

JOB RECOMMENDATION RECSYS SUMMER SCHOOL 2023

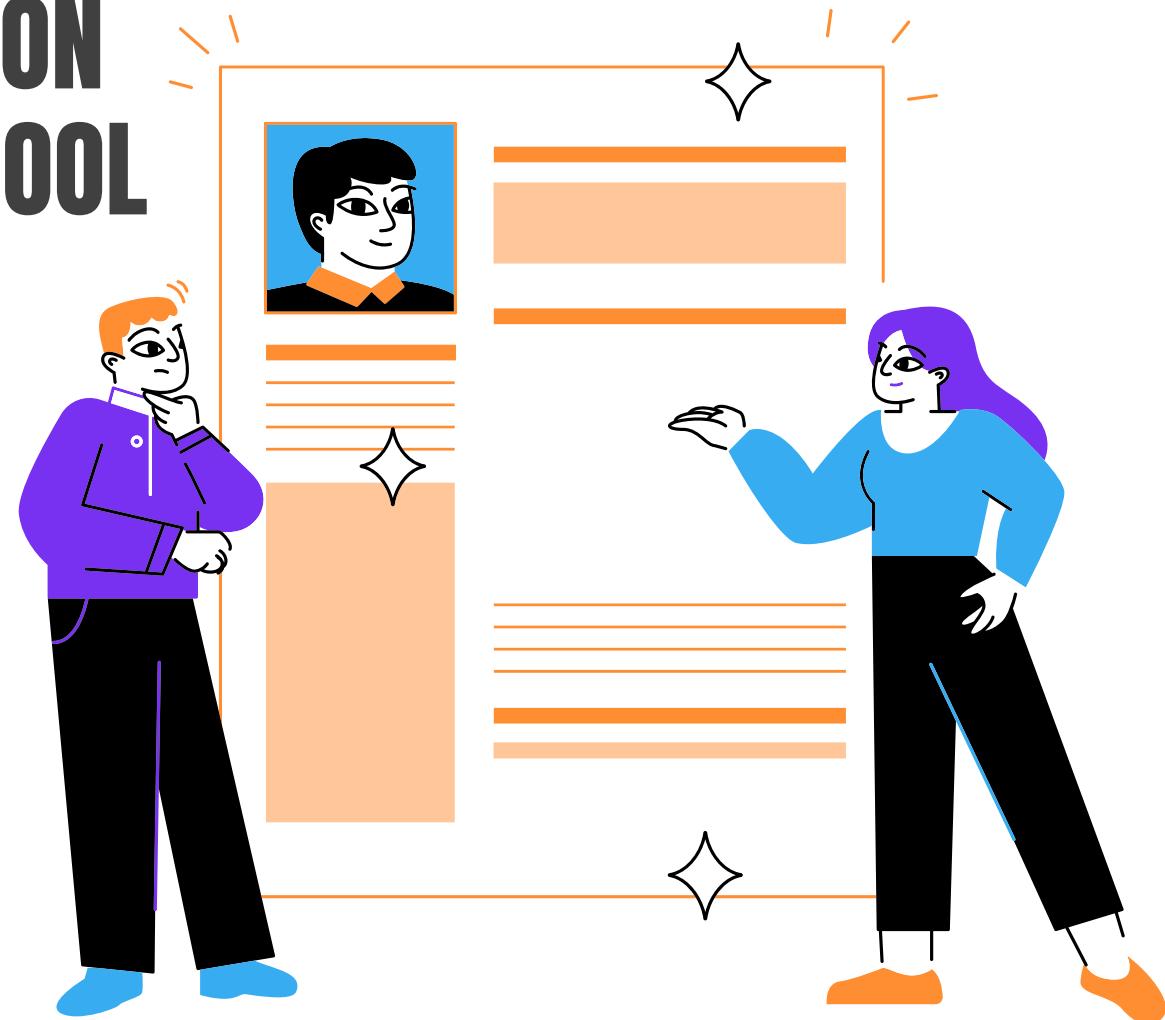
MESUT KAYA

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The slides: <https://github.com/mesutkaya/recsys-summer-school-2023>

Me - Mes - Mesut

Postdoctoral Researcher



PhD

Intent-aware diversity in RecSys

Research

Interests

- Fairness in group recommendations
- Diversity in news recommendations
- Automatic Playlist Continuation
- Job Recommendations

