Analysing CV Corpus for Finding Suitable Candidates using Knowledge Graph and BERT DBKDA 2021

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Presenter: Yan Wang

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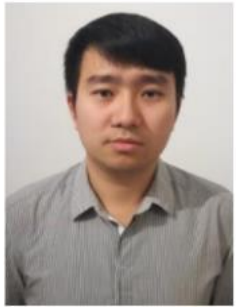


Dr. Yan Wang is a research project manager in the Direction of Research & Innovation (DRI) of Capgemini Engineering, France. He received his Master (2014) and PhD (2018) degree in Enterprise Engineering from University of Bordeaux. He received his Bachelor (2012) of Computer Science and Master (2014) of Software Engineering from Harbin Institute of Technology. He made two postdocs of Computer Science from Paris 1 Panthéon-Sorbonne University and Sorbonne University. His research interests include Discrete Event Modeling and Simulation, Process Mining, Fuzzy Logic, Constraint Programming, Reinforcement Learning. His current research is on NLP, Knowledge Graph, Recommender System.

Research and Development Project TNT

TNT (Talent Needs Trends) is a research and development project of the program Future of Engineering. The objective of this project is to propose a competence management system advanced and adapted to Capgemini. The purpose is to improve the synergy between skills, resources and customers, simplify the process of HR-Analytics.

TNT is launched from 2014 with a lot of propositions and development tools. In this paper, we focus on the proposal of the competence search engine using BERT and Knowledge Graph, with the purpose of improving the existing HR management tool Linx.

Problem of Competence Search Engine

- The rapid evolution of the competences of the candidates
  - The continuing evolution of candidate experience and technology
- The rapid evolution of the requirements of the clients
- HR adaptation and treatment time is getting longer and longer
- The need of advanced Natural Language Processing (NLP) tool to understand the context of candidate competences and clients requirements

Challenge of BERT

Bidirectional Encoder Representations from Transformers (BERT) have been proposed to better understand client searches, a feature extractor based on deep Neural Probabilistic Language Model (J. Devlin et al. 2018).

- Bidirectional: A so-called bidirectional NLP model is a model that reads editorial content in its entirety and in both directions.
- Masked Language Modeling (MLM) : MLM is a fill-in-the-blank task, where a model uses the whole context words to predict the masked word.
- Named-Entity Recognition (NER) : NER can classify tokens based on a class, for example, identifying a token as a person, an organization, or a location.
- Encoder: The encoder is a neural network used to transform the input sequence into a vector representation of the sequence.
- Decoder: Second network after the encoder which is used to generate words sequentially.

The challenges today is the need of adaptive data for the specific staffing tasks of BERT.

Challenge of Knowledge Graph (KG)

Knowledge Graph (KG) has been proposed to discover the relation information with the property of powerful language understanding and rapid data analysis. It is first proposed in 2012 by Google, a theory of semantic structure combining applied mathematics, computer graphics, information visualization and machine learning. With the help of KG, users can get a more accurate recommendation as well as the explanations for recommended items. (Q. Guo et al. 2020)

The challenge today is the design and construction of Knowledge Graph based on competence keywords.

Example of CVs from Linx

The CVs that we use in this paper are from Linx, they can be exported as Excel files with the section of experience, core skills, activities, keywords, languages, diplomas, certifications, capacity available, location.

CORPORATE ID	EXPERIENCE
336048	Chef de projet chez ALTRAN - France: 01/2019 à Aujourd'hui (27 mois) Road traffic management Consultant(e) chez UNIVERSIDAD DE LOS ANDES / MEALS DE COLOMBIA - Colombie: 03/2014 à 05/2014 (3 mois) Analyse and improve of the production chain of Meals de Colombia (Ice cream company in Colombia) Analyste chez DOWER PEOPLE - Colombie: 09/2013 à 11/2013 (3 mois) Analysis of employee compensation

CORE SKILLS 0	CORE SKILLS 1	CORE SKILLS 2
Technologie pour la chaîne logi	Gestion de la planification	Gestion de l`approvisionnemen

