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The challenge of the TV game *La Ghigliottina* to NLP

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Abstract

In this paper, we describe a Telegram bot, *Mago della Ghigliottina* (*Ghigliottina Wizard*), able to solve *La Ghigliottina* game (*The Guillotine*), the final game of the Italian TV quiz show *L'Eredità*. Our system relies on linguistic resources and artificial intelligence and achieves better results than human players (and competitors of *L'Eredità* too). In addition to solving a game, *Mago della Ghigliottina* can also generate new game instances and challenge the users to match the solution.

Keywords: Telegram Bot, Linguistic Games, Artificial Intelligence

1. Introduction

In this paper, we present *Mago della Ghigliottina*, a Telegram bot able to solve *La Ghigliottina* (*The Guillotine*), the final game of the Italian TV quiz show *L'Eredità*. Given a set of five words (clues), the competitor has to guess the sixth word (solution) that is linked with each of these five clues. For example, given the five clues: *pie*, *bad*, *Adam*, *core*, *eye* the solution is *apple*, because: *apple-pie* is a kind of pie; *bad apple* is a way to refer to a trouble maker; *Adam's apple* is the prominent part of men's throat; *apple core* is the center of the apple; *apple of someone's eye* is a way to refer to someone's beloved person. The game is one of the most popular games in Italy, viewed by nearly three million spectators (approximately 20% share). Audience at home also enjoys participating in the game and tries to match the solution. Some players compete in *Ghigliottiniamo*[1], an app that enables people to challenge each other while the game is being broadcasted. *Mago della Ghigliottina* participated as *UNIOR4NLP* (Sangati et al., 2018) in the shared task NLP4FUN (Basile et al., 2018), which was part of the EVALITA 2018 (Caselli et al., 2018), a periodic evaluation campaign of Natural Language Processing (NLP) and speech tools for the Italian language.[2]

The paper is organized as follows: in Section 2 we present *La Ghigliottina* TV game and its rules. In Section 3 we make a brief overview about NLP systems related to games. In Section 4 we describe our approach to solve the game: how we built our artificial player and how the system attempts at finding the correct solution. In Section 5 we describe *Mago della Ghigliottina*. Conclusions and Future Work are in Section 6.

2. *La Ghigliottina* game

L'Eredità represents one of the most popular TV games in Italy and in 2020 reached its 18th season. The game involves seven competitors that challenge each other in elimination games. The player who reaches the final game (named *La Ghigliottina*) can win the jackpot. The game works as follows: given a set of five words (clues), the player has to guess a sixth word (the solution) that is linked with the five clues. The five clues are unrelated to each other, but each is in relation with the solution. In figure 1 we show an example of the game.

Figure 1: A screenshot of *La Ghigliottina*. In this case, the solution is *cassa*: i) *cassa del cinema* (*cinema box office*), ii) *grancassa* (*bass drum*), iii) *cassa comune* (*petty cash*), iv) *battere cassa* (*beat the check*), and v) *coda alla cassa* (*checkout line*)

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3. NLP and games

Games represent an interesting playground to conduct research in NLP and Artificial Intelligence (AI) (Yannakakis and Togelius, 2018). There are a number of popular TV quiz based on language games, such as *The Wheel of Fortune* and *Who Wants to be a Millionaire?*. The current work focuses on *La Ghigliottina*, which is particularly interesting for AI and NLP because it is based on how words are connected to each other. OTTHO (Semeraro et al., 2009; Basile et al., 2014) represents the first artificial player of the game and exploits resources from the web such as Wikipedia to build i) a lexicon and a knowledge repository and ii) a knowledge base modeling represented by an association matrix which stores the degree of correlation between any two words in the lexicon. Word correlations are detected by connecting lemmas to the entries in the dictionary definition, pair of words occurring in proverbs, movie or song

[1] https://appadvice.com/app/ghigliottiniamo/1447355292
[2] http://www.evalita.it

titles, and pair of similar words by exploiting Vector Space Models (Salton et al., 1975).