Skills

Distracted



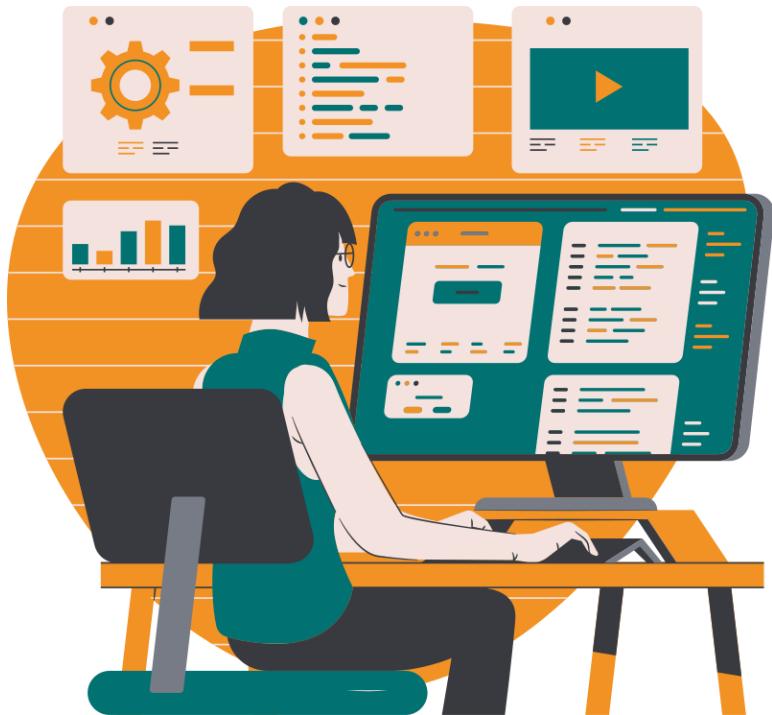
Public Speaking



Faking to be
student



OVERVIEW



Introduction to Job Recommendation Problem

Case Study: JobMatch Project

Understanding Recruiter's Search Behaviour

Talent Recommendation

Evaluating Talent Recommendation Algorithms

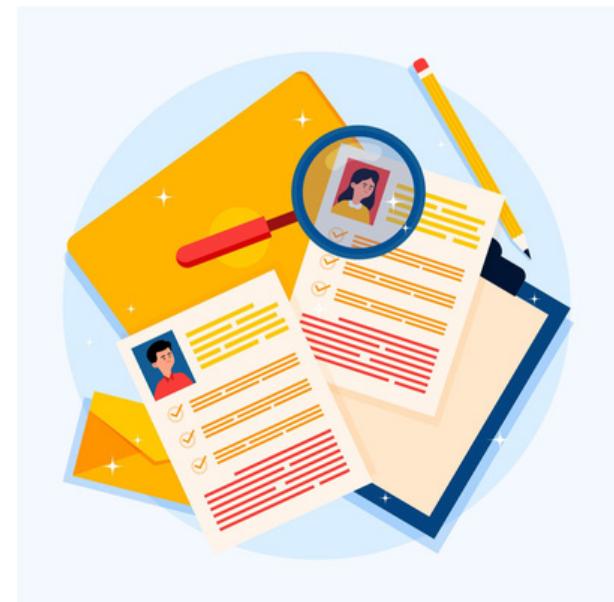
Lessons Learned

JOB RECOMMENDATION

PERSON-JOB FIT



Job opening

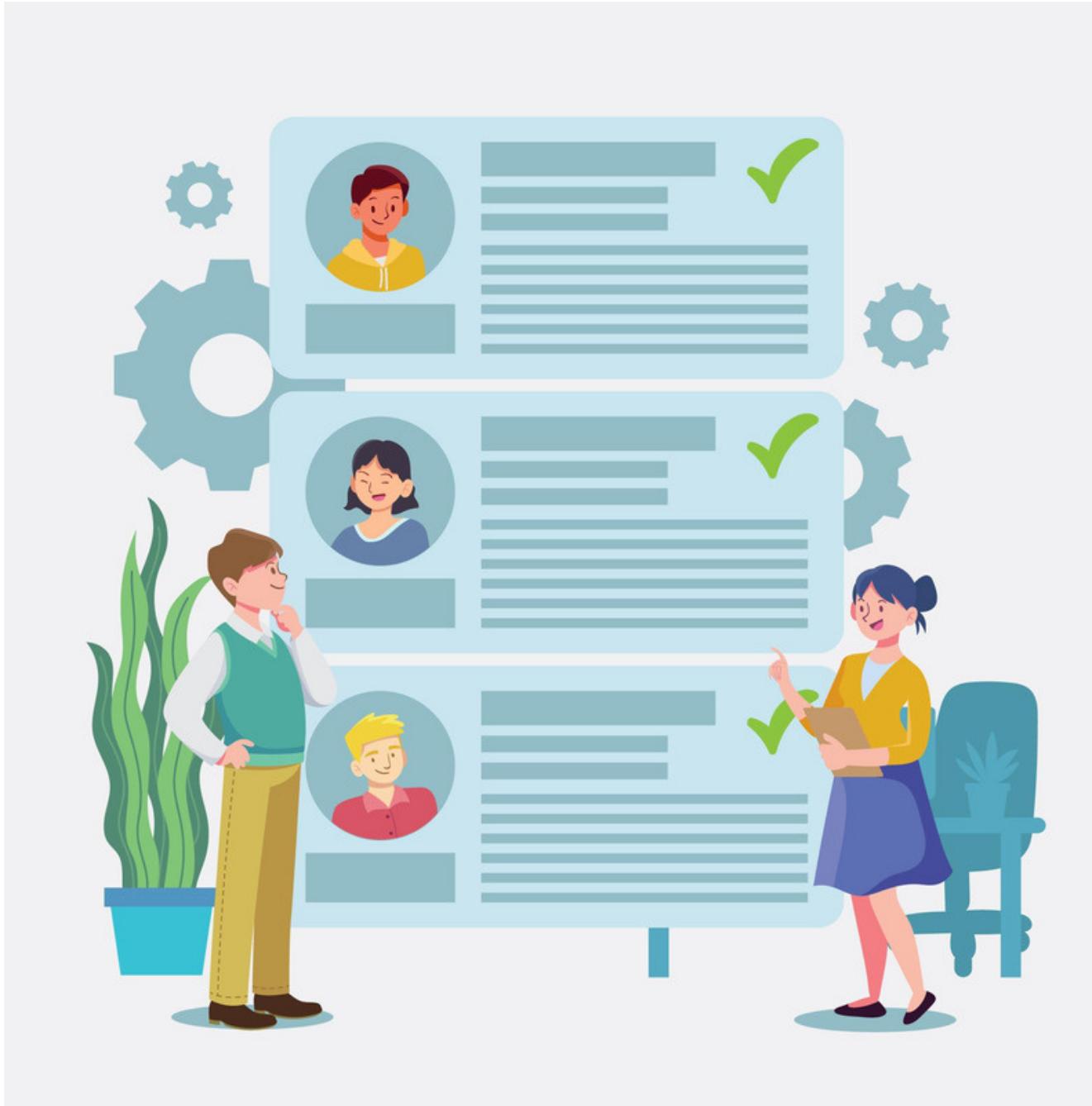


Resume

Recommending relevant jobs to job seekers



Recommending relevant job seekers to open job positions



Earlier Approaches



Collaborative Filtering



Content-based

Representation Learning



$d = \{t_1, t_2, \dots, t_m\}$

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Textual data source

$h_u = \{\vec{d}_{i1}, \vec{d}_{i2}, \dots, \vec{d}_{in}\}$

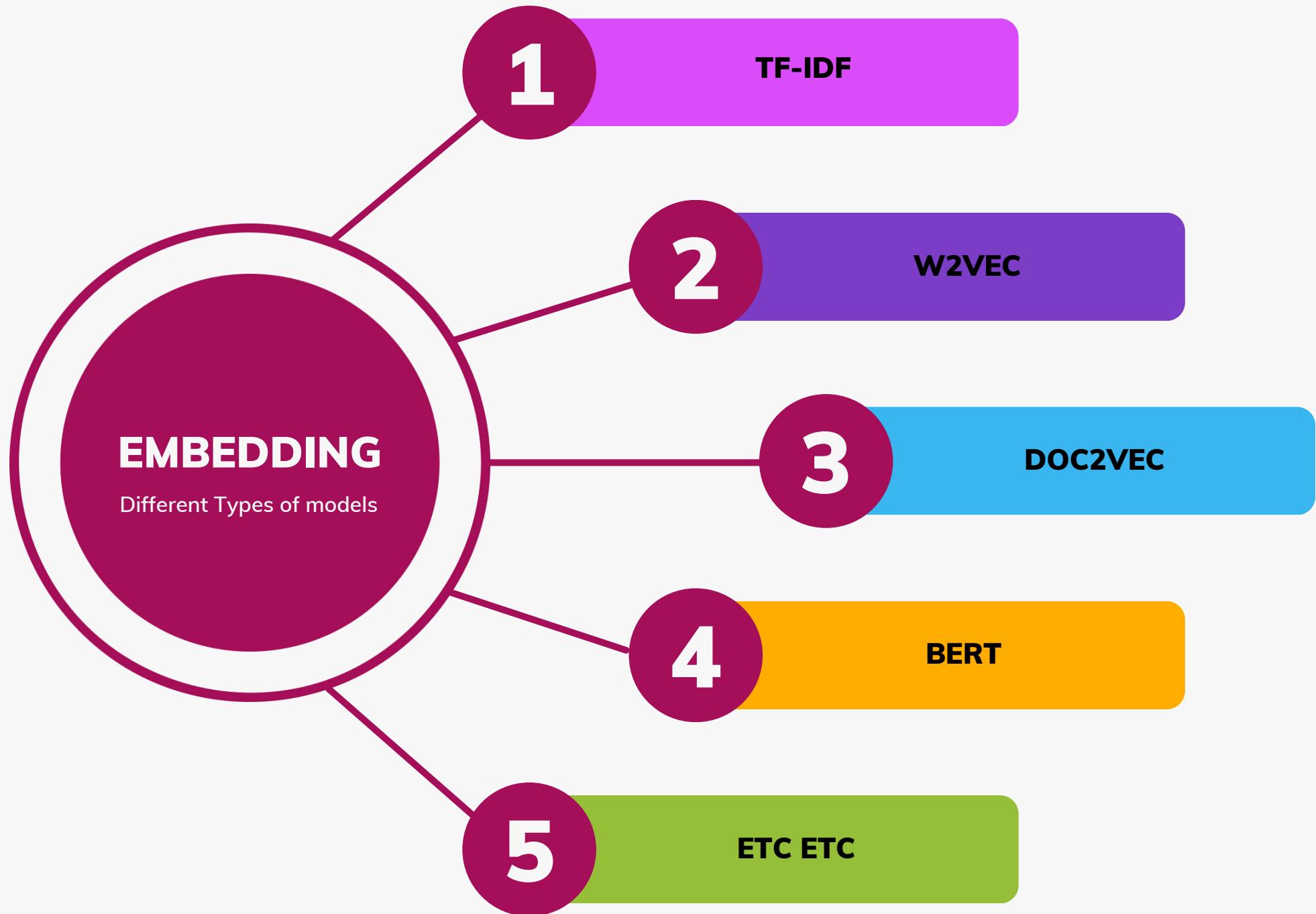
$h_i = \{\vec{d}_{u1}, \vec{d}_{u2}, \dots, \vec{d}_{ul}\}$

Interaction data

Embedding Model

0.21 | 0.93 | 0.01 | 0.12 | ...

0.34 | 0.73 | 0.41 | 0.02 | ...





You are a Python Developer with a solid experience in Web development and can manage projects.

You easily adapt in a new environment and speak French and English







JobMatch Project

A 3-year research project is now trying to crack the code of matching jobseekers with the right jobs. The project is supported by Innovation Fund Denmark with 7 million Dkr.



Understanding Recruiters' Search Behaviour



Contextual Inquiry



Search in CVs

1

[See manual](#)

sales supply chain

Choose job titles

Search

Enter work location (e.g. postcode or city)

Choose category/categories

Reset

Filter your search

2

Following company

 Testfirma

Education level

At least

Maximum

Work experience (years)

10 Maximum

Management experience (years)

5 Maximum

Salary expectations

40,000 kr. Maximum

60,000 kr.

Tags

Found 1,845 users.

[Contact CVs](#)[Clear CVs](#)[Sent me](#)

4

Language skills English**Management experience** 5+**Notice period** 1 month notice**Salary expectations** 40,000 kr.–60,000 kr.**Search among** Online CVs + followers**Search term** sales supply chain**Special groups** Full-time**Work experience** 10+[Create CV Agent](#)

Experienced Supply Chain Management Professional

Job wishes: Supply Chain Director, Category Manager, COO, Director and 6 others**Latest job:** Owner and founder ([REDACTED])**Geography:** [REDACTED]**Education:** Graduate Diploma in Business Administration) – HD 2. Supply Chain Management ([REDACTED])**Salary expectations:** DKK 40-50,000**Work experience:** 24 years**Conditions of employment:** Full-time and temp**Management experience:** 20 years

Experienced Supply Chain Management Professional – with extensive international leadership experience from Strategic Sourcing, Procurement, Supply Chain Management, Product Portfolio Management, Business & Product Development and leading global international teams.

... one of the best managers within Supply Chain and Procurement in [REDACTED] ...
... PROFILE I am an Experienced Supply Chain Management Professional with a solid ...

[supply shipment](#)[Experienced Supply Chain Management Professional](#)[Global Supply Chain Jobs](#)[ABC](#)[+ 134 others](#)[Add tag](#) [Add comments](#)

Advanced

3

Language skills

 English

Minimum language proficiency

Notice period

1 month notice

Employment / groups

 Full-time

Search among

Online CVs + followers

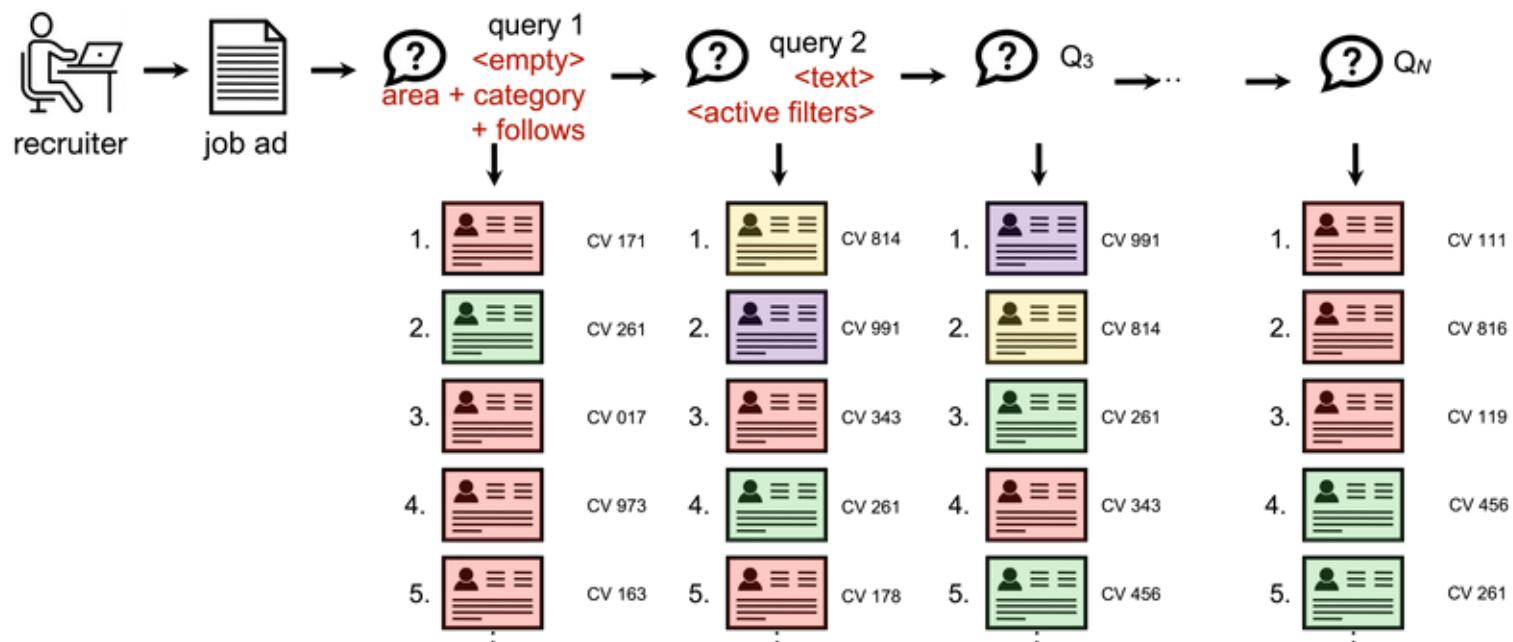
Saved searches

[View all your searches](#) →

Supply Chain, Procurement and Logistics Specialist

Job wishes: Business Development, Key account, Procurement, Sourcing and 2 others**Latest job:** Head of Supply Chain, Procurement and Logistics ([REDACTED])**Geography:** [REDACTED]**Education:** Cand. merc. [REDACTED]**Salary expectations:** DKK 50-60,000**Work experience:** 10 years**Conditions of employment:** Full-time**Management experience:** 5 years