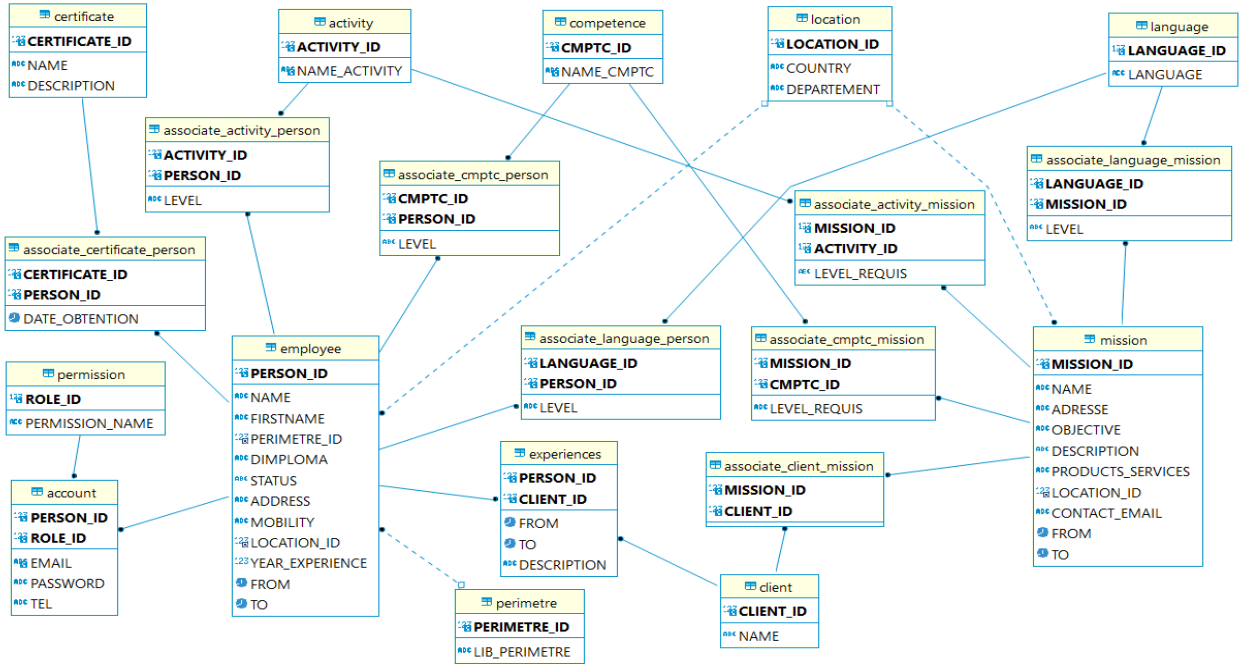
ACTIVITIES	KEYWORDS	LANGUAGES	DIPLOMAS 0	DIPLOMAS 1
(Recherche, Innovation & Veille	(Matlab)-(Object-Oriented Prog	Espagnol:Langue MaternelleAn	2019:logistics-Université de Tec	2013:Production management,

CERTIFICATIONS 0	CERTIFICATIONS 1	IC STATUS	CAPACITY AVAILABLE
industrial engineering-Universidad de los Andes-Colombia		UNB (INT-I)	100

LOCATION	WORKSITE
France	France - Vélizy (Topaz)