4. Our approach to solve *La Ghigliottina*

Our approach uses similar resources with respect to the ORTHO system. However, regarding word relations we don't focus on word similarity but on a restricted set of syntactic constructions (patterns).

4.1. Preliminary steps in building our artificial player

Building an automatic solver for *La Ghigliottina* game requires three preliminary steps: game analysis, definition of linguistic patterns, and extraction of linguistic resources.

Game analysis We analyzed a sample of 100 *La Ghigliottina* instances that we collected from past editions of the TV game. We found out that almost in all combination the clue is connected to the solution because they form a Multiword Expression (MWE). A MWE is a sequence of words that presents some characteristic behaviour (at the lexical, syntactic, semantic, pragmatic or statistical level) and whose interpretation crosses the boundaries between words (Sag et al., 2002). MWEs have to be considered as lexical items which convey a single meaning different from the meanings of its constituent words, such as in the idiomatic expression *kick the bucket* where the simple addition of the meanings of *kick* and *bucket* does not convey the meaning of *to die*. Our system has been built on this key observation. After the official dataset was released, we found out that the great majority of game instances confirmed our initial hypothesis.

Linguistic Patterns Clue words are typically nouns, verbs, or adjectives, while the solutions are typically nouns or adjectives (almost never verbs). We detected six possible clue-solution combination that generate MWEs:

- **A-B** (Noun-Adjective, Adjective-Noun, Verb-Noun, Noun-Noun) *permesso premio* ('permit price' → good behaviour license);
- **A-determiner-B** *dare il permesso* ('give the permit' → authorize);
- **A-conjunction-B** *stima e affetto* (esteem and affection);
- **A-preposition-B** *colpo di coda* ('flick of tail' → last ditch effort);
- **A-articulated preposition-B** *virtù dei forti*, part of the famous Italian proverb *La calma è la virtù dei forti* (patience is the virtue of the strong);
- **A+B**: compounds such as *radio* + *attività* = *radioattività* (radio + activity = radioactivity).

Linguistic Resources We collected the linguistic resources which we deemed necessary for the task. To this end we used the following freely available corpora:

- **Paisà**: 250 million tokens corpus automatically annotated (Lyding et al., 2014).
- **itWaC**: 1.5 billion words corpus automatically annotated (Baroni et al., 2009)
- **Wiki-IT-Titles**: Wikipedia-IT titles downloaded via WikiExtractor (Attardi, 2012).
- **Proverbs**: 1,955 proverbs from (Wikiquote, 2016) and 371 from an online collection (Dige, 2016).

In addition, we have constructed the following lexical resources:

- **DeMauro-Ext**: words extracted from "Il Nuovo vocabolario di base della lingua italiana"(De Mauro, 2016b), extended with morphological variations obtained by changing last vowel of the word and checking if the resulting word has frequency $\geq$ 1000 in `Paisà`.
- **DeMauro-MWEs**: MWEs extracted from the "De Mauro online dictionary" (De Mauro, 2016a) composed of 30,633 entries.

4.2. System description

In order to build our system, we started processing the selected corpora via standard tokenization (only single word tokens) and removal of punctuation marks and non-word patterns. Next, we constructed two lexical sets: C_{LEX} to cover the *clue* words, and S_{LEX} to cover the *solution* words. S_{LEX} (composed of 7,942 nouns and adjectives in `DeMauro-Ext`) is smaller than C_{LEX} (composed of 19,414 words from the full `DeMauro-Ext` and `DeMauro-MWEs`) because solution words are almost always nouns or adjectives as described in Section 4.1.
Secondly, we built a co-occurrence matrix M_c which stores the counts $c_{i,j}$ for every pair of words $w_i \in S_{LEX}$ and $w_j \in C_{LEX}$ such that w_i co-occurs with w_j in the resources according to patterns described in Section 4.1. Co-occurrence patterns were extracted from `Paisà` and `itWaC` with weight $w = 1$, from `DeMauro-MWE` with $w = 200$, from `Proverbs` with $w = 100$, and from `Wiki-IT-Titles` with $w = 50$. The weight were chosen manually taking into account the likelihood that a pattern in a given corpus represented a valid MWE. Compound patterns (A+B) were extracted from C_{LEX}: for every word w in C_{LEX} if $w = ab$, a and b are both in C_{LEX}, and a and b have at least 4 characters, the count for the pair (a, b) is incremented by 1 in the co-occurrence matrix.
Thirdly, for every pair of words w_i and w_j in M_c, we populate the association-score matrix M_{pmi} via the Pointwise Mutual Information measure:

$$M_{pmi}(w_i, w_j) = \log \frac{p(w_i, w_j)}{p(w_i) \cdot p(w_j)} \quad (1)$$

where

$$p(w_i) = \sum_{w_j \in C_{LEX}} M_c(w_i, w_j) \quad (2)$$

$$p(w_j) = \sum_{w_i \in S_{LEX}} M_c(w_i, w_j) \quad (3)$$

$$p(w_i, w_j) = \frac{M_c(w_i, w_j)}{\sum_{\substack{x \in S_{LEX} \\ y \in C_{LEX}}} M_c(x, y)} \quad (4)$$

Finally, for a given game instance with the 5 clue words $G = (w_{c1}, w_{c2}, w_{c3}, w_{c4}, w_{c5})$, we choose the solution word $\widehat{w_s} \in S_{LEX}$ such that:

$$\widehat{w_s} = \max_{w_s \in S_{LEX}} \sum_{w_c \in G} M_{pmi}(w_s, w_c) \quad (5)$$

that is, we choose the word in S_{LEX} which maximizes the score obtained by summing the pmi between each clue word and the candidate word. If two words are never seen co-occurring together in a pattern in the training corpora, we assign to them the lowest pmi value in M_{pmi}.
The system has been implemented in Python and the code is open source. After the matrix has been loaded into memory the response time on an average laptop is around 1-2 seconds.

5. *Mago della Ghigliottina* bot

Mago della Ghigliottina offers two game modalities: the first one (solution mode) allows users to insert the five clues and to challenge the bot to match the solution, while the second one (generation mode) presents the user with five clue words and challenges to find the correct solution.

5.1. Solution mode

In solution mode, it is possible to write the five clues or to send a picture with the five clues. As shown in Figure 2, *Mago della Ghigliottina* uses OCR to recognize the words from the image.
Mago della Ghigliottina returns its prediction with a degree of accuracy accompanied by an emoji face that reflects the specific degree of accuracy:

- 😎 *sono quasi certo* (I'm fairly certain, as shown in the example below).
- 🙂 *credo che* (I believe that);
- 🤔 *sono abbastanza convinto* (I'm quite sure);
- 😜 *non sono sicuro, ma* (I'm not sure, but);

Until now (April 2020), 9,333 *Ghigliottina* instances (4016 unique) have been submitted to the bot by a total of 740 Telegram users and 133 Twitter users.
Mago della Ghigliottina is automatically tested every day on the TV show instances and is able to guess the solution correctly about 2/3 of the time. It must be considered that every day several users submit the same instance of *La Ghigliottina* game, so this performance has been calculated discarding duplicates. The bot definitely outperforms humans in solving the game. In comparing the performance of our AI system with that of a top player, we analyzed the games played by Andrea Saccone, who has been the biggest champion of the Ghigliottina game so far: he was champion for 13 days (3-15 March 2018), and he managed to find the correct solution three times.[3] In comparison *Mago della Ghigliottina* was able to win the same game instances 9 times.
As mentioned in section 3, the other AI model that has been developed to solve the same task is OTTHO (Basile et al., 2014), which makes use of Vector Space Models (among other things). We observe that they achieve a precision of around 30% which is well below ours (75%).[4]
Users can send live to *Mago della Ghigliottina* the *Ghigliottina* instance. Alternatively, users can send new instances made up on the spot whenever they want, just thinking at five words related to the word they imagine as the solution. Obviously, in this case prediction performaces can drop because pairs clue-solution can never be accurate as well as those of the TV show.