I am a hardworking and ambitious [REDACTED]-year-old with specialty in International Business, Supply Chain, Procurement and Logistics. I have experience in working in a dynamic environment, where pace and overview are decisive elements. You will get a dedicated, hardworking and social employee with a theoretical and practical background within Business Administration, Supply Chain and International Business. I will be able to contribute with positive energy, new ideas, new



Interviews with Recruiters



Introduction

- Ask their consent for the interview
- Learn about their recruitment experience, which industry etc.

Searching & filtering candidates

- How they decide which **search terms** and **filters** to use, **how long** this search process took,
- How many **query reformulations** they went through
- How their inspection of the search results changed their perception of their search terms and search criteria.

Shortlisting Candidates

What information about jobs and CVs was used by the participants to determine whether a candidate was relevant

Contacting Candidates

- Whether and to what degree the messages are personalized before they are sent out,
- which aspects of the job or CVs are highlighted in these messages
- whether participants use personal templates or company-wide templates





NUMBER OF RELEVANT CVS

most recruiters aim for a shortlist of around 20 relevant candidates before they move on to the contacting phase.

SKILL, KNOWLEDGE, ABILITY

The most important relevance criteria when assessing the relevance of a candidate for the position are whether they match the required knowledge, skills and abilities stated in the job posting.

PAST WORK EXPERIENCE

participants would contrast the most recent positions a candidate has held to the required skills to better be able to determine whether the candidate really possesses those skills

LOCATION

it has a strong influence on whether candidates will be interested in applying for a job.

OTHER INFORMATION

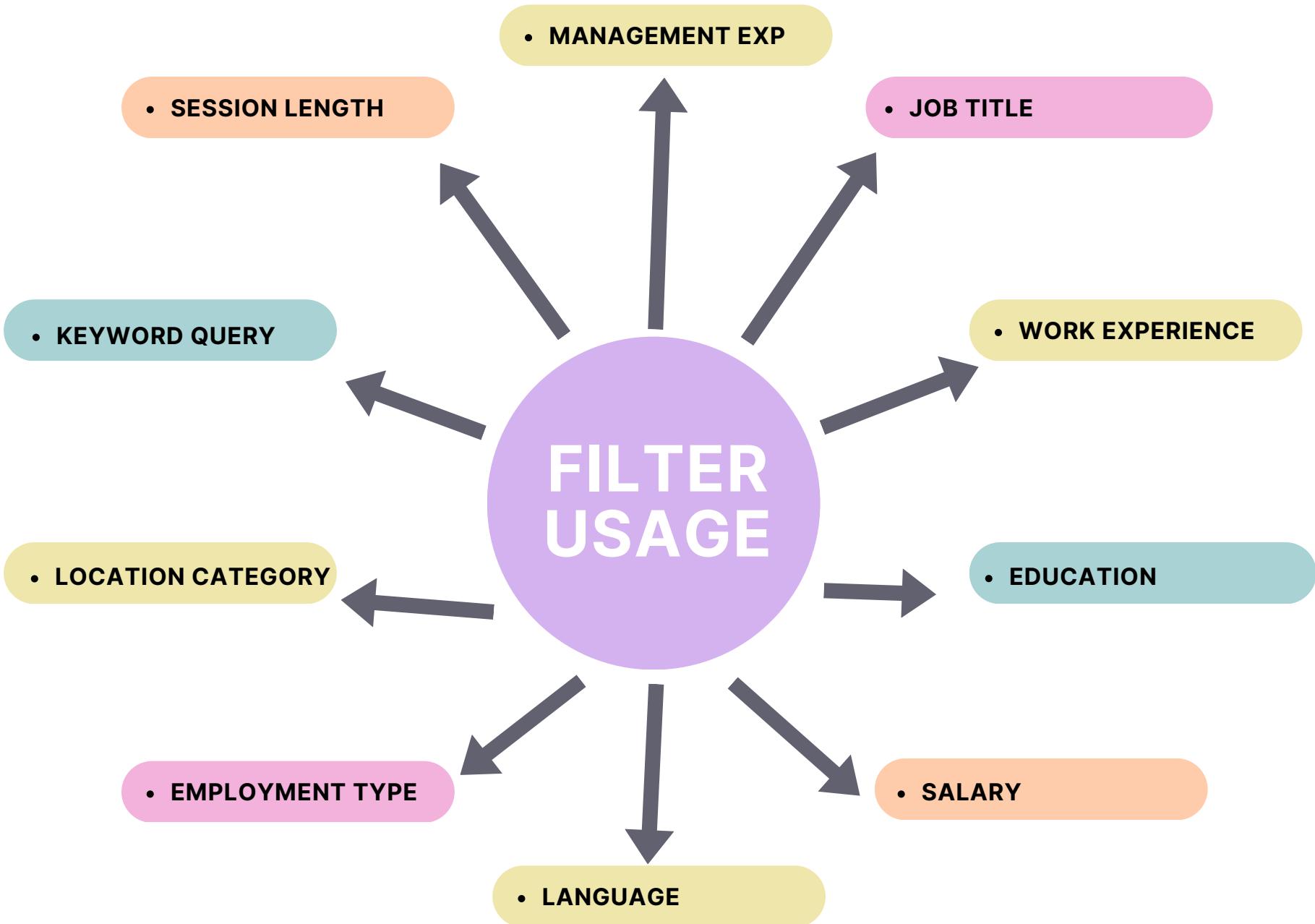
When necessary, participants would check unstructured personal CVs that are included as PDFs, although this was not common due to this taking more time to assess

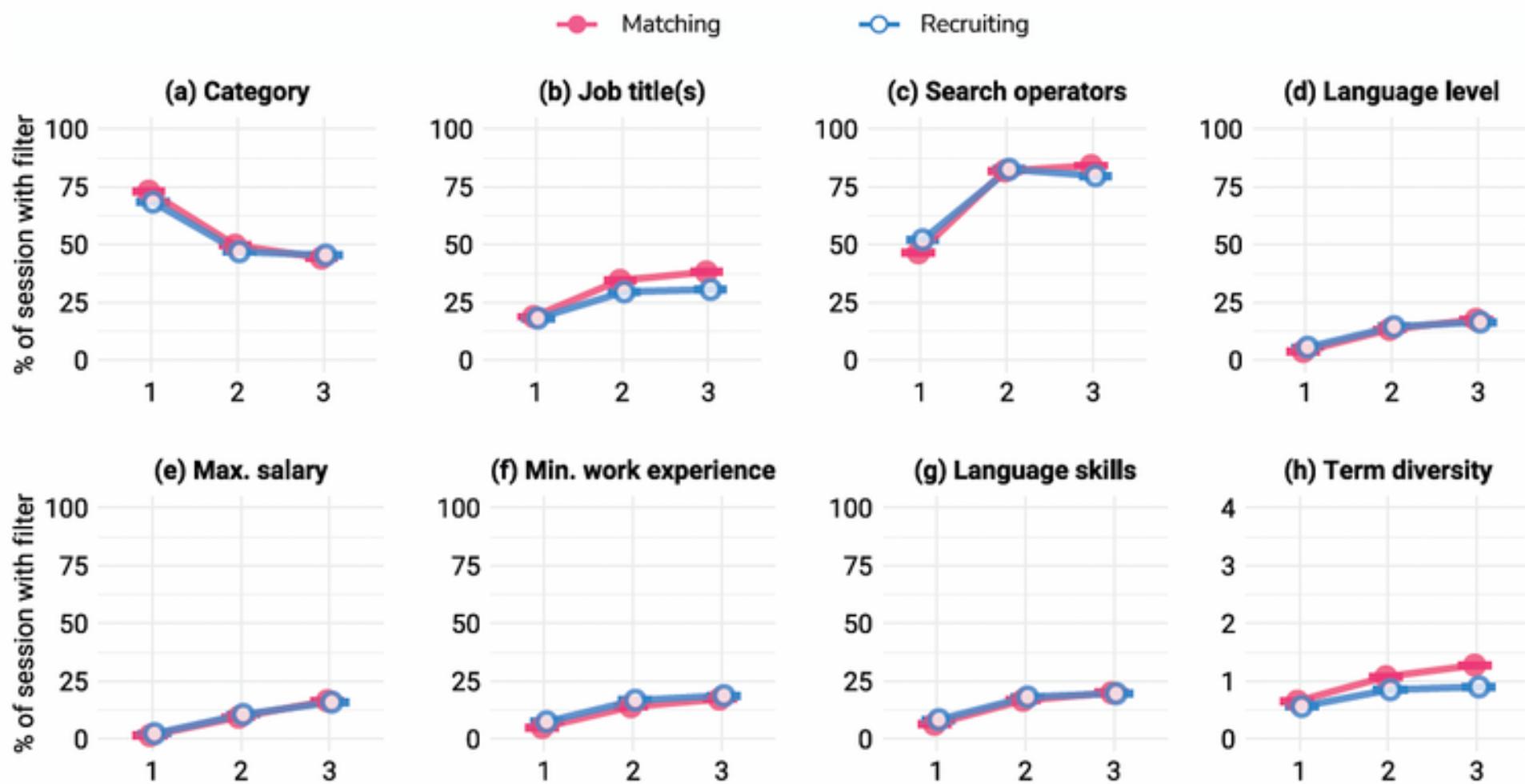
Search Log Analysis

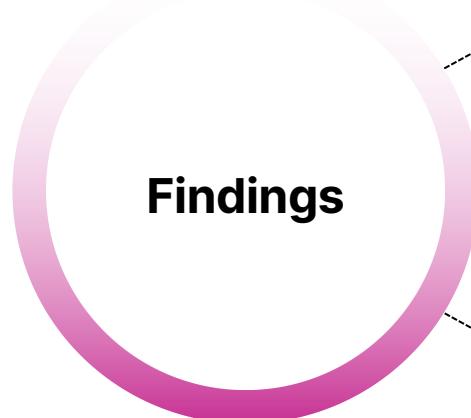


Search Stage Partitioning









1

2

3

4

5

TALENT SEARCH IS COMPLEX

Formulating multiple complex and diverse queries along with the use of different filters in search sessions that can last several hours.

