

JOB RECOMMENDATION RECSYS SUMMER SCHOOL 2023

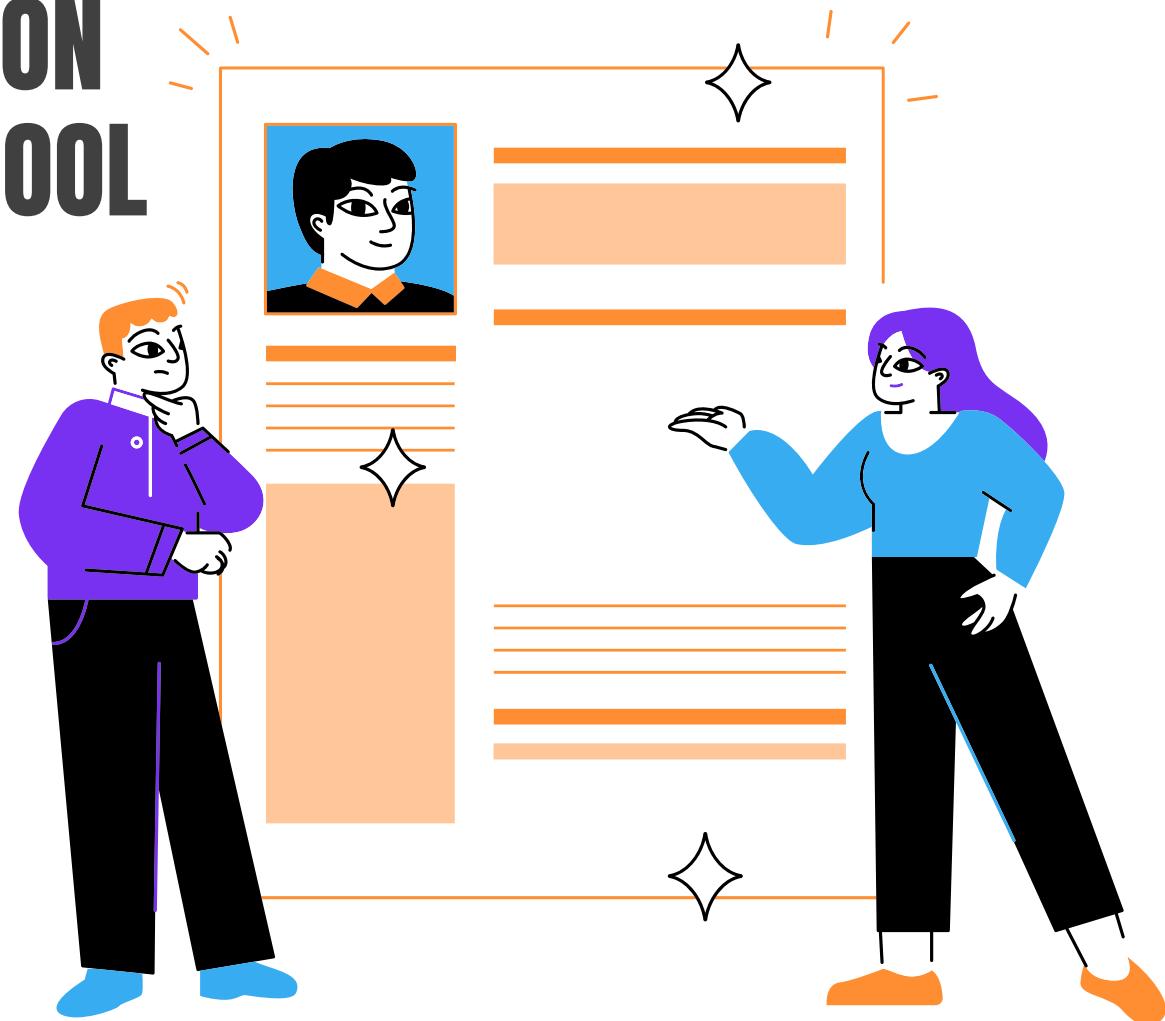
MESUT KAYA

Postdoc @AAU

mkaya@ikp.aau.dk



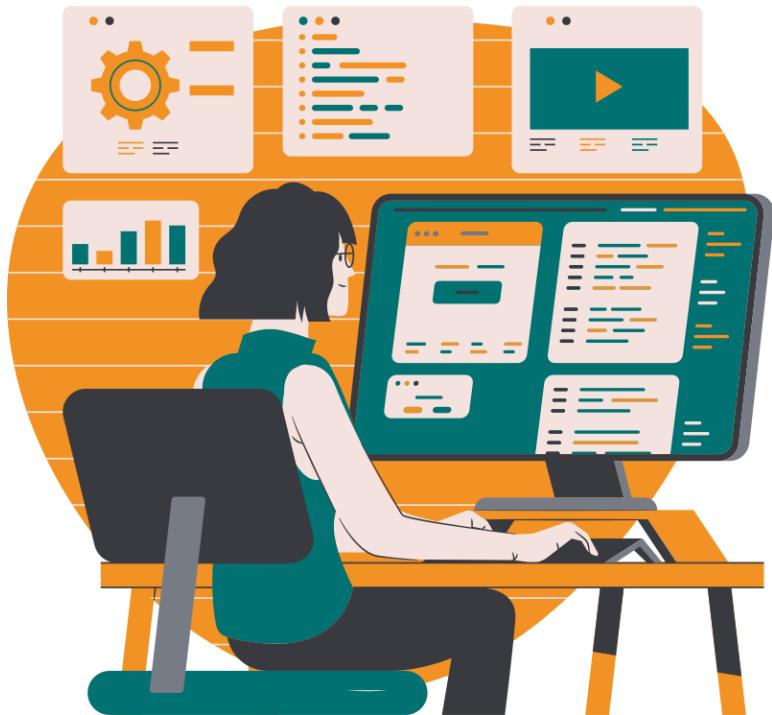
@kayaa_mesutt





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

OVERVIEW



Introduction to Job Recommendation Problem

Case Study: JobMatch Project

Understanding Recruiter's Search Behaviour

Talent Recommendation

Evaluating Talent Recommendation Algorithms

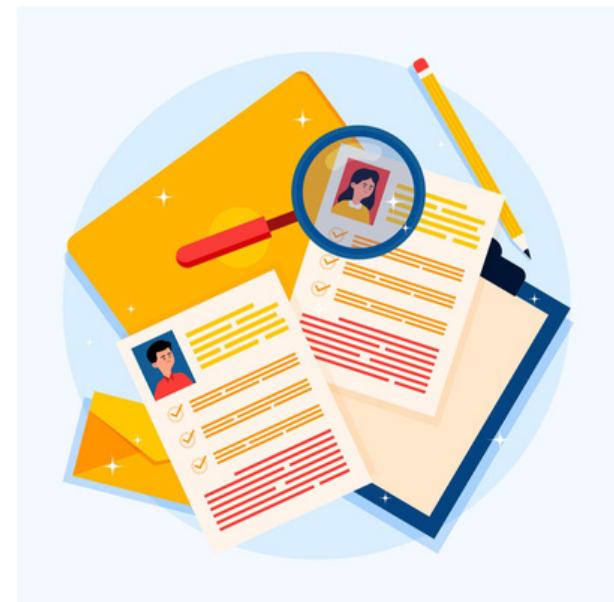
Lessons Learned

JOB RECOMMENDATION

PERSON-JOB FIT



Job opening

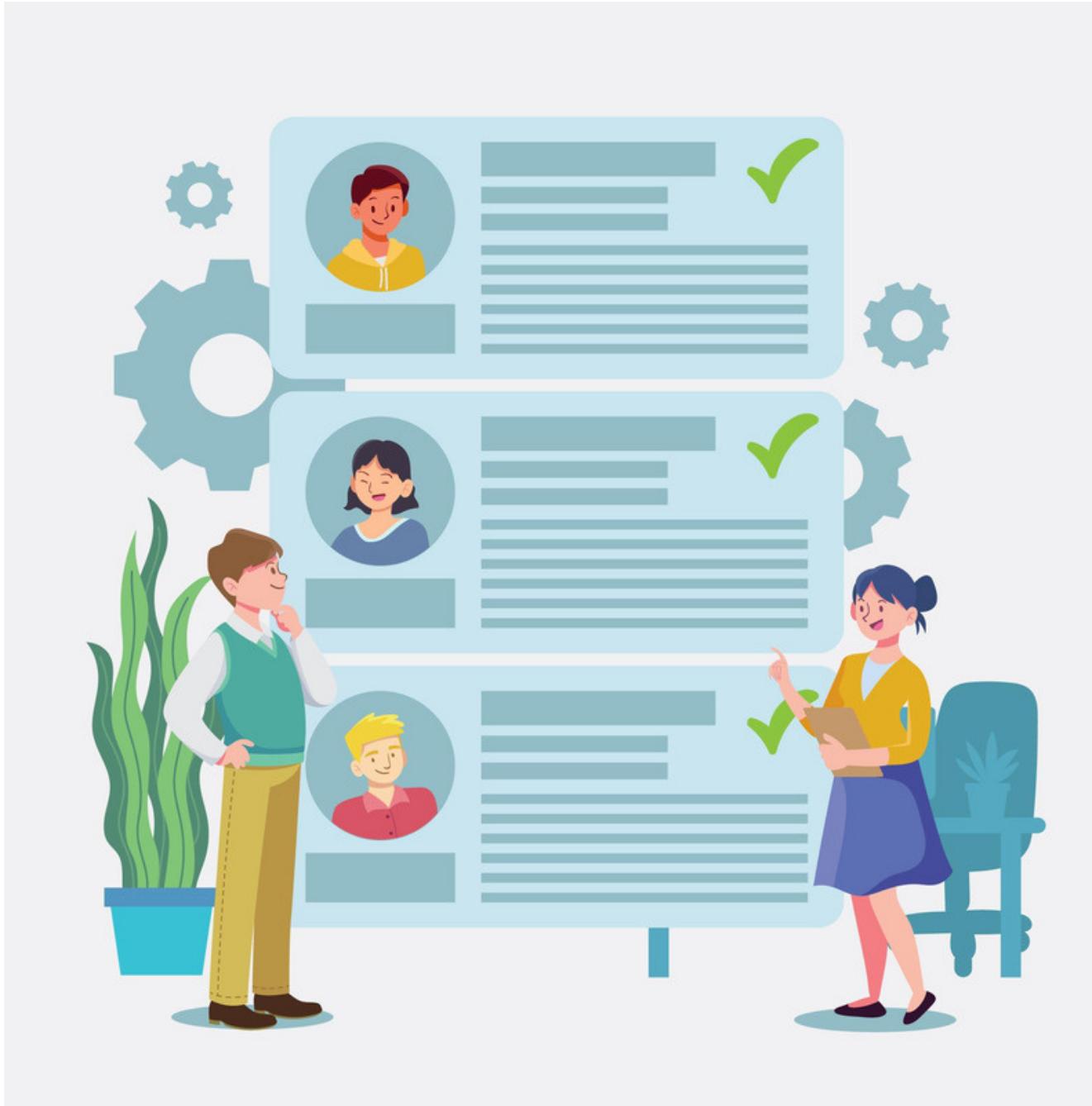


Resume

Recommending relevant jobs to job seekers



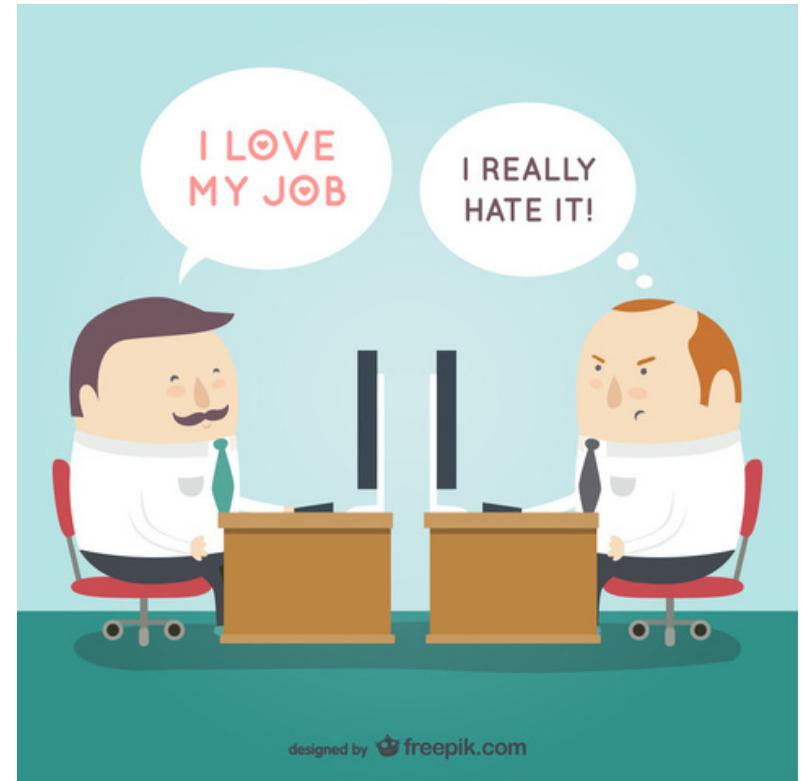
Recommending relevant job seekers to open job positions



Earlier Approaches



Collaborative Filtering



Content-based

Representation Learning



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

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Textual data source

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