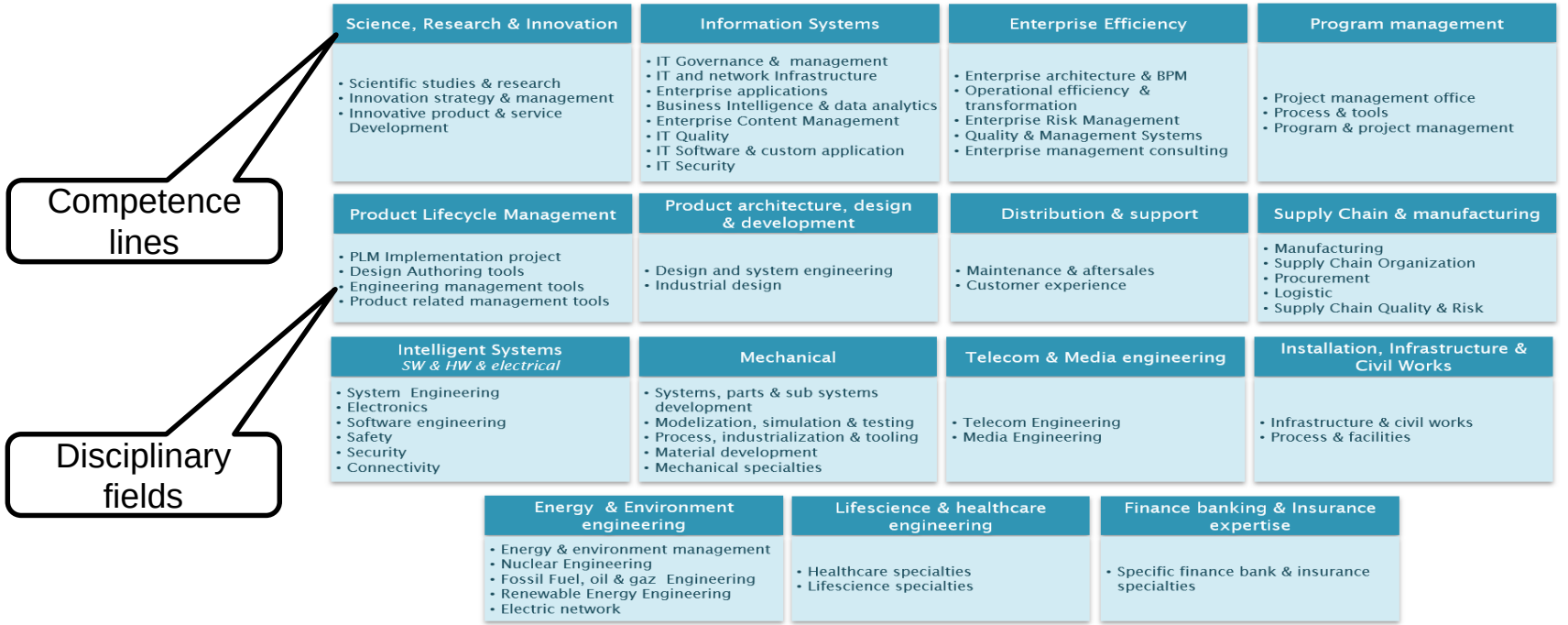
Proposed Global Database

The proposed global database is used to save the input of CVs. It has five typical tables – certificate, activity, competence, location, language.



Competence Map (CMAP)

CMAP is a homogeneous description of the competencies across Altran.