MATCHING VS RECRUITMENT

Not much difference

EARLY SEARCH STAGES

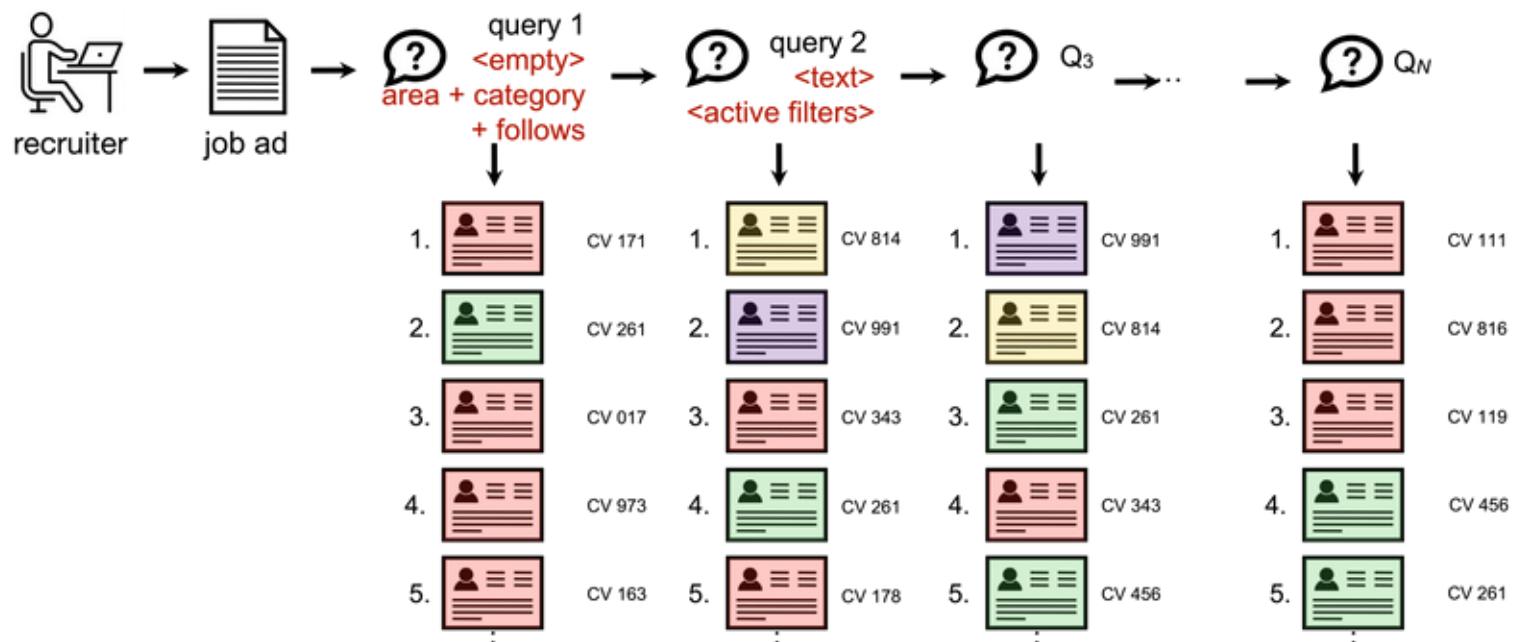
in the early stages recruiters learn from the job posting which **requirements, skills** and **abilities** relevant candidates are required to possess.

LATER SEARCH STAGES

As their search task progresses, recruiters **increase their use of filters, formulate longer queries with more diverse query terms and advanced search operators**

LEARNING AS SEARCHING

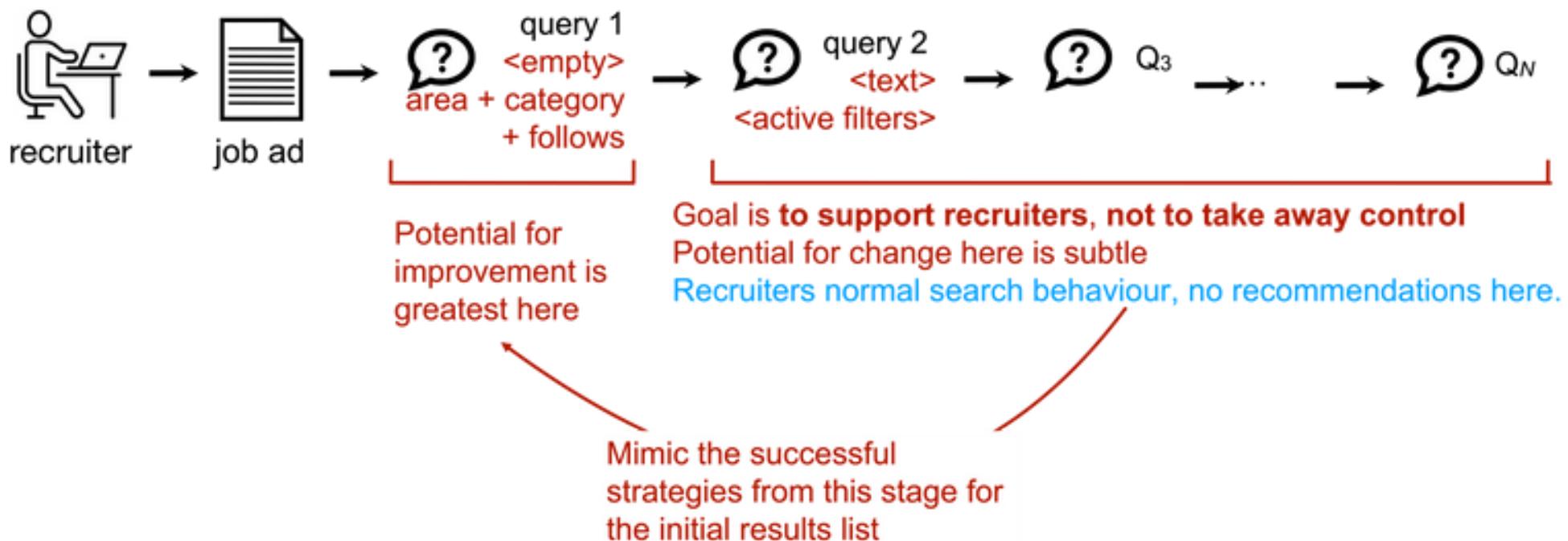
for each new job posting, recruiters gradually learn how to search more effectively as their search session progresses, something confirmed by our earlier work



TALENT RECOMMENDATION

Recommendations

What are we trying to improve?



JobMatch - Recommender Prototypes

1st Prototype

w2vec embeddings using
job title only

2nd prototype

use historical interaction
as additional info

Current prototype

Fine tune Bert, using
other features.

03

02

01



- Compare embeddings based solely on job titles to embeddings of full-text description of resumes and job postings.



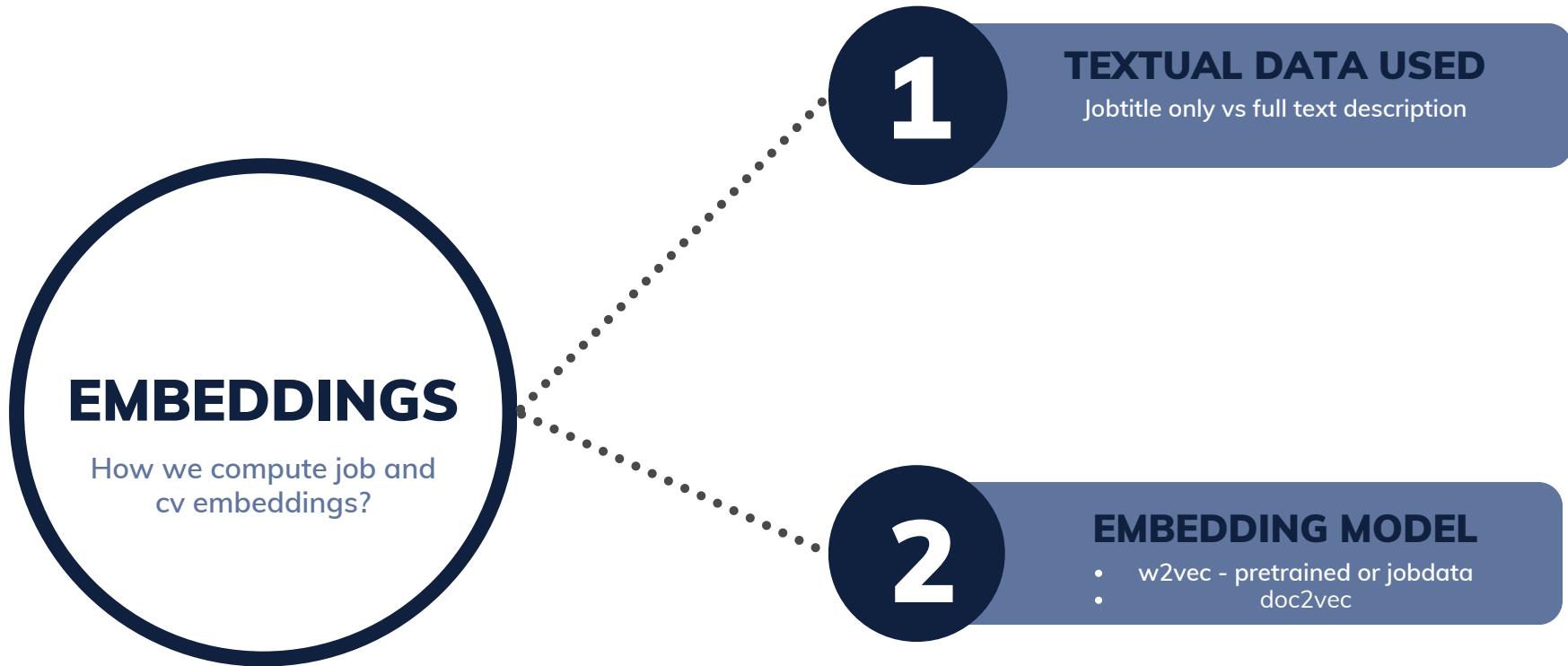
$d = \{t_1, t_2, \dots, t_m\}$

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Textual data source

Embedding Model





Recommendation Task: given a ‘reference’ vector that is the representation of a user u (i.e., job postings)—to find the top- N similar vectors among item vectors (i.e., job seekers).