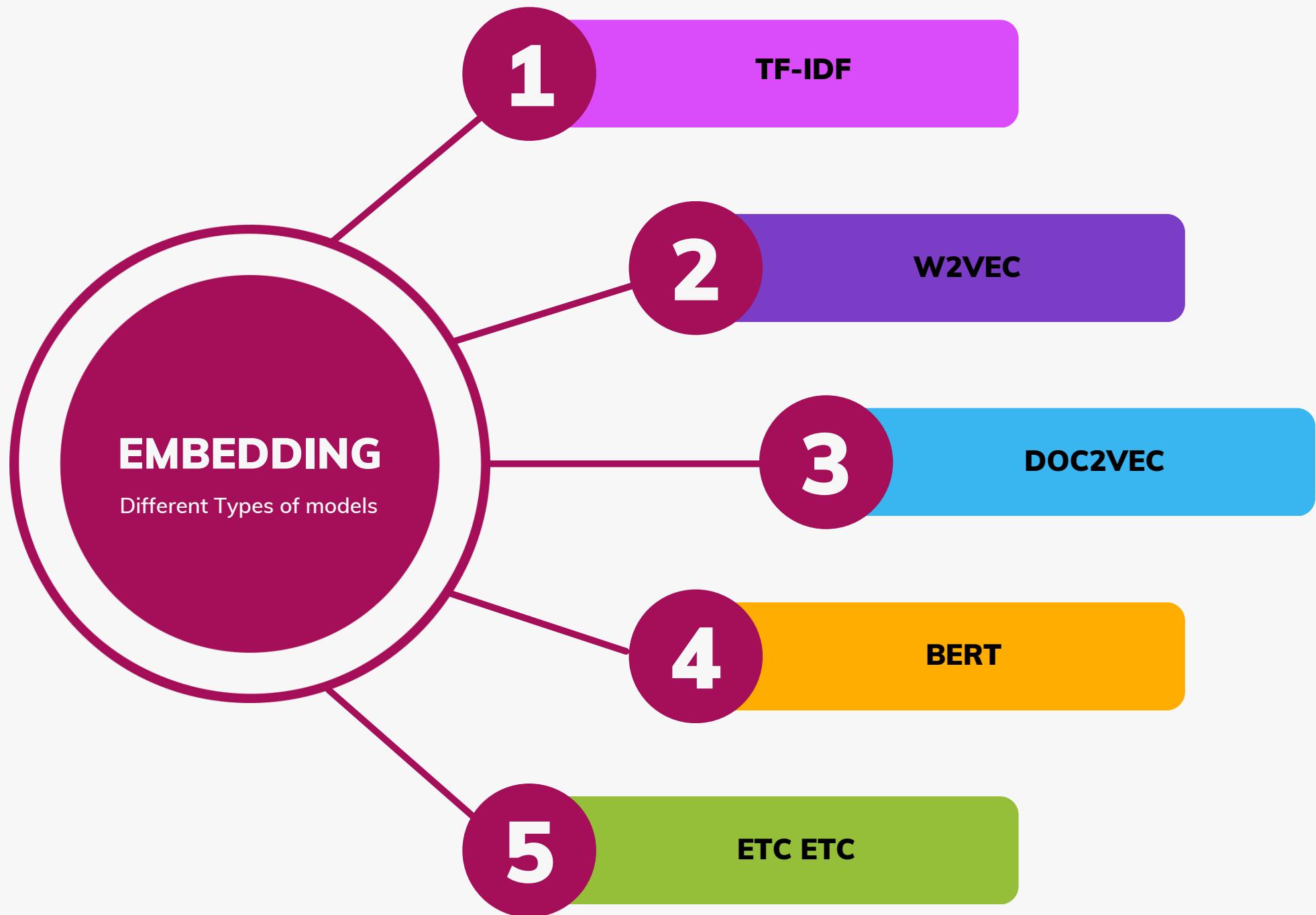
$h_i = \{\vec{d}_{u1}, \vec{d}_{u2}, \dots, \vec{d}_{ul}\}$

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

Management experience (years)

5

Salary expectations

40,000 kr. 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](#)

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](#) 

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) –

Salary expectations: DKK 40-50,000

HD 2. Supply Chain Management ([REDACTED])

Conditions of employment: Full-time and temp

Work experience: 24 years

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

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]

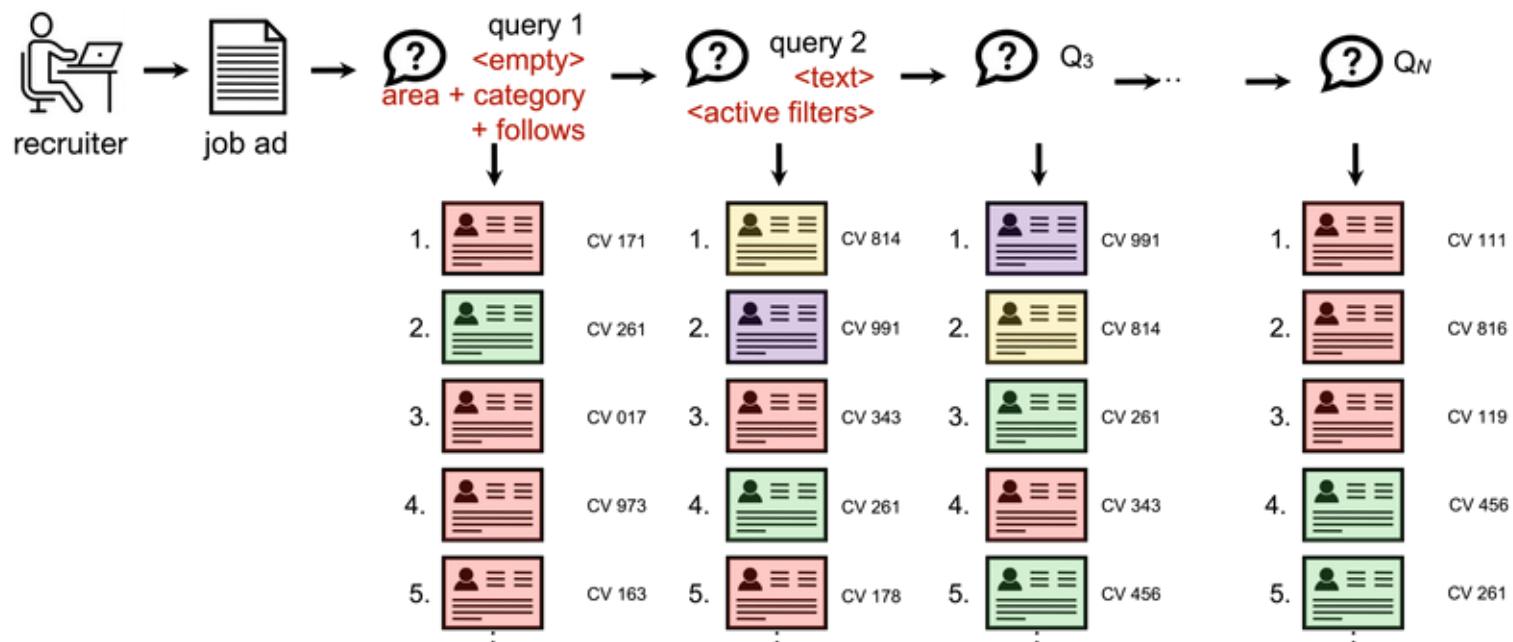
Salary expectations: DKK 50-60,000

Work experience: 10 years

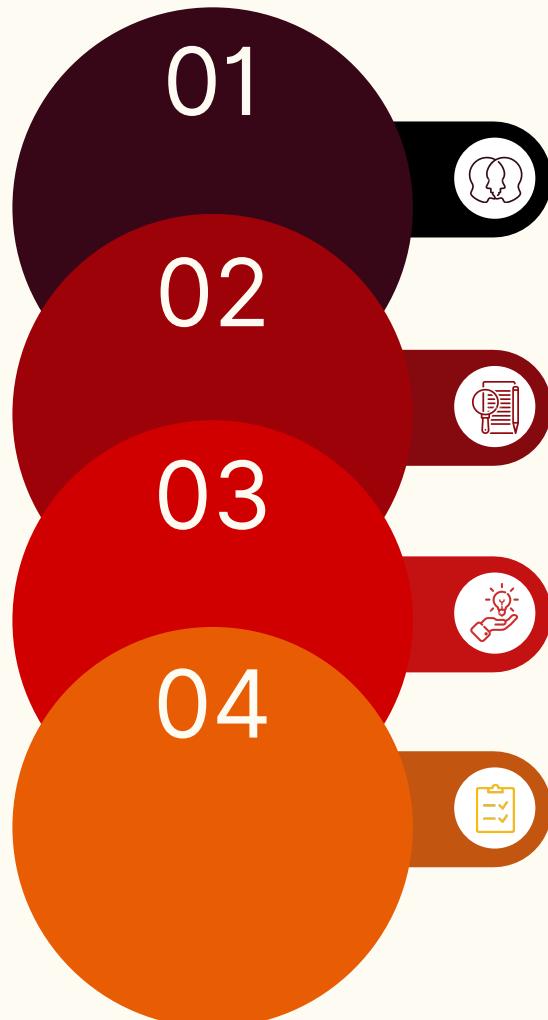
Conditions of employment: Full-time

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



JOB OFFER

Initial Analysis of job posting



DESCRIPTION OF COMPANY

If the recruiter is unfamiliar with the organization, the first thing is go through it