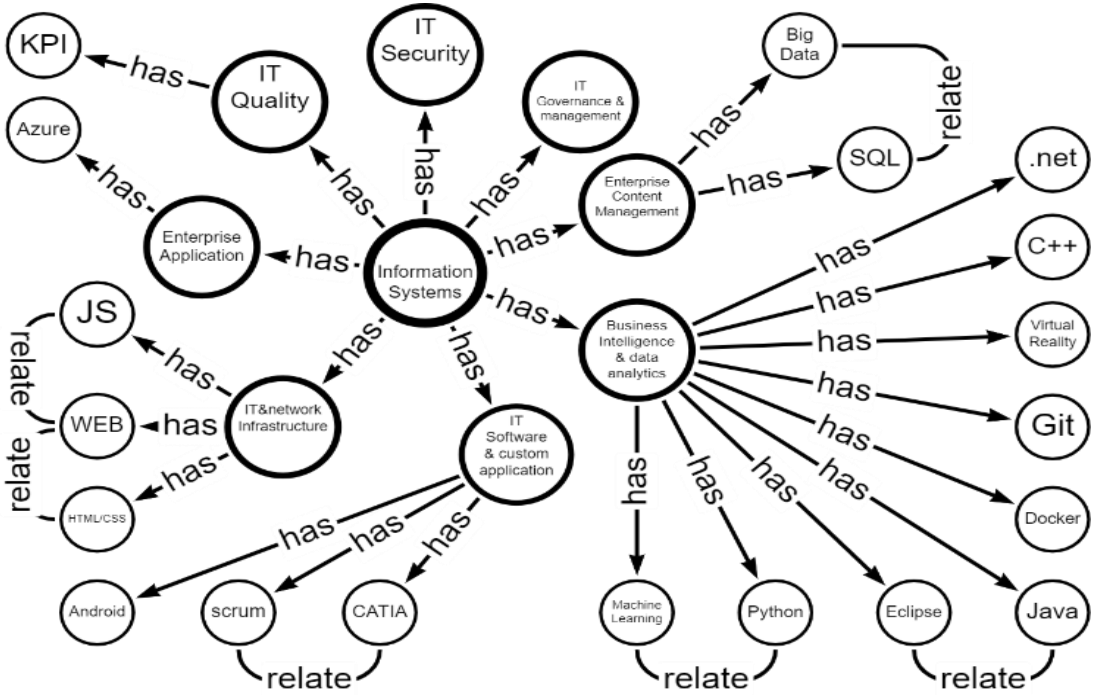
Proposed Knowledge Graph

Label - part of a group:
- *Competence Keywords*

Relationship type:
- *Has*
- *Is a*

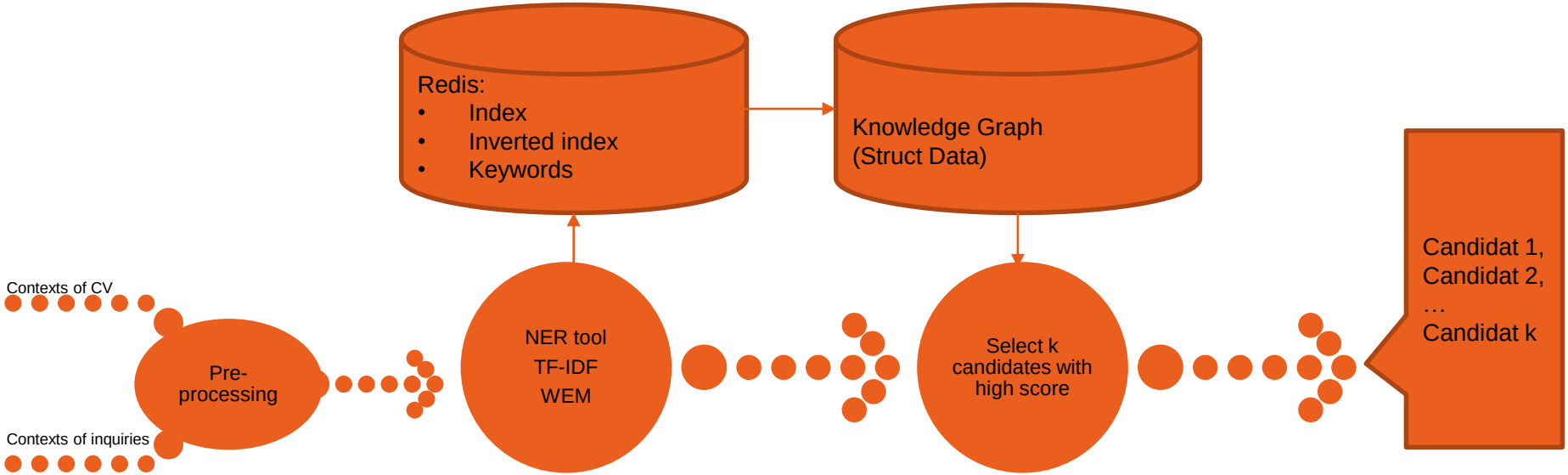
Scale-free network - a scale-free network is produced when there are power-law distributions and a hub-and-spoke architecture is preserved regardless of scale, such as in the World Wide Web.

Flavors of Graphs:
- *Disconnected*
- *Unweighted*
- *Tree*
- *Sparse*
- *Bipartite – function and specialty*



Proposed approach of search engine

In the search engine, we take two kinds of files as input – CV and clients inquiries. We make a pre-processing to remove the ambiguous (for example, “JS” is “Java Script”). Then we use NER tool based on DistilBERT-base-multilingual-case to extract the competence keywords and TF-IDF to calculate the score of the competence keywords. We also use Weight Average Method (WAM) to calculate a global score. The scores are stored in Redis with index and inverted index. We select a list of candidates with high score as well as the related competence keywords from the Knowledge Graph.