KEEP VECTORS ON **SOLR** and PERFORM VECTOR SEARCH

- Compare embeddings based solely on job titles to embeddings of full-text description of resumes and job postings.



$$d = \{t_1, t_2, \dots, t_m\}$$

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Textual data source

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$$h_i = \{\vec{d}_{u1}, \vec{d}_{u2}, \dots, \vec{d}_{ul}\}$$

Interaction data

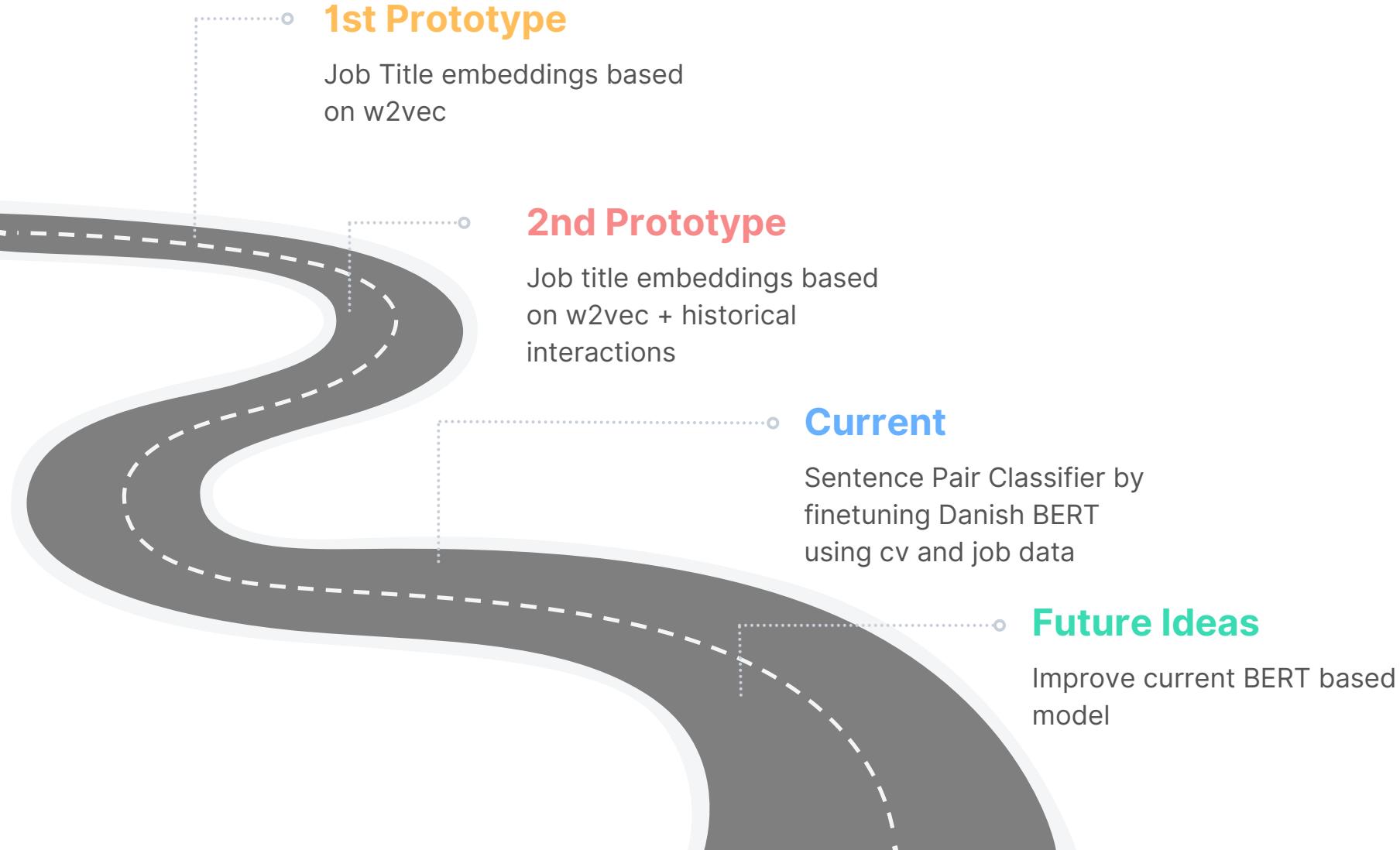
Embedding Model



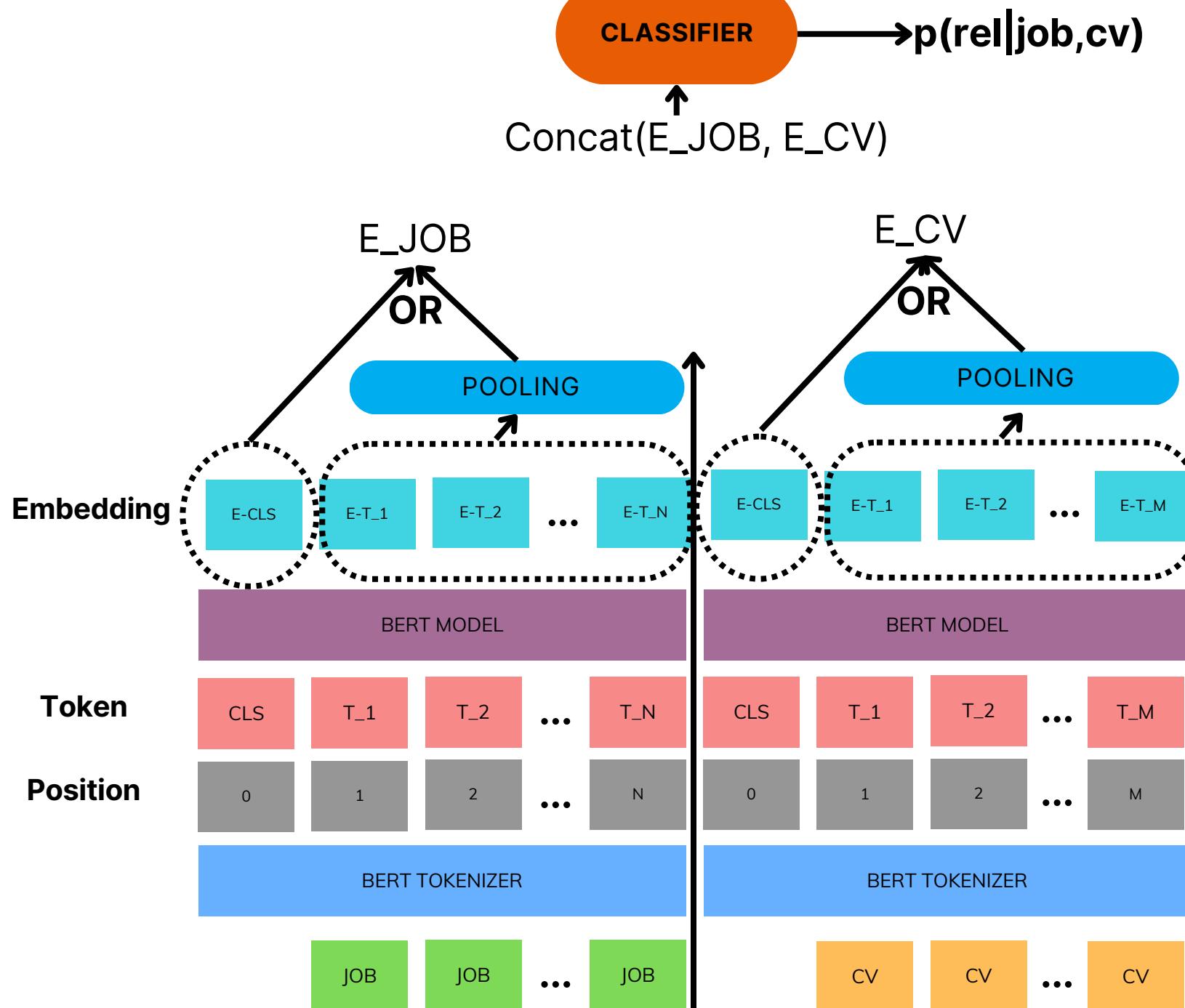
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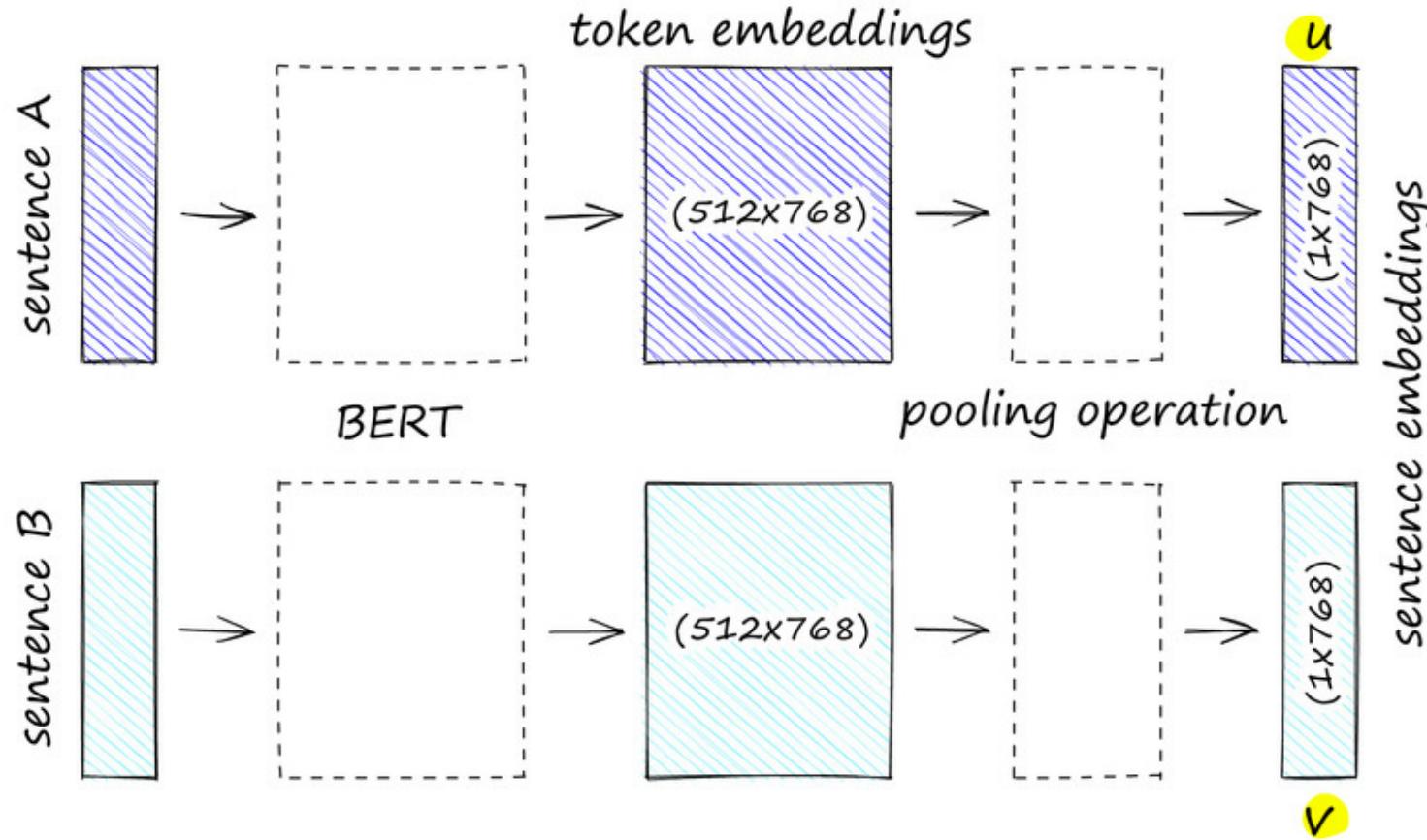
KEEP VECTORS ON FAISS and PERFORM VECTOR SEARCH