IDENTIFY RELEVANT INFORMATION

identify the **job title** as well as the **knowledge, skills** and **abilities** the ideal candidate is required to have



ESSENTIAL VS USEFUL REQUIREMENTS

use their recruiting experience to further distinguish between **essential** and **useful** requirements



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

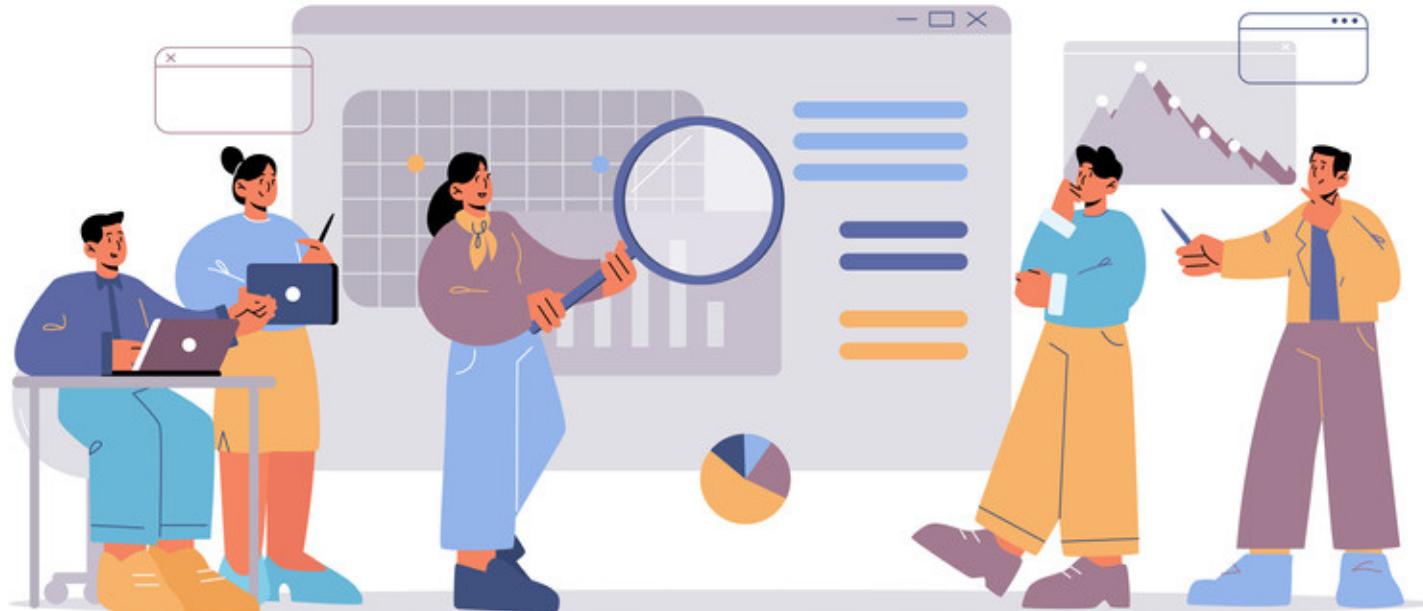
LOCATION

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

OTHER INFORMATION

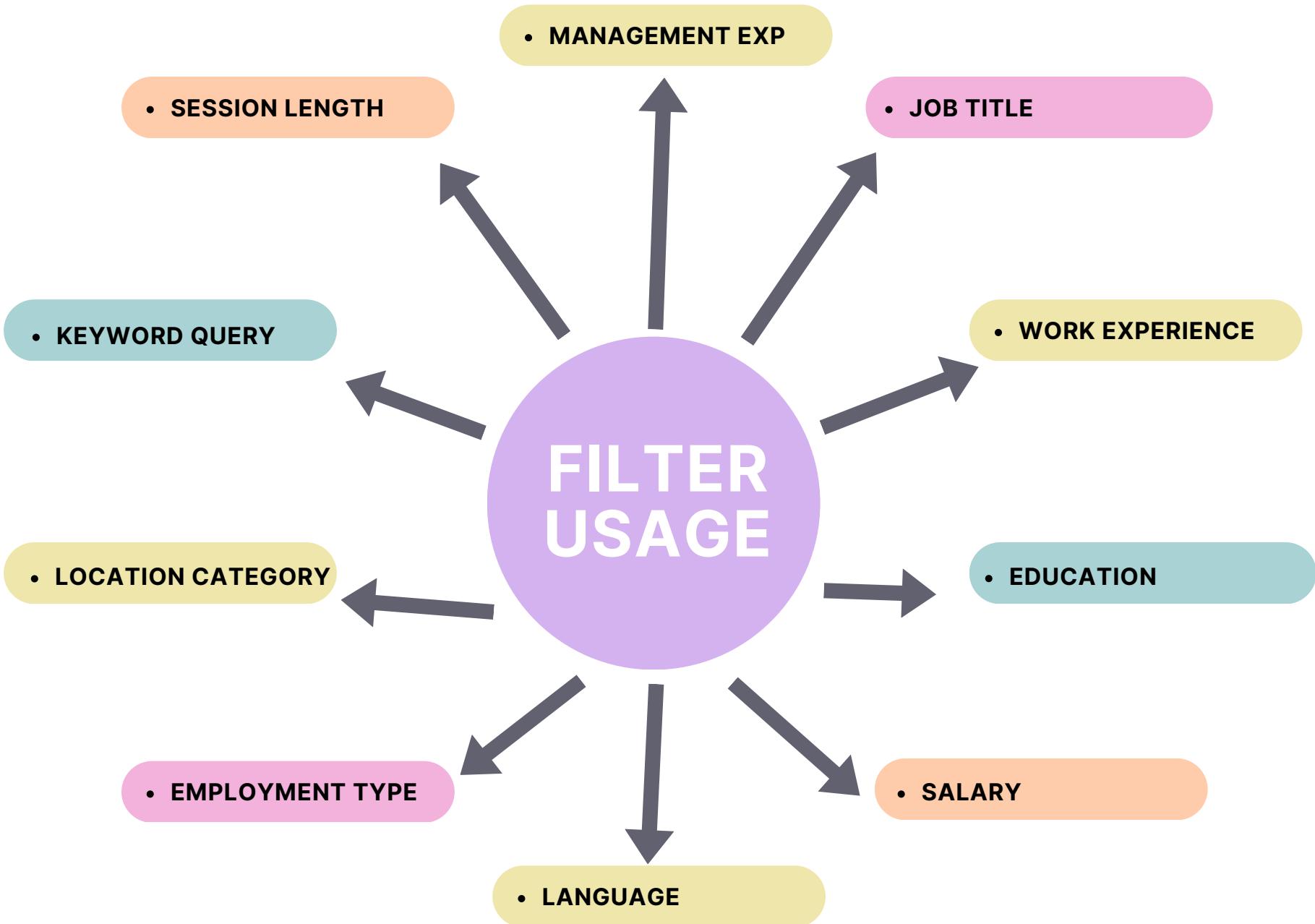
When necessary, participants would check unstructured personal CVs that are included as PDFs, although this was not common due to this taking more time to assess