Term Frequency–Inverse Document Frequency (TF-IDF)

TF-IDF method is used at first to represent text as a vector of dimension D such that D is the number of words in the vocabulary - competency keywords.

$$w_{i,j} = tf_{i,j} \times \mathrm{idf_i}$$

$$\mathrm{id}f_i = \log\left(\frac{1+N}{1+df_i}\right)$$

$w_{i,j}$ = score of term i in document j

$tf_{i,j}$ = number of occurrences of term i in document j

df_i = number of documents containing the term i

N = total number of documents

Weight Average Method

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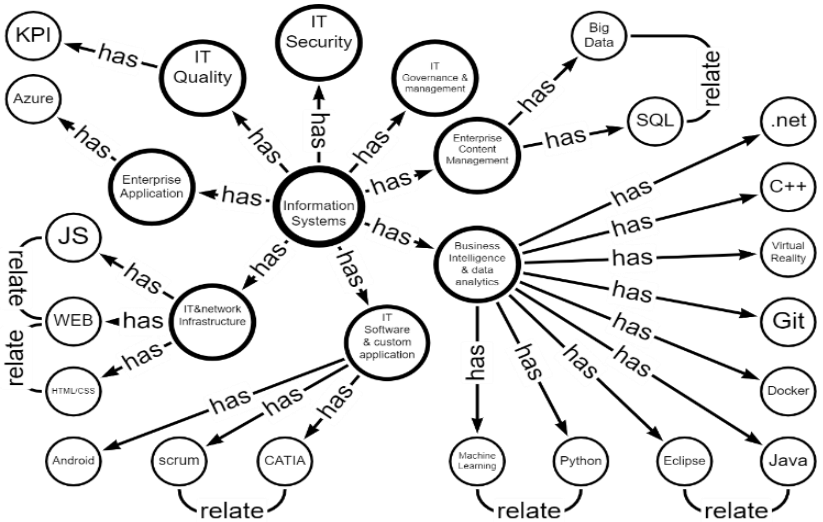
Propose the weighting to calculate an overall score for the four sections of the CV - experience, core skill, skill keyword and activity keyword.

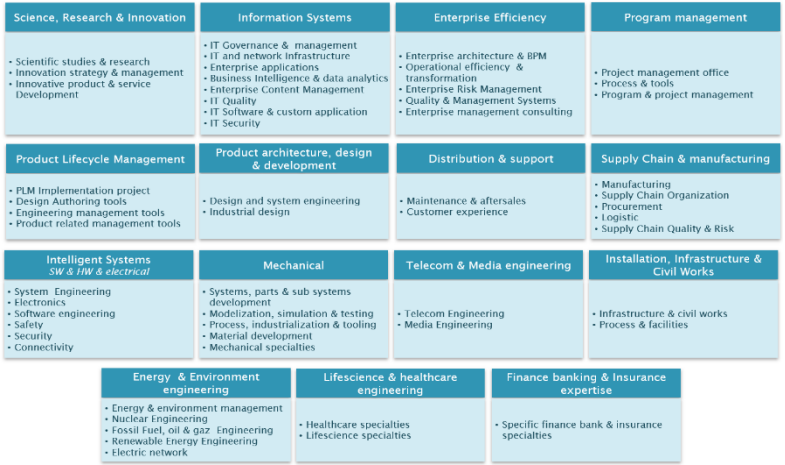
Defuzzification methods:

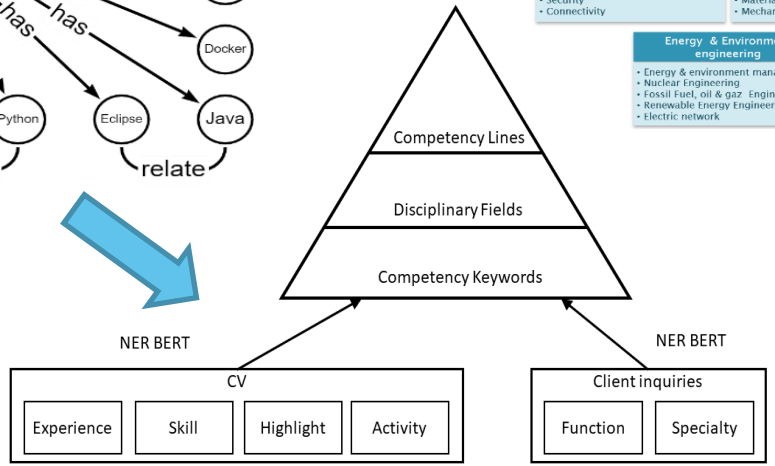
- Center of gravity
- Centroid method
- Center of sum
- Max-membership principal
- **Weight Average Method**

$$Z = \frac{\sum \mu(\bar{z}) \bullet \bar{z}}{\sum \mu(\bar{z})}$$

Scientific approach for the search engine







Experimentation results – search candidates by « Java »

