantic [6]. While semantic embeddings perform poorly on morphological analogies, one can wonder if the newly developed morphological word embedding of [1] is able to perform well on semantic analogies.
A potential application of the results obtained is to manipulate semantic and morphological analogies with the same model, which could lead to a specific form of pun: "*woman* is to *womango* as *man* is to *mango* (like the fruit)".

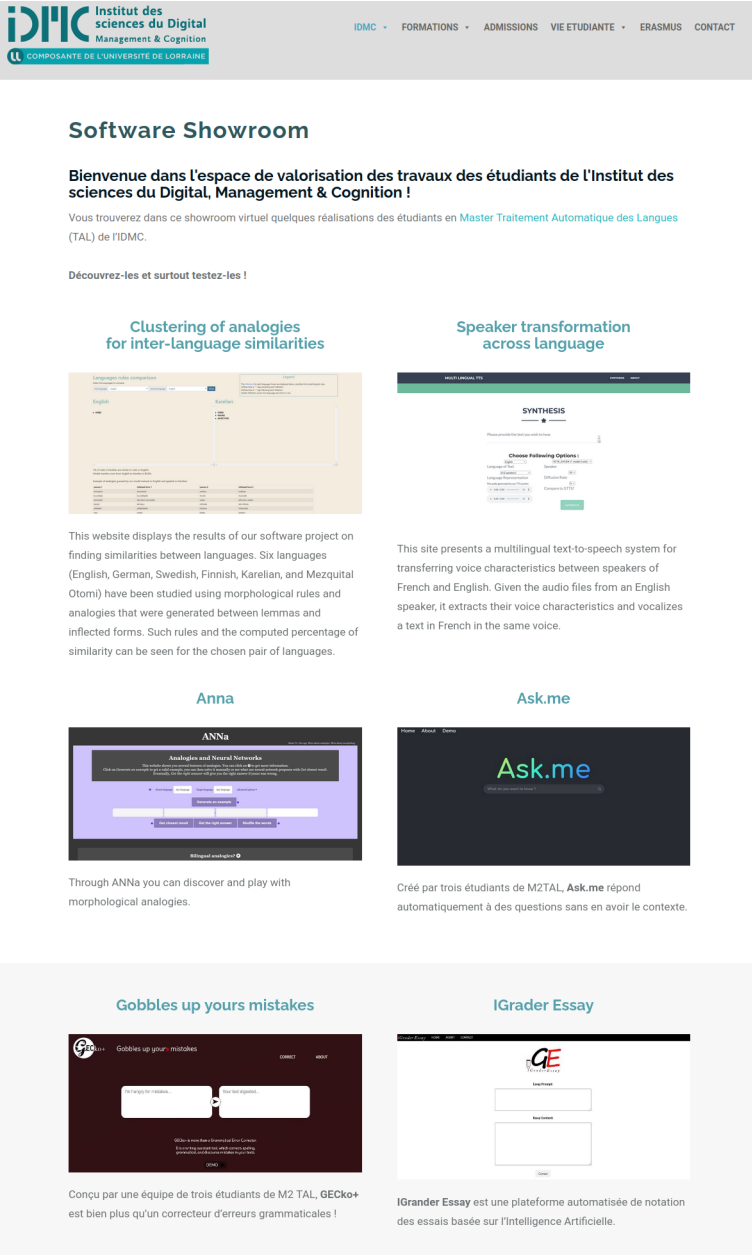
Project goal: experimenting with semantic and morphological embeddings to build a single model for both semantic and morphological analogies.

Proposed Project VII

Open Project

Students are invited to propose their own topic. It should focus on *implementing* an *innovative* approach to some problem/application.
You can for example use data from Kaggle, UCI datasets, ...

From previous year software projects



https://idmc.univ-lorraine.fr/software-showroom/

Papers from previous year software projects

E. Marquer, S. Alsaidi, A. Decker, P.-A. Murena, and M. Couceiro. "A Deep Learning Approach to Solving Morphological Analogies". In: *30th ICCBR*. 2022, pp. 159–174

Kevin Chan, Shane Peter Kaszefski-Yaschuk, Camille Saran, Esteban Marquer, and Miguel Couceiro. "Solving Morphological Analogies Through Generation". In: *IARML@IJCAI-ECAI 2022*. Vol. 3174. 2022, pp. 29–39

Eduardo Calò, Léo Jacqmin, Thibo Rosemplatt, Maxime Amblard, Miguel Couceiro, and Ajinkya Kulkarni. "GECko+: a Grammatical and Discourse Error Correction Tool". In: *TALN 2021*. ATALA, 2021, pp. 8–11. URL: https://hal.archives-ouvertes.fr/hal-03265914

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[1] Safa Alsaidi et al. "A Neural Approach for Detecting Morphological Analogies". In: *The 8th IEEE International Conference on Data Science and Advanced Analytics (DSAA)*. 2021. URL: https://hal.inria.fr/hal-03313556.

[2] Safa Alsaidi et al. "On the Transferability of Neural Models of Morphological Analogies". In: *AIMLAI, ECML PKDD 2021: European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases*. 2021. URL: https://hal.inria.fr/hal-03313591.

[3] Eduardo Calò et al. "GECko+: a Grammatical and Discourse Error Correction Tool". In: *TALN 2021*. ATALA, 2021, pp. 8–11. URL: https://hal.archives-ouvertes.fr/hal-03265914.

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[4] Kevin Chan et al. "Solving Morphological Analogies Through Generation". In: *IARML@IJCAI-ECAI 2022*. Vol. 3174. 2022, pp. 29–39.

[5] Ian Goodfellow et al. "Generative adversarial nets". In: *Advances in neural information processing systems* 27 (2014).

[6] Suryani Lim et al. "Classifying and completing word analogies by machine learning". In: *International Journal of Approximate Reasoning* (2021). URL: https://www.sciencedirect.com/science/article/pii/S0888613X21000141.

[7] E. Marquer et al. "A Deep Learning Approach to Solving Morphological Analogies". In: *30th ICCBR*. 2022, pp. 159–174.

[8] E. Marquer et al. *Siganalogies - morphological analogies from Sigmorphon 2016 and 2019*. Version V1. 2022.

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[9] Esteban Marquer et al. "Transferring Learned Models of Morphological Analogies". In: *ATA@ICCBR 2022*. 2022.

[10] Julia Peyre et al. "Detecting unseen visual relations using analogies". In: (2019). URL: https://arxiv.org/abs/1812.05736.

[11] Scott E Reed et al. "Deep Visual Analogy-Making". In: *Advances in Neural Information Processing Systems 28*. 2015. URL: http://papers.nips.cc/paper/5845-deep-visual-analogy-making.pdf.

[12] Fereshteh Sadeghi et al. "Visalogy: Answering Visual Analogy Questions". In: *Advances in Neural Information Processing Systems 28*. 2015. URL: http://papers.nips.cc/paper/5777-visalogy-answering-visual-analogy-questions.pdf.

Questions?