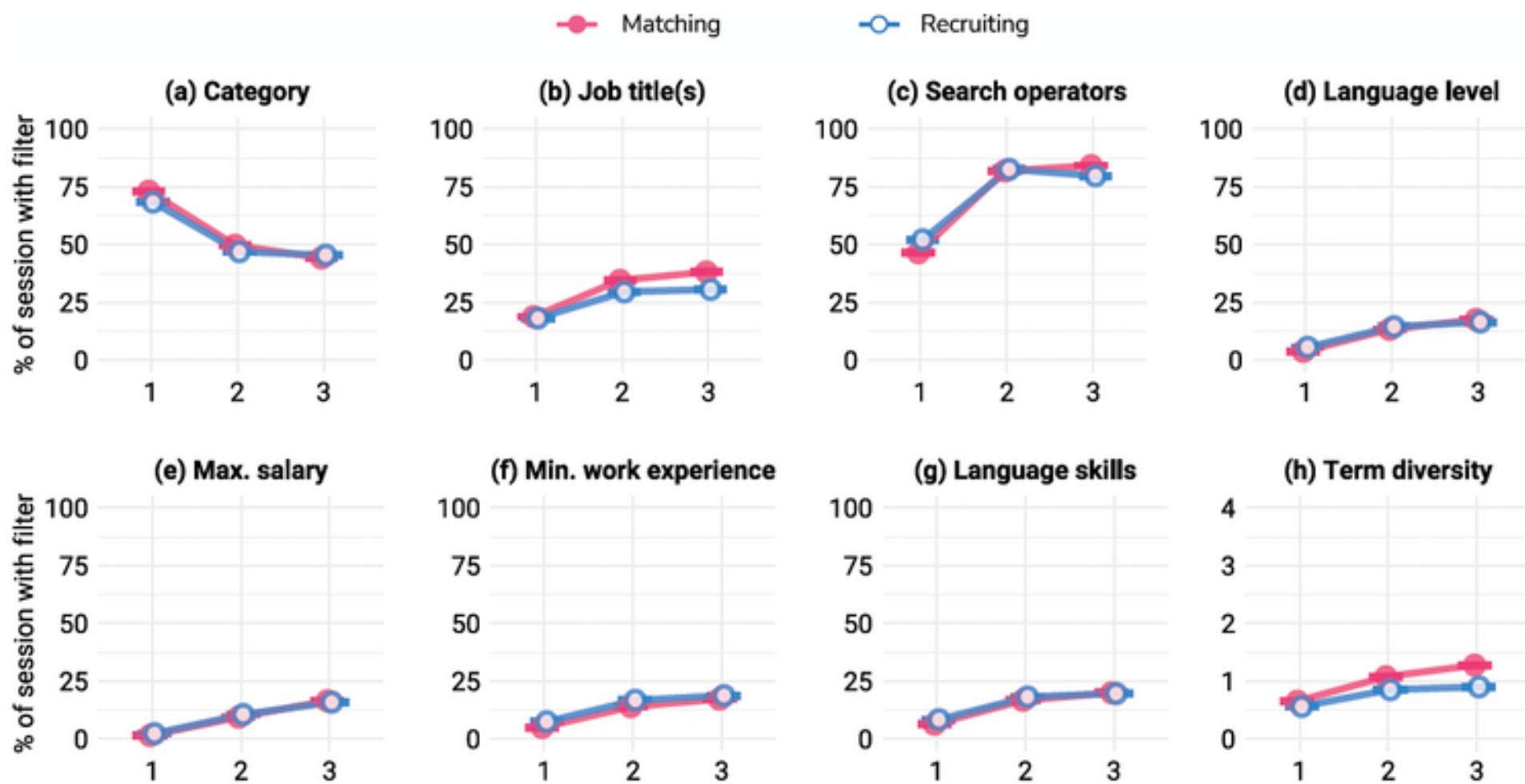
Search Log Analysis



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

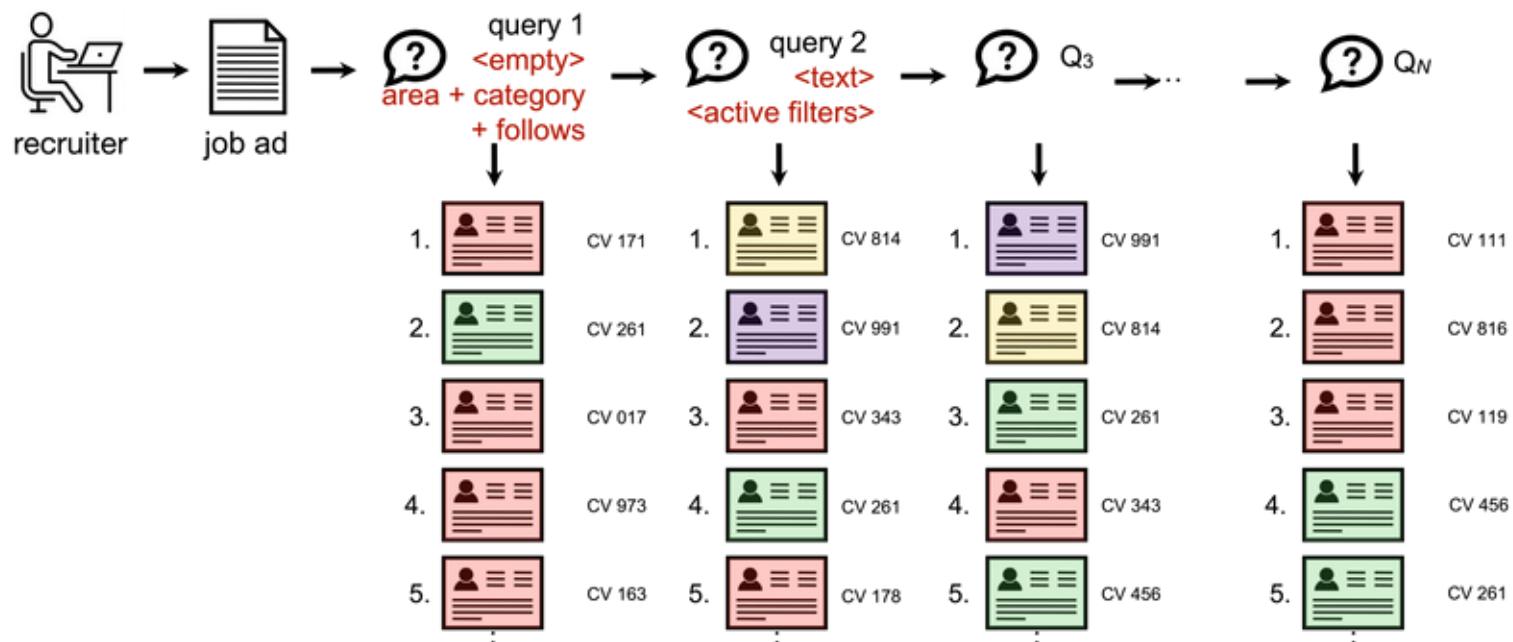
in the early stages recruiters learn from the job posting which **requirements, skills** and **abilities** relevant candidates are required to possess.

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

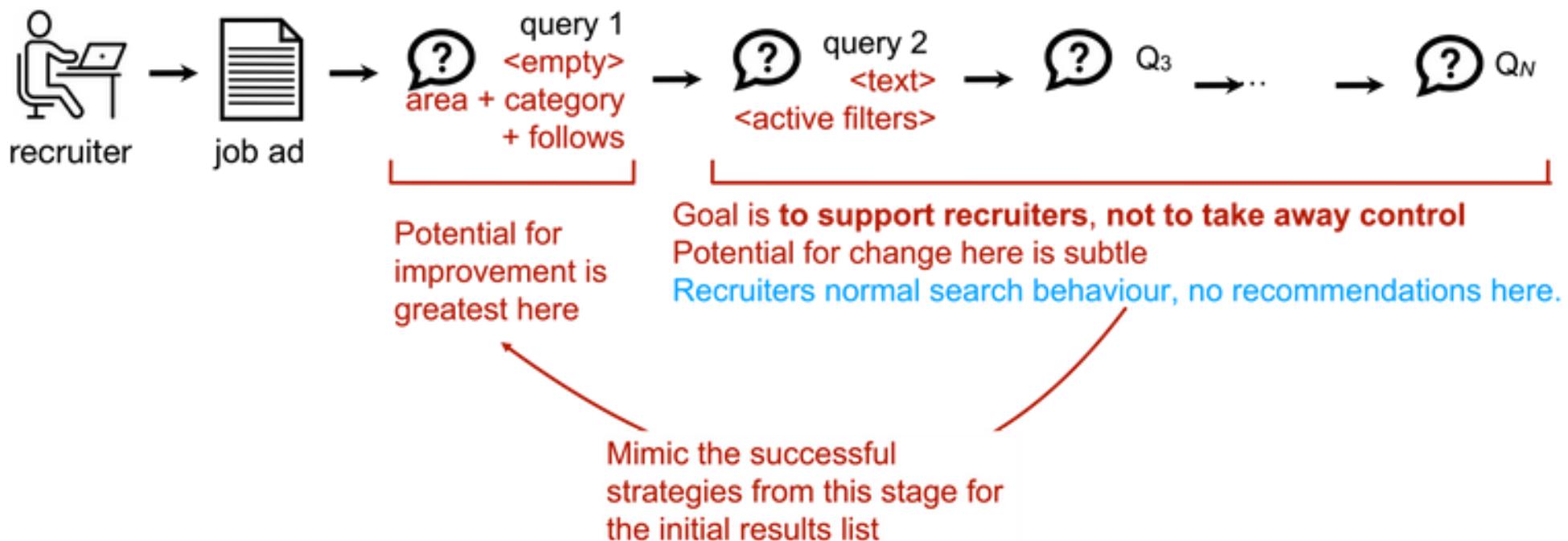
for each new job posting, recruiters gradually learn how to search more effectively as their search session progresses, something confirmed by our earlier work



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.



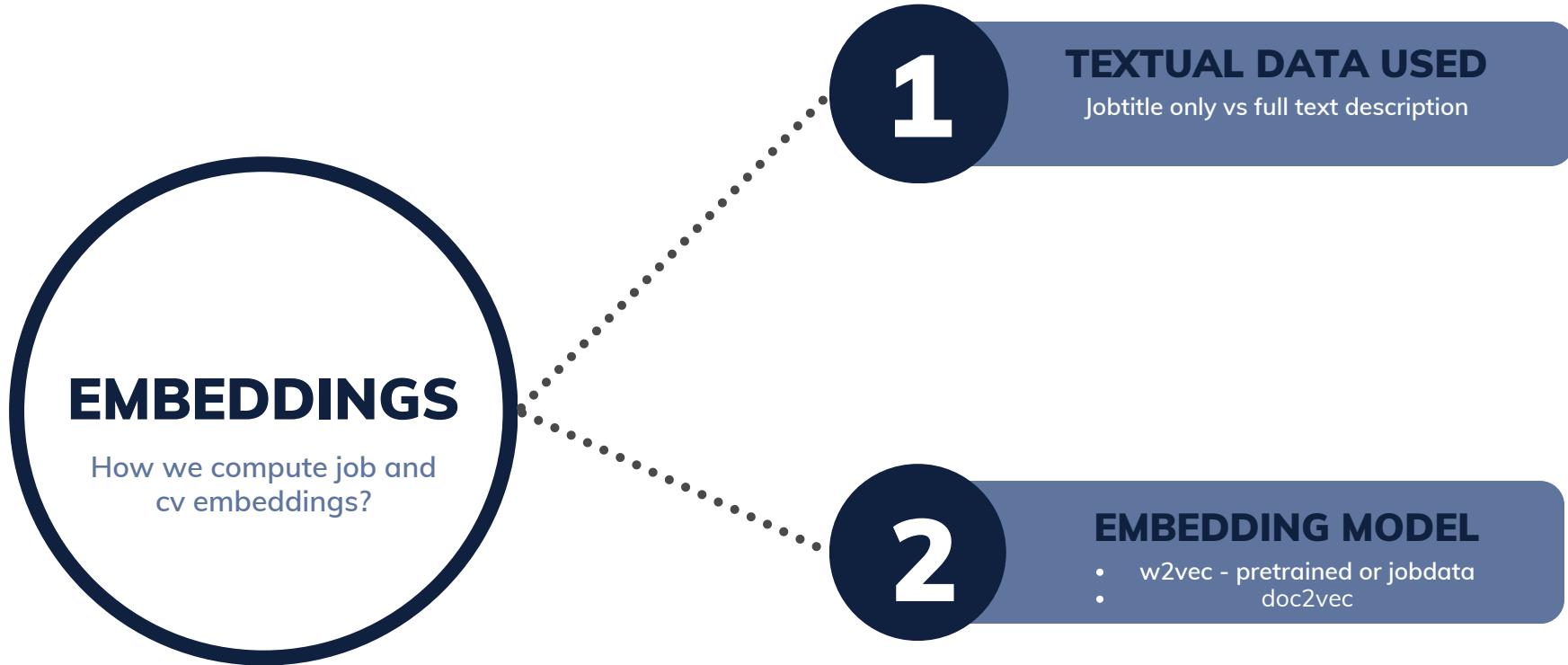
$d = \{t_1, t_2, \dots, t_m\}$

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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