It is obvious to see that Linx does not pay attention to the experiences of candidates. All the three candidates from BERT have experiences of Java and this skill is also highlighted on the section of core skill and skill keyword. Especially, the first candidate from BERT has the experience of “Eclipse” which is related to “Java” in the knowledge graph.

Linx				BERT			
ID_ candidate	Experience	Core Skill	Skill Keyword	ID_ candidate	Experience	Core Skill	Skill Keyword
16874	Developer at ENGIE - France Developer within the Genesys team then WattsOn at GEM IS Consultant at SFR - France Project manager / IT Engineer MOE - Scalable and corrective maintenance of various applications. IS Consultant at SOCIETE GENERALE - France IT MOE Engineer - Scalable and corrective maintenance of several applications	Test automation, Analysis & development of software requirements, Software design	DDD, Microsoft Visual Studio 2010, Entity Framework 4.0, C# 4.0, Java TDD	346575	Developer at AIRBUS - France: Creation of a Platform for Icing studies Developer at AIRBUS - France: Prerevolution Software Developer at DASSAULT AVIATION - France: Eclipse RCP based Verification Tool development for SCADE ENSO	Modelling, Model-Based Systems Engineering, IT Test & Validation, Automation	JUNIT, Maven, EMF, Tortoise Gi Java 8
17071	Study engineer at BNP PARIBAS - France Universal Plug application - migration from Exadata to AIX, optimization Technical consultant at SOCIETE GENERALE - France I2R - Performance optimization of the Oracle Exadata database; migration from Oracle 11gR2 to 12c Technical consultant at SOCIETE GENERALE - France Optimization of the AGORA-AIR application database	DBA study, Database development, System and database	Oracle PL/SQL, Oracle Exadata, Oracle 12c, Oracle SQL Developer, Java 8	67747	Developer at ALTRAN - France: Clinuikali project - Java Application development Developer at ALTRAN - France: Python Application development Testing & Validation Engineer at ALTRAN - France: ACS - Automatic Testing within Continuous Integration	Software design, Marketing studies and strategy, Integration Validation Verification & Qualification,	Python, Software Development, Java, CSS 3, Html5
15868	Tester at HP ENTERPRISE SERVICES COMMUNICATION & MEDIA SOLUTIONS - France System Tests and Functional Tests on a virtualized system of the 4G network core, 2G / 3G environment (MAP, Diameter, AAA, EIR protocols) Integrator at HP ENTERPRISE SERVICES COMMUNICATION & MEDIA SOLUTIONS - France Integration of software solutions - Pre-Integration Tests Management of off-shore teams Industrialization & production engineer at TOTAL - France Outsourcing control on data transfer applications Definition of new flows; Dedicated projects with high business impact	Functional testing and validation, Test and technical validation, Collaboration and networking	Collabnet Svn, Teamforge Svn, Microsoft Office, HP ALM, Collaborative Tools	67711	Developer at ACS - France: OA: The system quantifies the fatigue at work for an employee during his working hours. Developer at ACS - France: LBS: Tracking the movement of physical assets on indoor and outdoor topology, by scanning barcode labels attached to assets or using smart labels, such as LORA or Antiote labels, which broadcast their location. Developer at ACS - France: OA: The system quantifies the fatigue at work for an employee during his working hours.	Application WEB, Core network mobile circuits, Product design and development	HTML, JavaScript, AngularJS, Angular, Java

Perspectives

- An advanced word embedding tool is required to replace TF-IDF Vectorizer.
- A richer KG is needed with the properties of each node and weighted relation for the dynamic management.
- A recommendation system with KG embedding method is needed for the matching between the profile of candidate and the description of mission.

Thank you for your attention !

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