Figure 2: A screenshot from Telegram in solution mode: *Mago della Ghigliottina* accepts the picture containing the five clues and in 1-2 seconds returns its prediction with a degree of accuracy. In this case, the system correctly guesses the solution because of the following MWEs i) *conoscere alla perfezione* (to perfectly know), ii) *grado di perfezione* (degree of perfection), iii) *modello di perfezione* (model of perfection), iv) *ideale di perfezione* (ideal of perfection), and v) *perfezione divina* (divine perfection).

5.2. Generation mode

In generation mode (Figure 3), the system can automatically create novel game instances. Using a reversed association-matrix,[5] it chooses a random word (the solu-

[3] The players who reach the "Ghigliottina" game (the champion) continue to participate in the subsequent episodes even if they do not guess the solution word.

[4] Unfortunately we were not able to make an exact comparison because the original data-set has not been made publicly available for copyright reasons.

[5] In generation mode, we make use of a smaller co-occurrence matrix extracted only from `DeMauro-MWEs`, in order to produce

tion) and presents a list of 5 clues with a high score. In addition, when the solution is given it provides a sentence for every clue-solution pair exemplifying the relations between the two words.

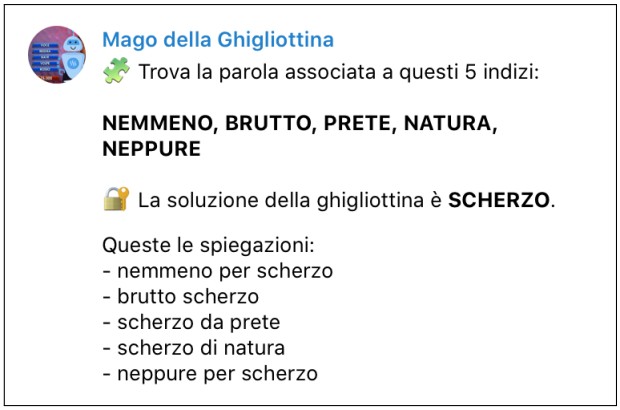

Figure 3: A screenshot from Telegram in generation mode. In this case, the solution is *scherzo* (*joke*): i) *nemmeno per scherzo* (*even as a joke*), ii) *brutto scherzo* (*bad joke*), iii) *scherzo da prete* (*sick joke*), iv) *scherzo di natura* (*trick of nature*), and v) *neppure per scherzo* (*even as a joke*)

6. Conclusions and Future Work

In this paper, we have described *Mago della Ghigliottina*, a Telegram bot that is able to solve *La Ghigliottina* game (*The Guillotine*), the final game of the Italian TV quiz show *L'Eredità*. *Mago della Ghigliottina* relies on linguistic resources and is tested every day on the TV show instances: it is able to guess on average two out of three *Ghigliottina* instances. Users can play with *Mago della Ghigliottina* also independently for the TV game by providing their own clues and asking the bot to solve the game (solution mode) or by asking the bot five new clues (generation mode). We aim to collect continuously data in order to develop a corpus with new game instances and improve our system. *Mago della Ghigliottina* is also available on Amazon Alexa[6] (simply ask *Mago della Ghigliottina* to match the solution providing it with the five clues) and Twitter[7] (users just need to write the five clues and tag @UNIOR4NLP in their tweet and the solution appears in a comment).

The methodology adopted for the bot can be successfully applied to all NLP tasks that aim at identifying co-occurrence and semantic relations between words.

As future work we intend to add a validation step by the users when they play with the bot independently from the TV game. The validation is carried out by asking users to confirm the correctness of the solution provided by the bot to their *Ghigliottina* instances. In addition, we also foresee to ask users to provide all the correct co-occurrences between their five clues and the solution they expect.

higher quality game instances.

[6] `https://www.amazon.it/Federico-Sangati-Mago-della-Ghigliottina/dp/B07VHKT43F`

[7] `https://twitter.com/UNIOR4NLP`

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