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

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Interaction data

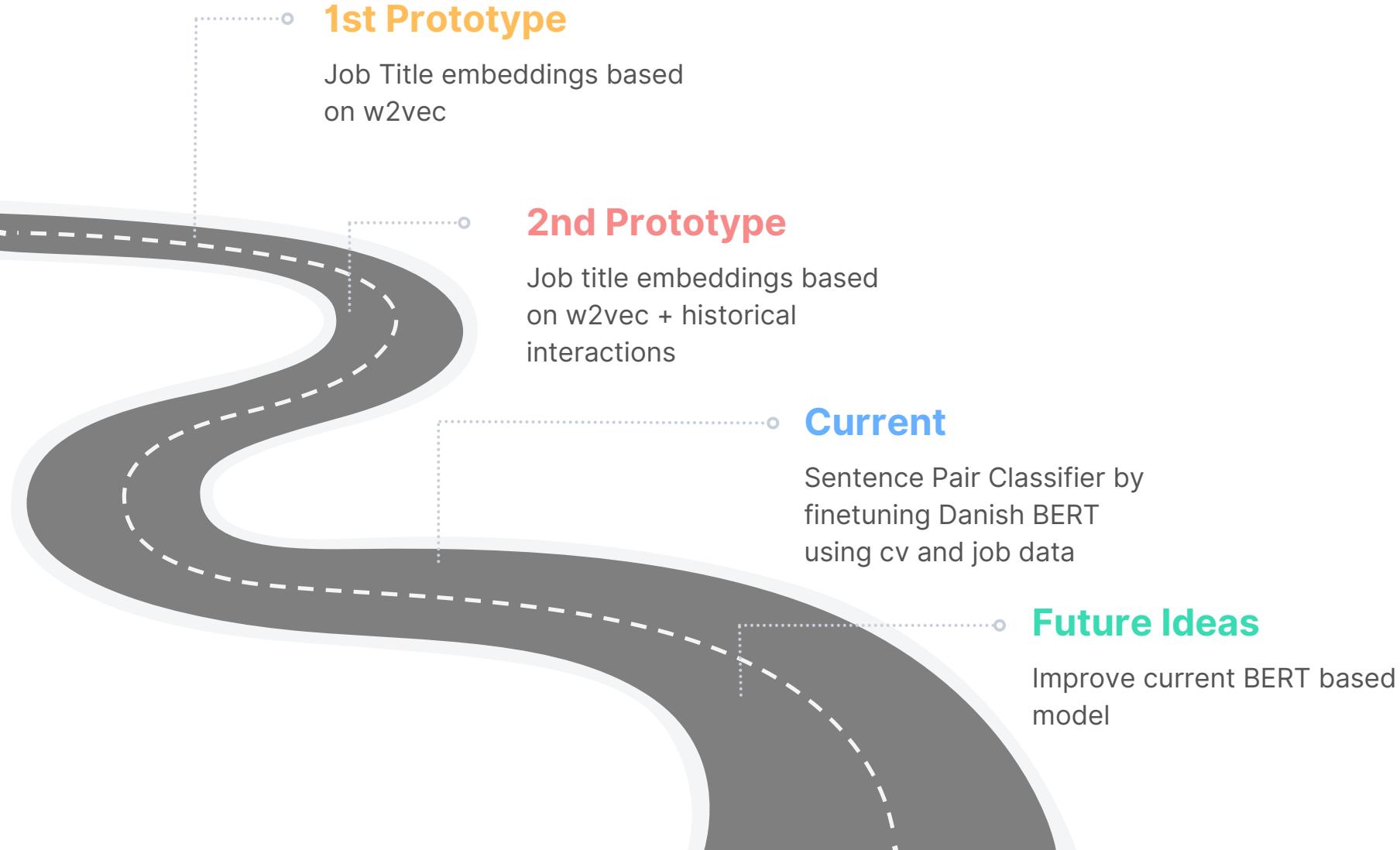
Embedding Model



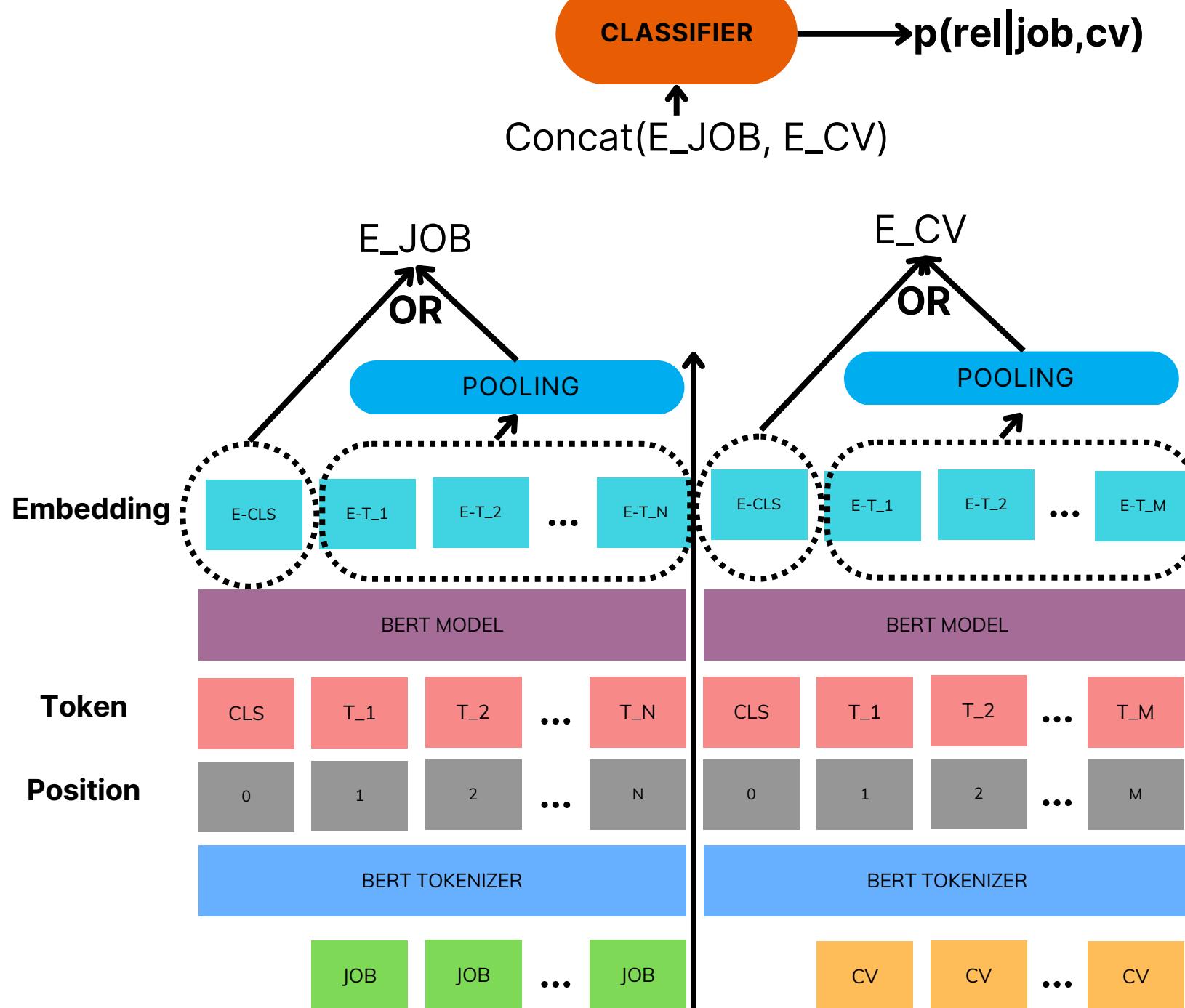
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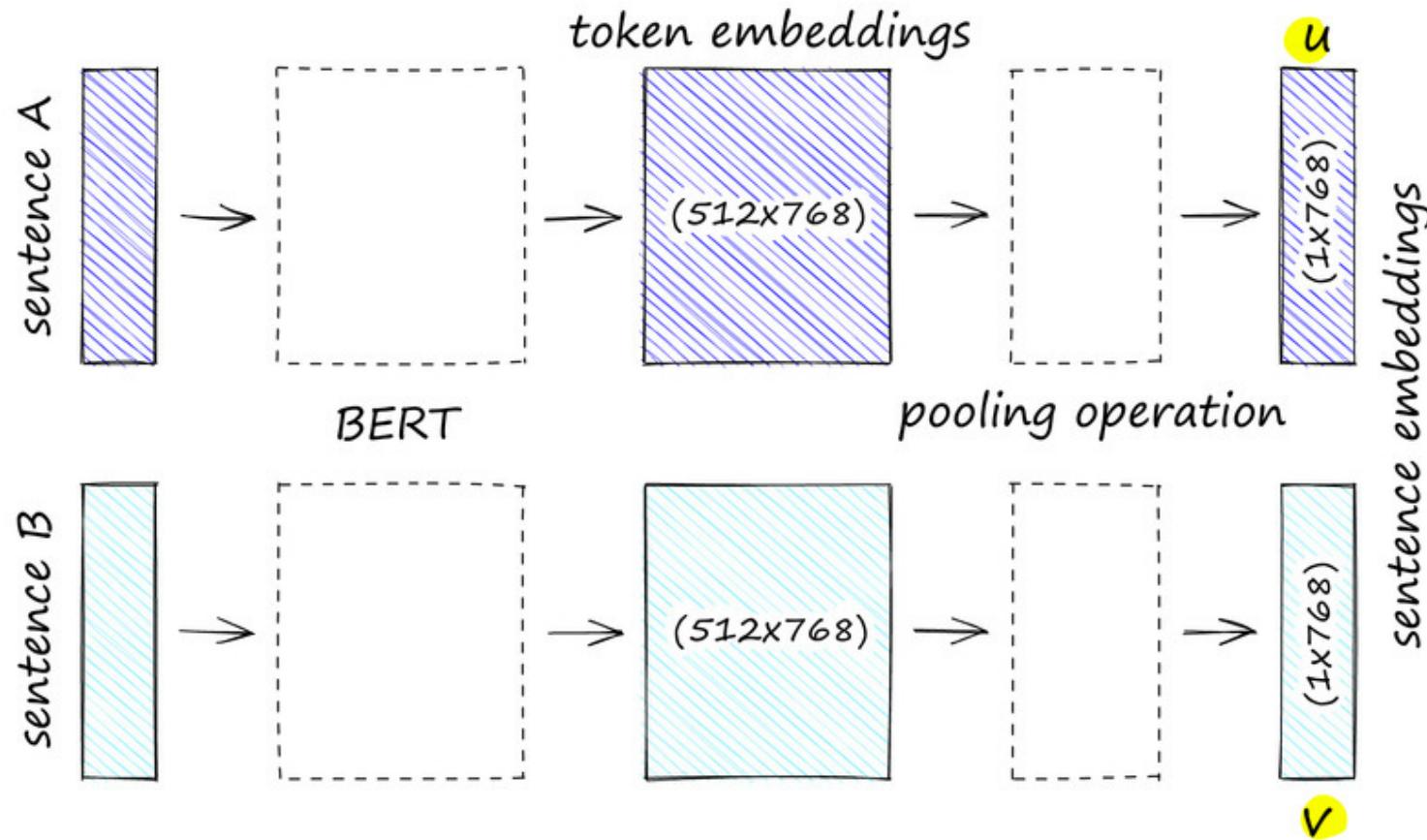
KEEP VECTORS ON FAISS and PERFORM VECTOR SEARCH