Recommender Prototype Process



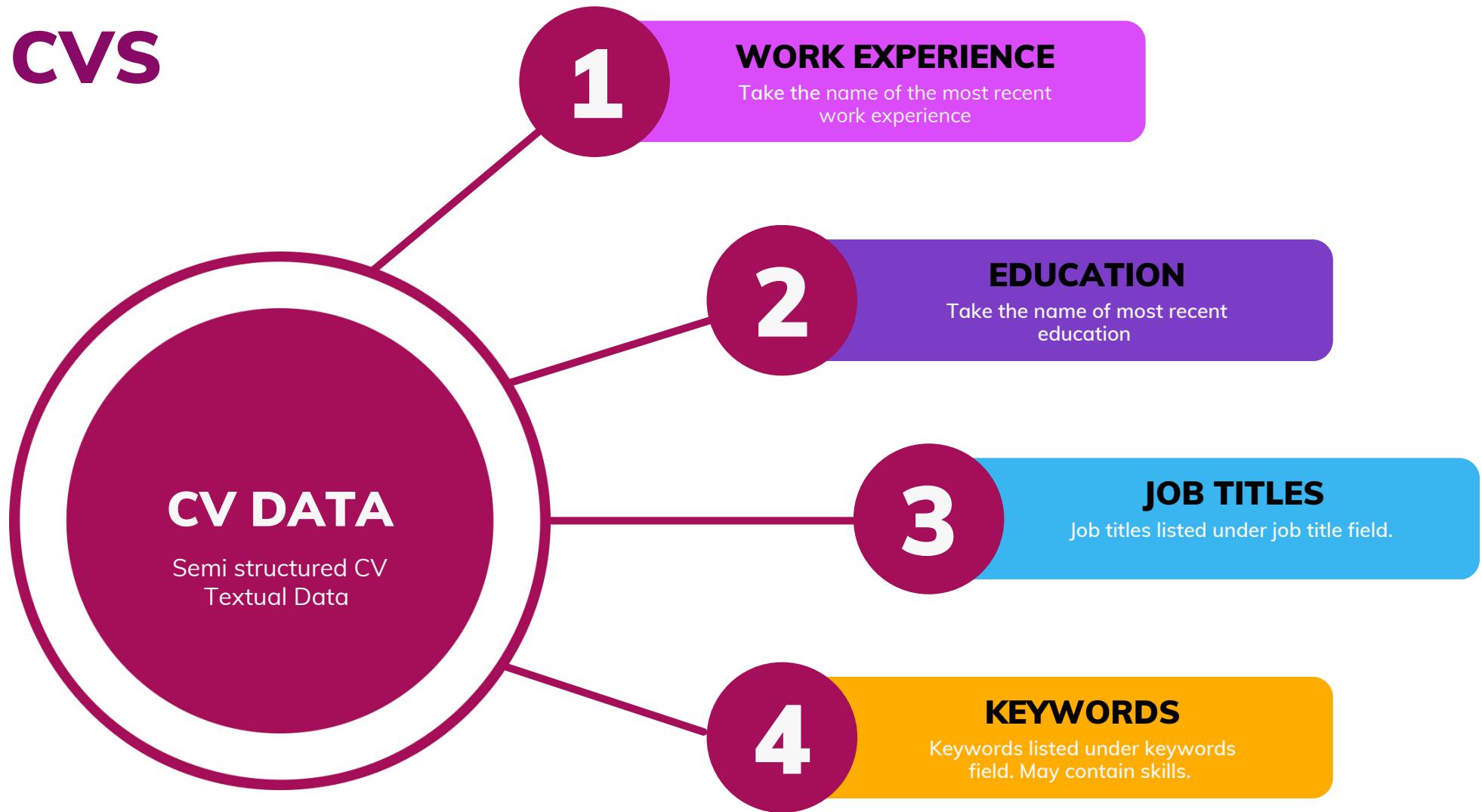
Sentence-BERT for Job Cv Match



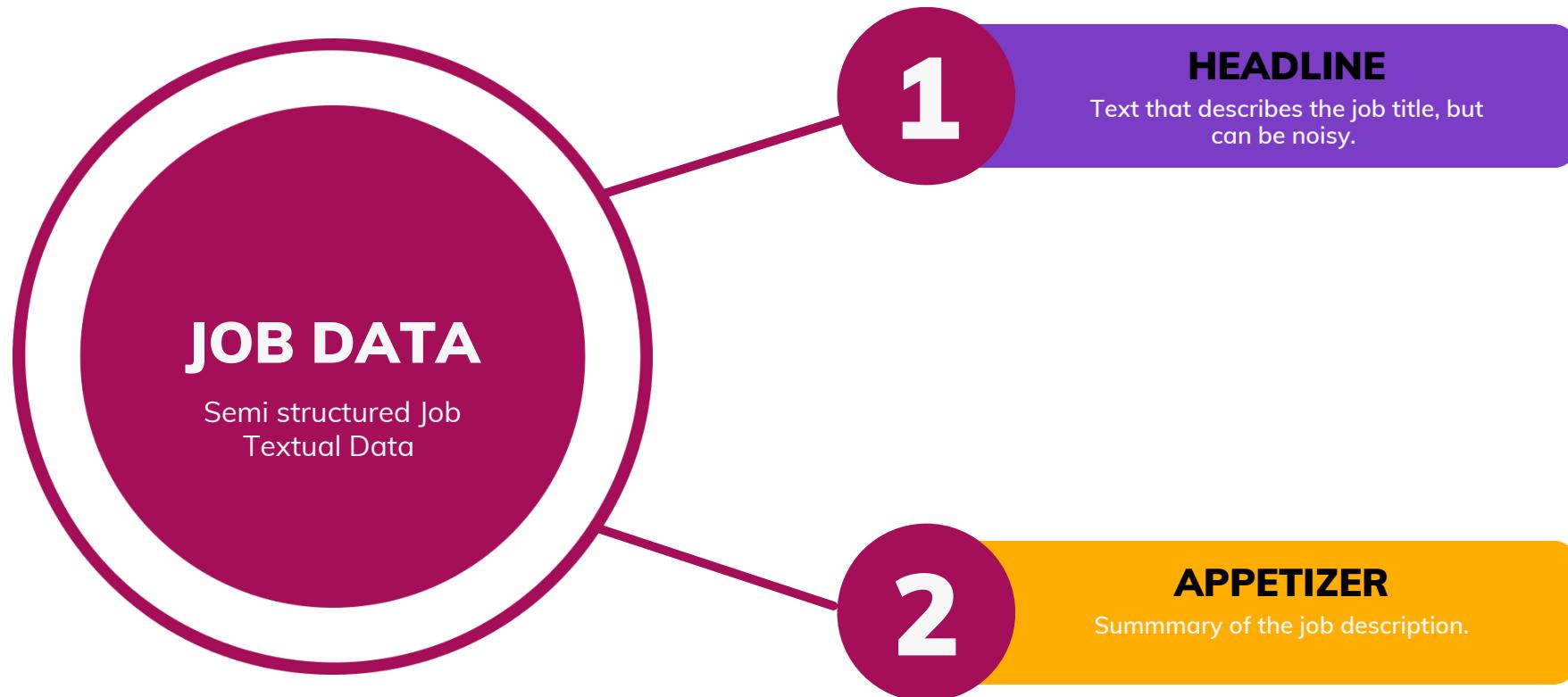


link: <https://www.pinecone.io/learn/sentence-embeddings/>

CVS



JOBS



Next Sentence Prediction with BERT OR Sentence Pair Classification

Sentence 1

Sentence 2

Next Sentence?

I am going outside.

I will be back after 6.