Recommender Prototype Process



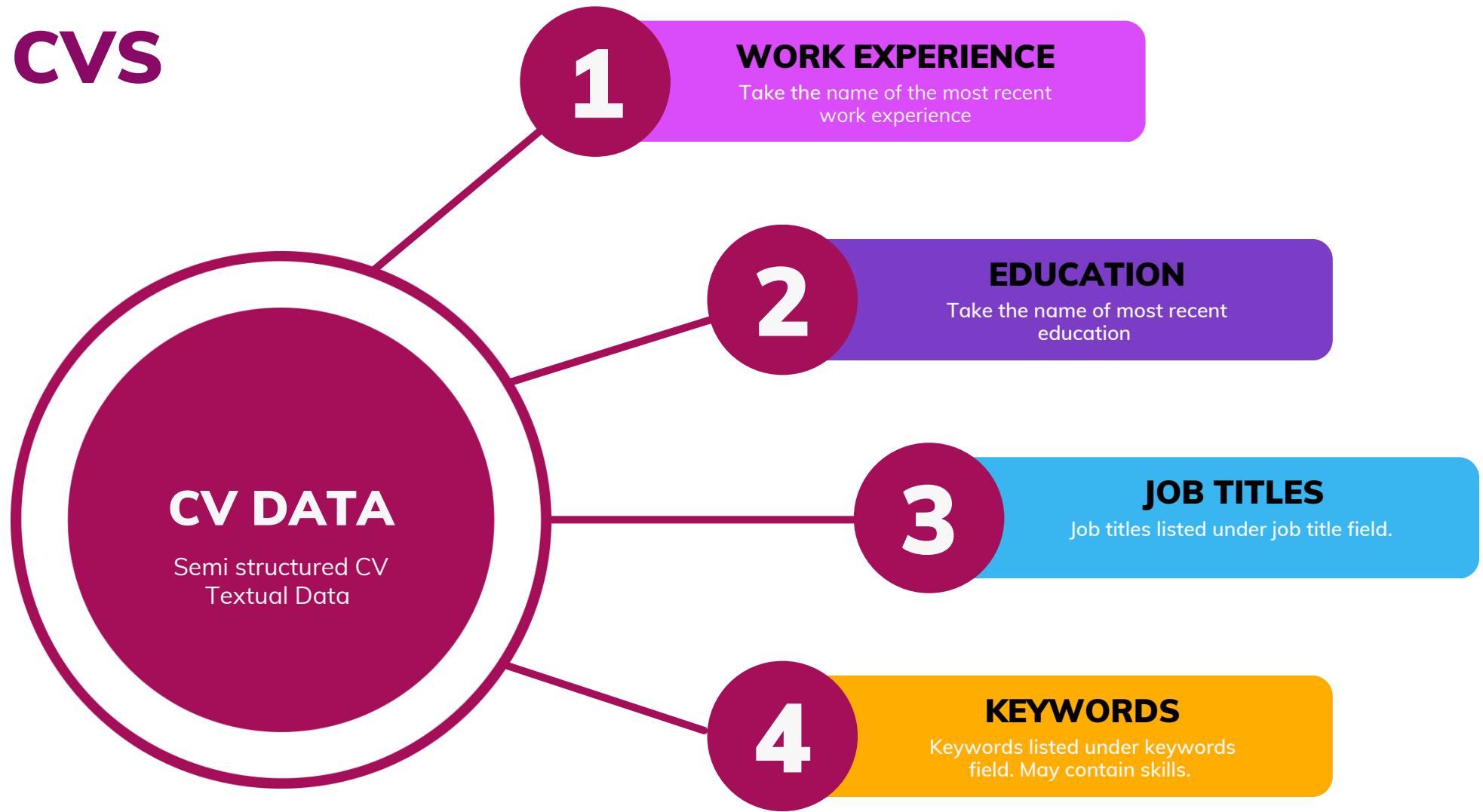
Sentence-BERT for Job Cv Match



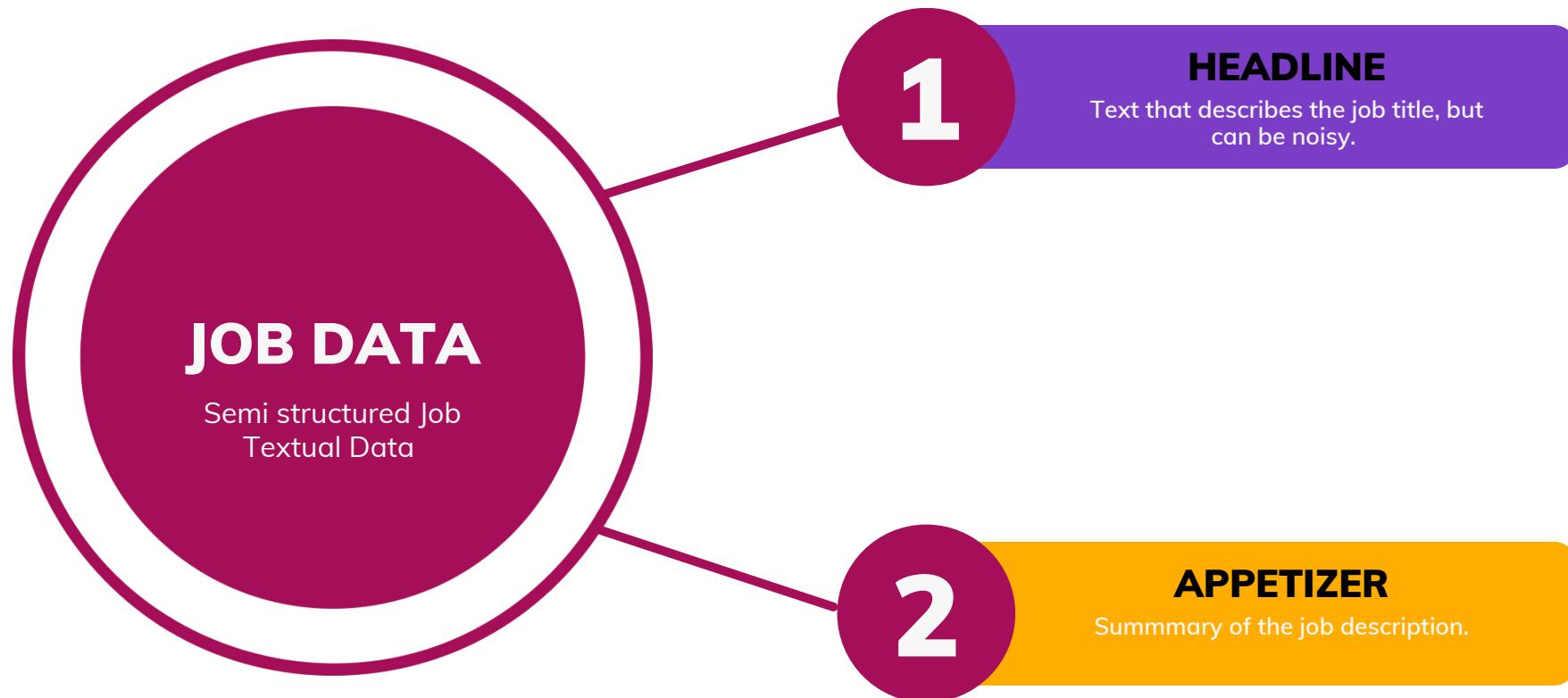


link: <https://www.pinecone.io/learn/sentence-embeddings/>

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.

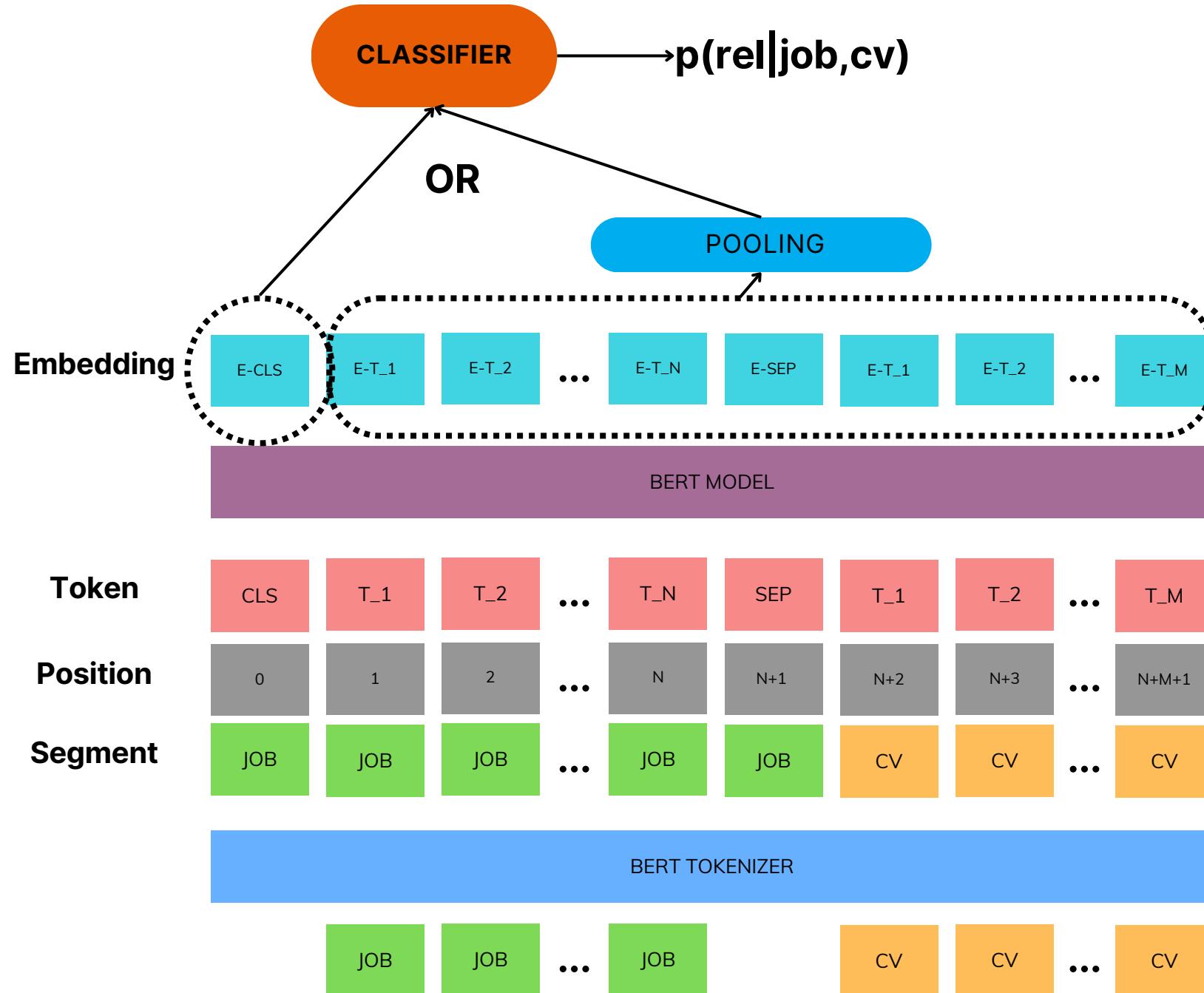
YES

I am going outside.

You know nothing John Snow.

NO

Sentence Pair Classification for Job Cv Match



SBERT vs SPBERT

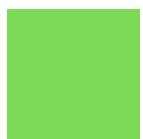
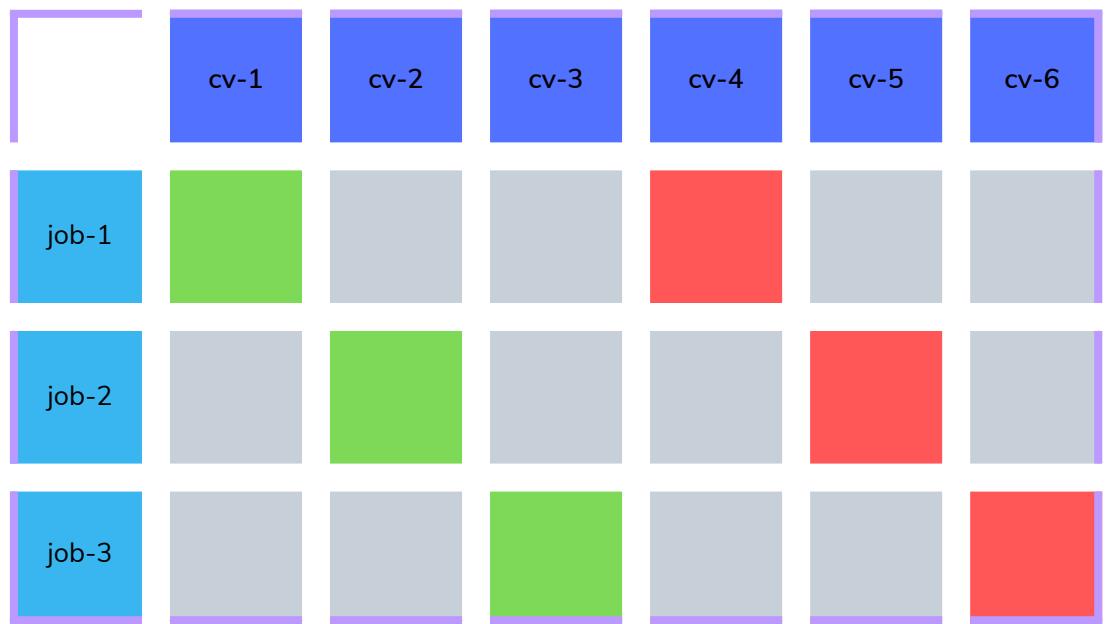
SBERT

- 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.

Negative Sampling



relevant (job, cv) pair
positive sample

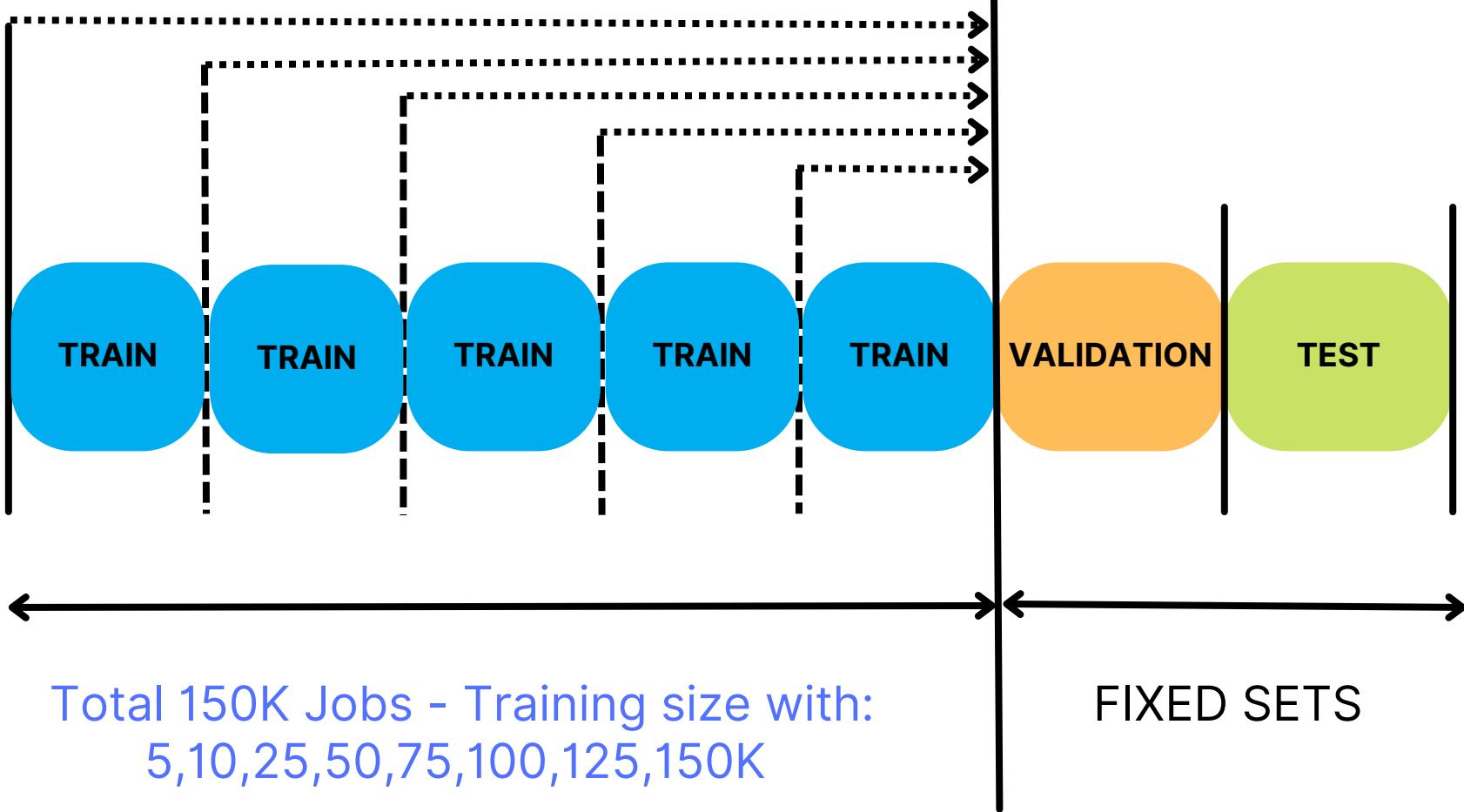


irrelevant (job, cv) pair
hard negative sample

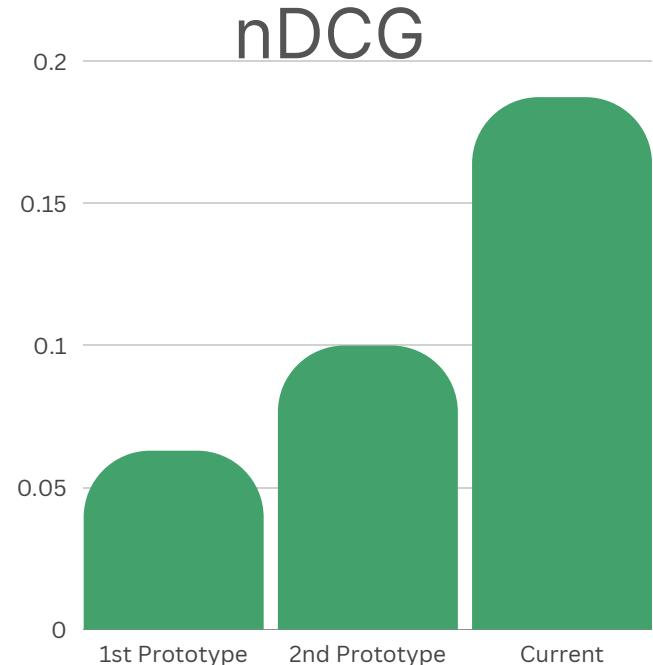
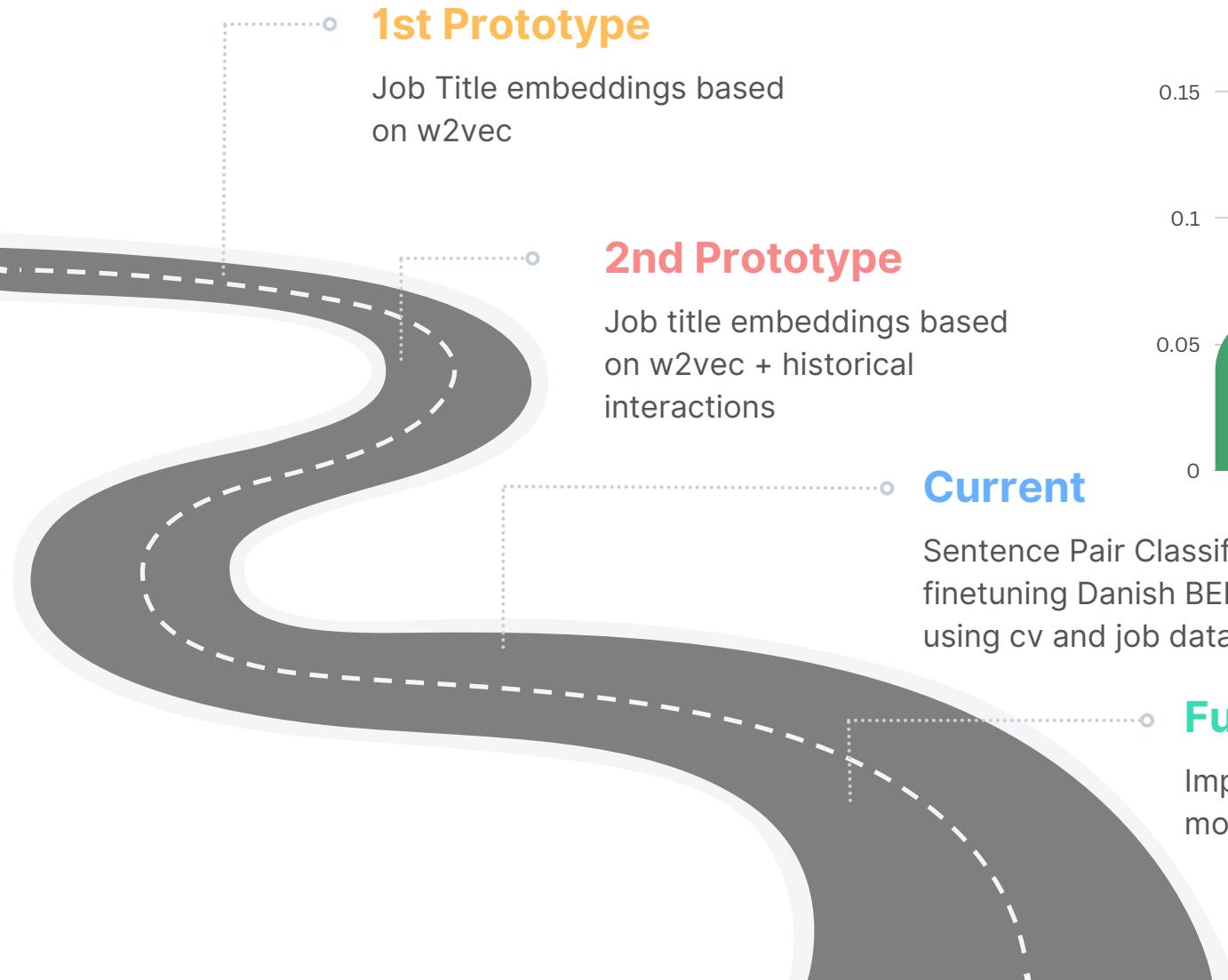