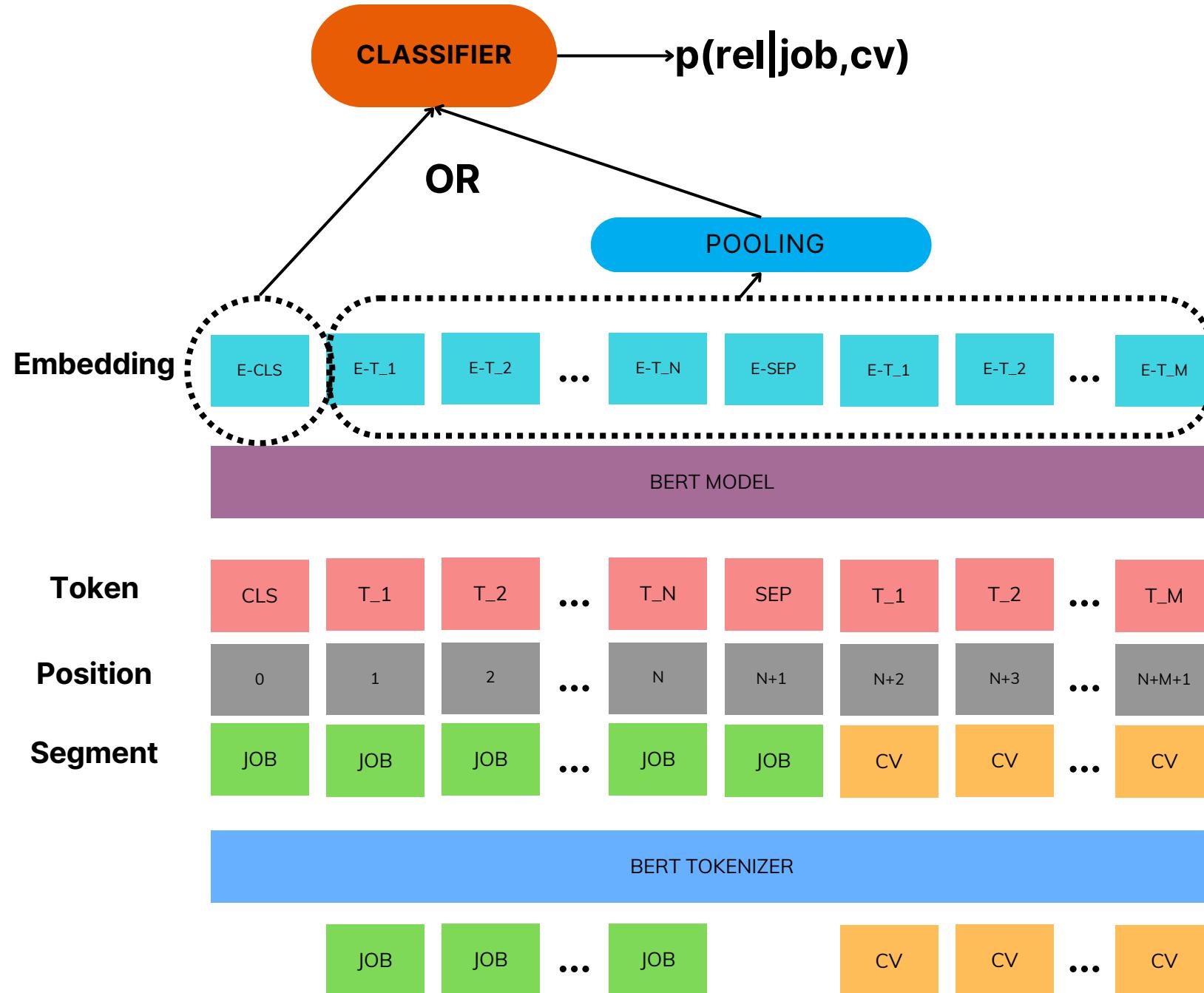
YES

I am going outside.

You know nothing John Snow.

NO

Sentence Pair Classification for Job Cv Match



SBERT vs SPBERT

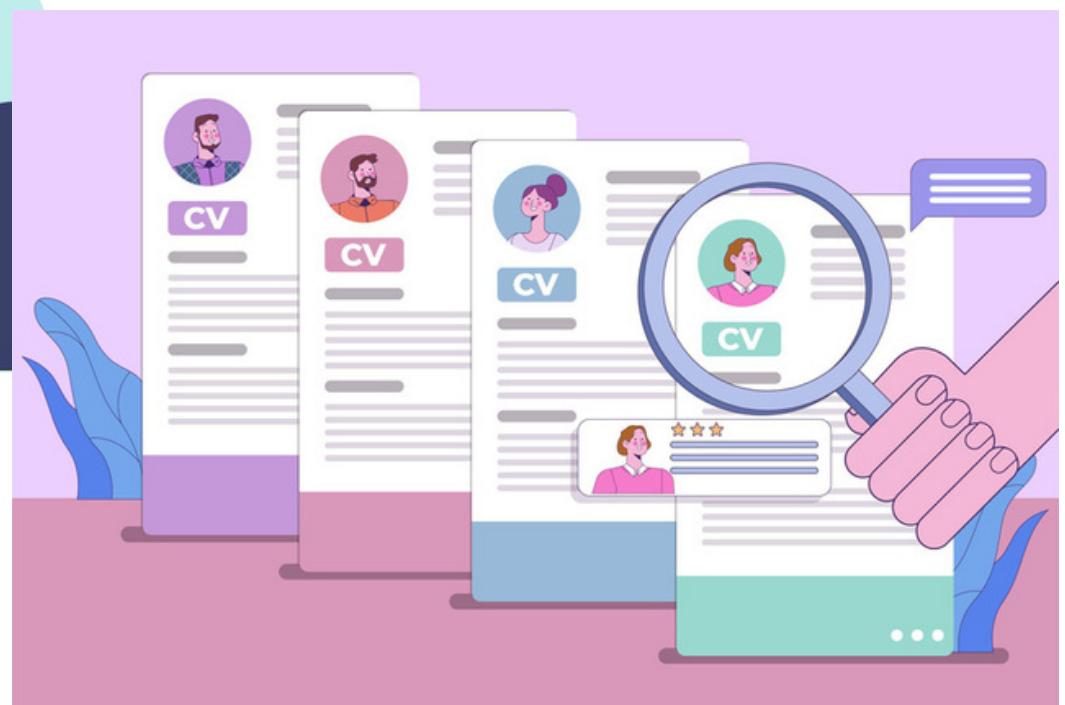
SBERT

- Superior in terms of scalability, since we can pre-compute the sentence embeddings, job and resume embeddings for job recommendations.

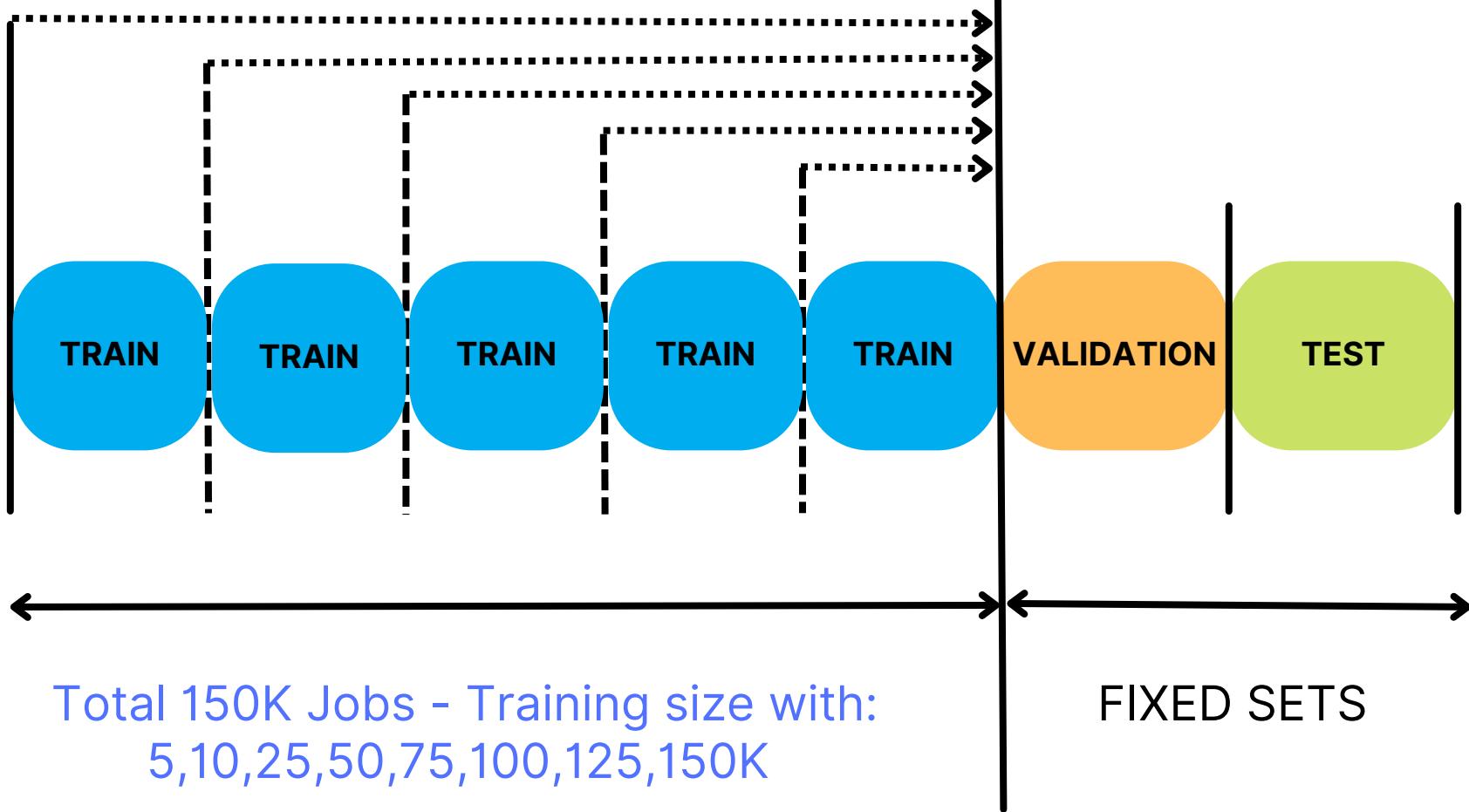
SPBERT

- Superior in terms of relevancy. If main goal is to improve relevancy and there is a chance to precompute recommendations with small to medium scale data.