irrelevant (job, cv) pair
random negative sample

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



Recommender Prototype Process

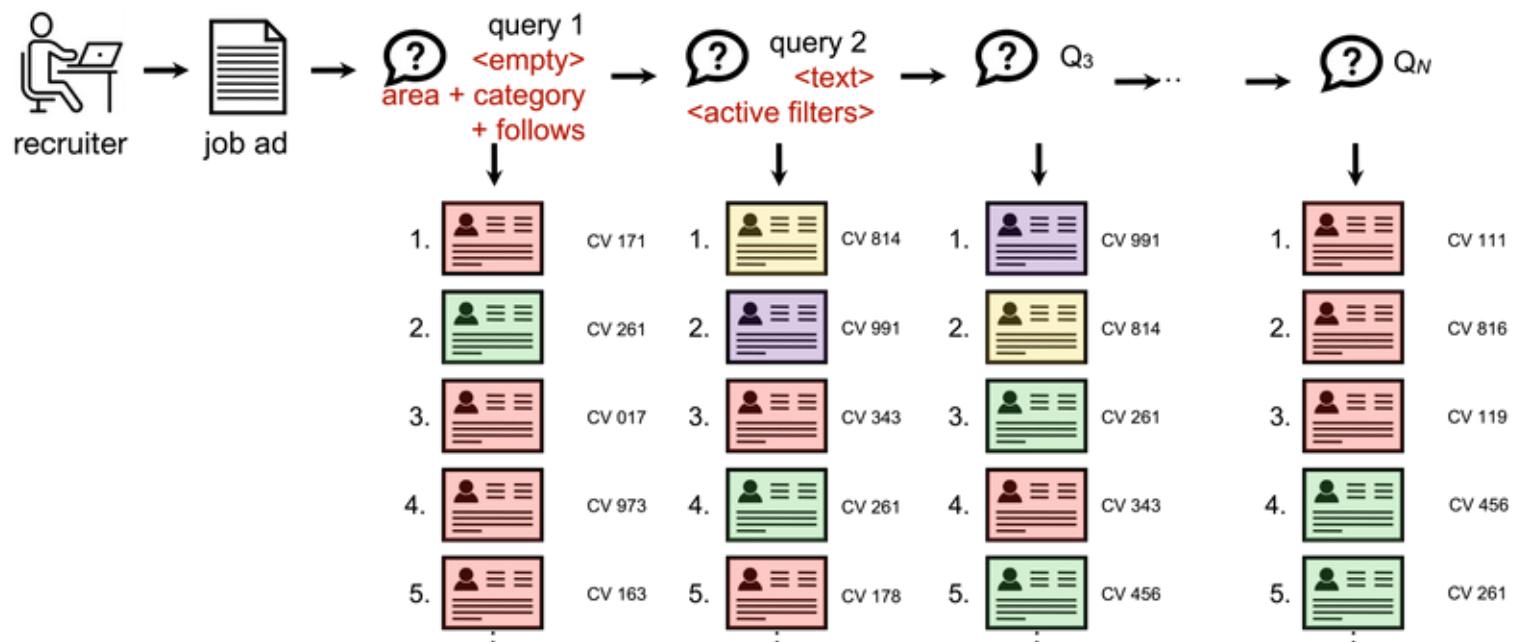


Online Experiment Results

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

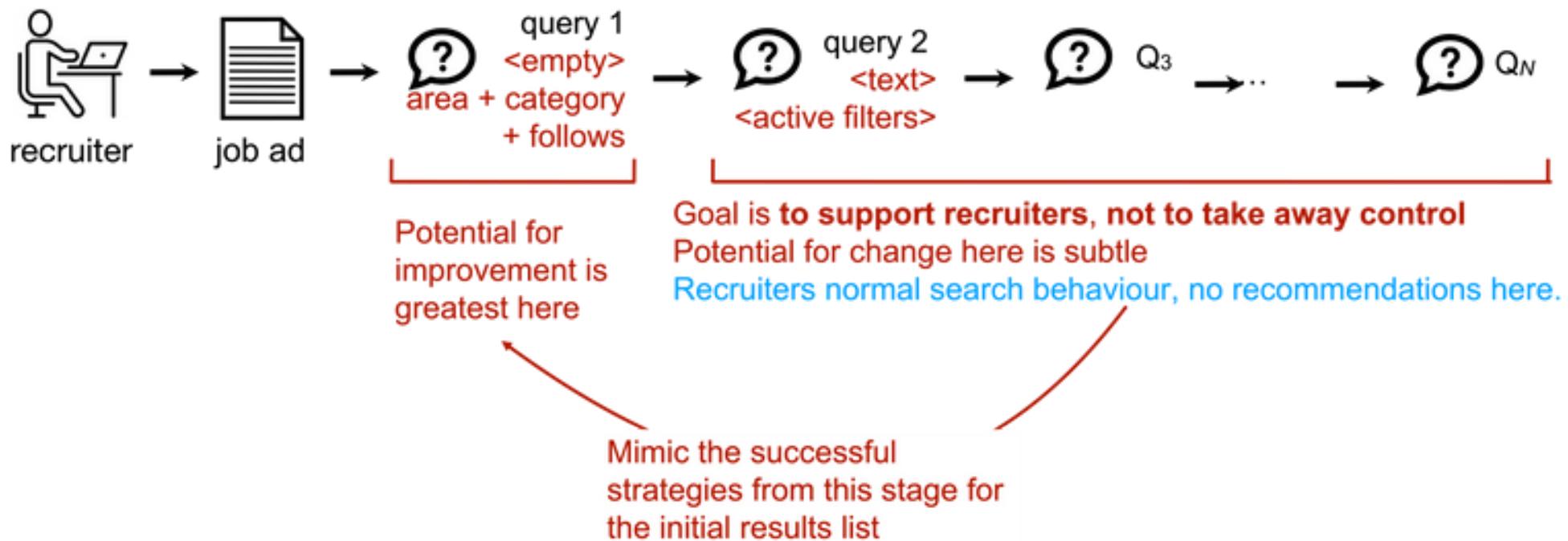
PRR: Positive Response Rate

CFR: Contacted From Recommendations

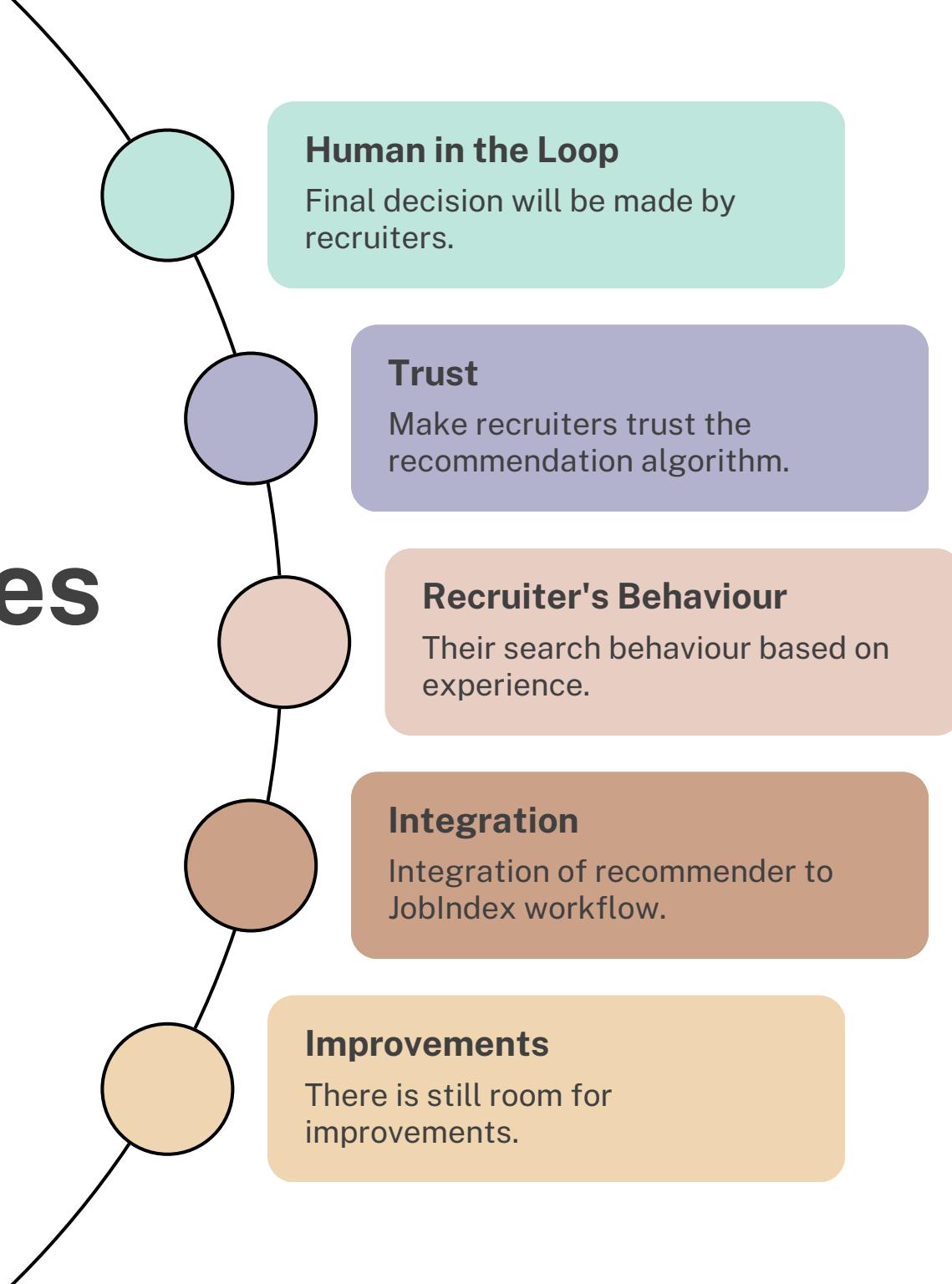


Recommendations

What are we trying to improve?



Challenges





mkaya@ikp.aau.dk



@kayaa_mesutt

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