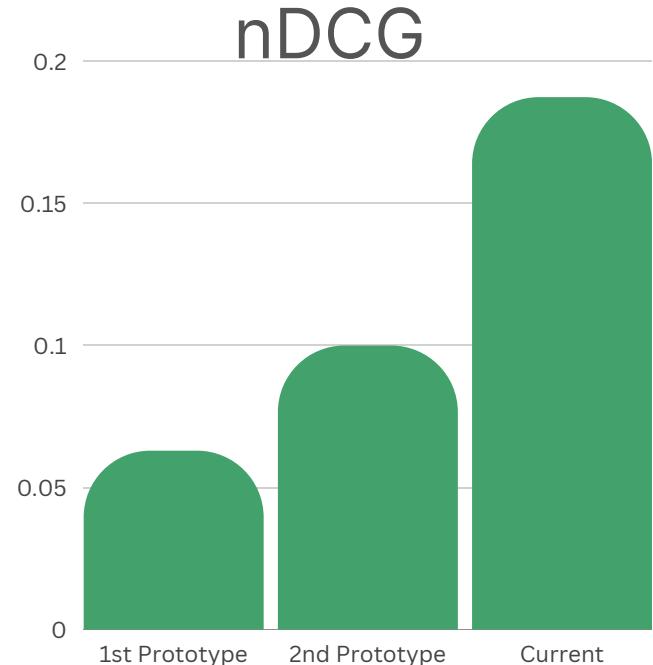
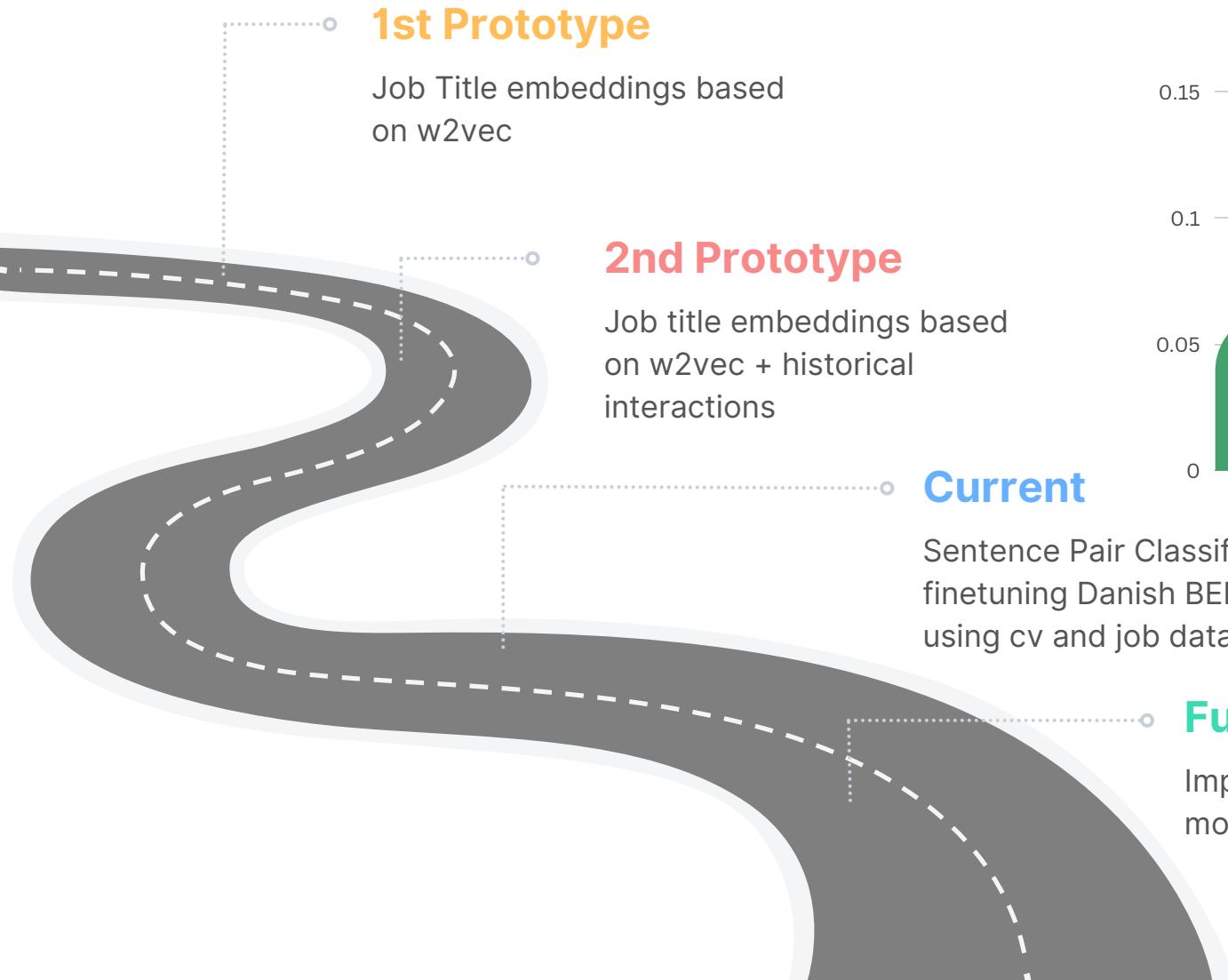
Pre-filtering the candidate set may help!



Varying number of training instances are used to train model, split is done via timestamp of the jobs



Recommender Prototype Process



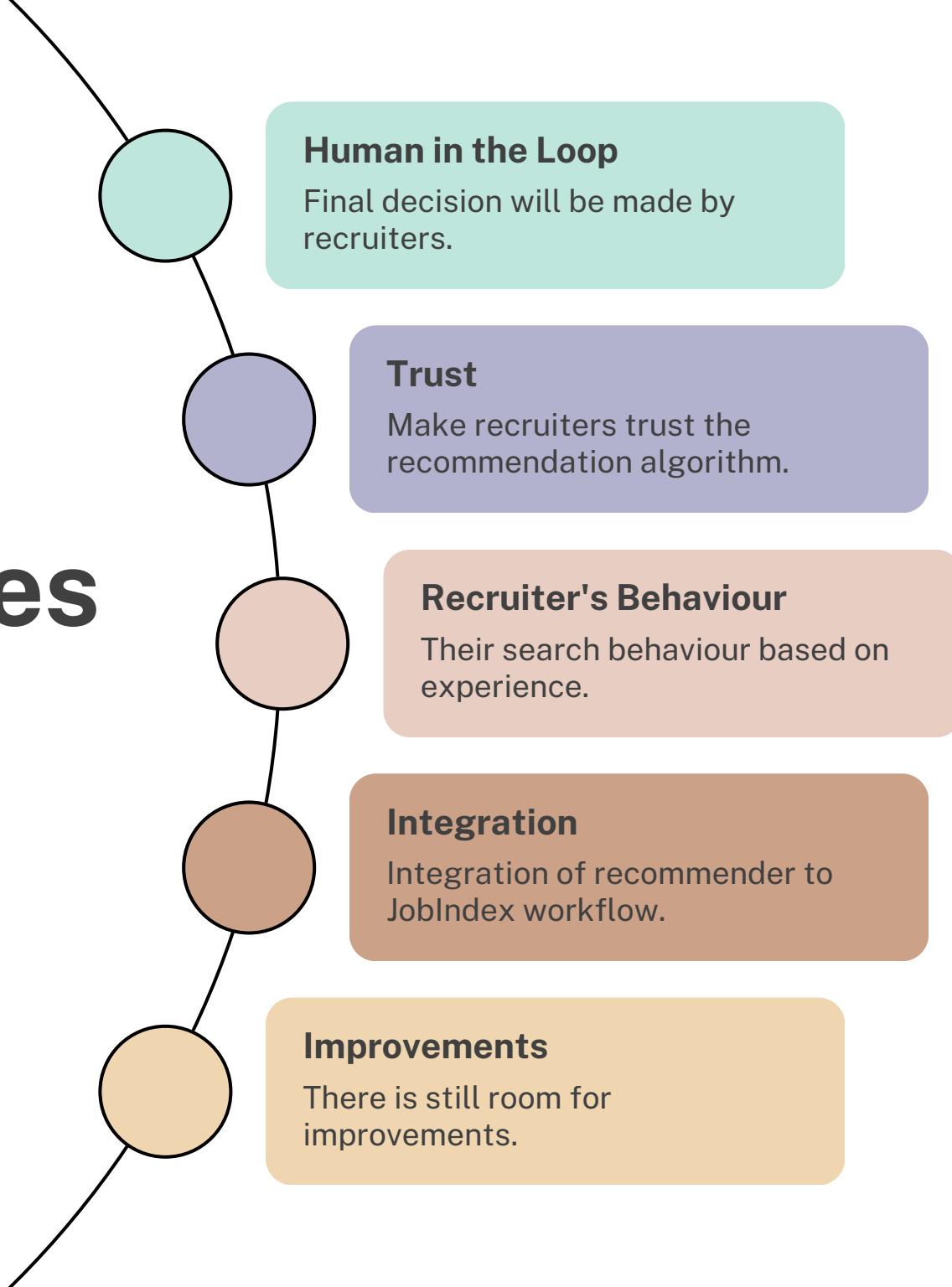
Online Experiment Results

	JTIH	SPBERT	% change
PRR	12.7	13.5	+10.44
CFR	24.75	41.1	+66.06

PRR: Positive Response Rate

CFR: Contacted From Recommendations

Challenges





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Illustrations are from <https://www.freepik.com>

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RECSYS IN HR 2023

RecSys in HR
Workshop on Recommender Systems for Human Resources

In conjunction with the 17th ACM Conference on Recommender Systems
Singapore, 18th-23rd September 2023

The RecSys in HR logo is overlaid on the right side, featuring a white gear shape containing a blue circle with red stylized human figures. The text "RECSYS IN HR" is at the top of the gear, and "RECOMMENDER SYSTEMS FOR HUMAN RESOURCES" is at the bottom.

WORKSHOP ON RECOMMENDER SYSTEMS FOR HUMAN RESOURCES

Co-located with the 17th ACM Conference on Recommender Systems, in Singapore.

IMPORTANT DATES

- Paper submission deadline: **August 3, 2023**
- Notification of paper acceptance: **August 27, 2023**
- Camera-ready version deadline: **September 10, 2023**
- Workshop (at RecSys 2023): **September 18-22, 2023**

Tweets from @RecSysHR