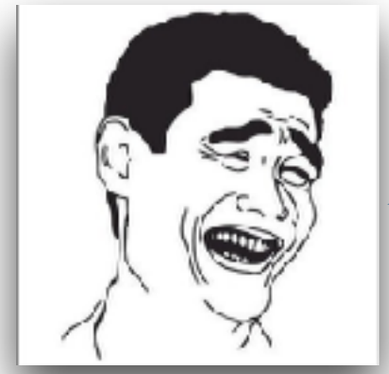
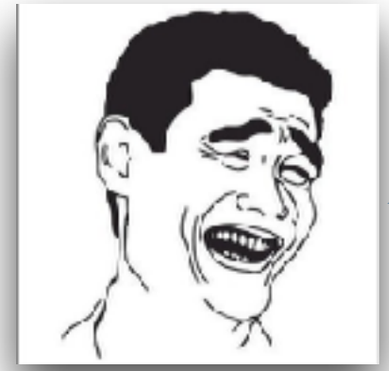
Learning to Rank Overview

Introduction of machine learning algorithms for ranking problem



I want top php engineers



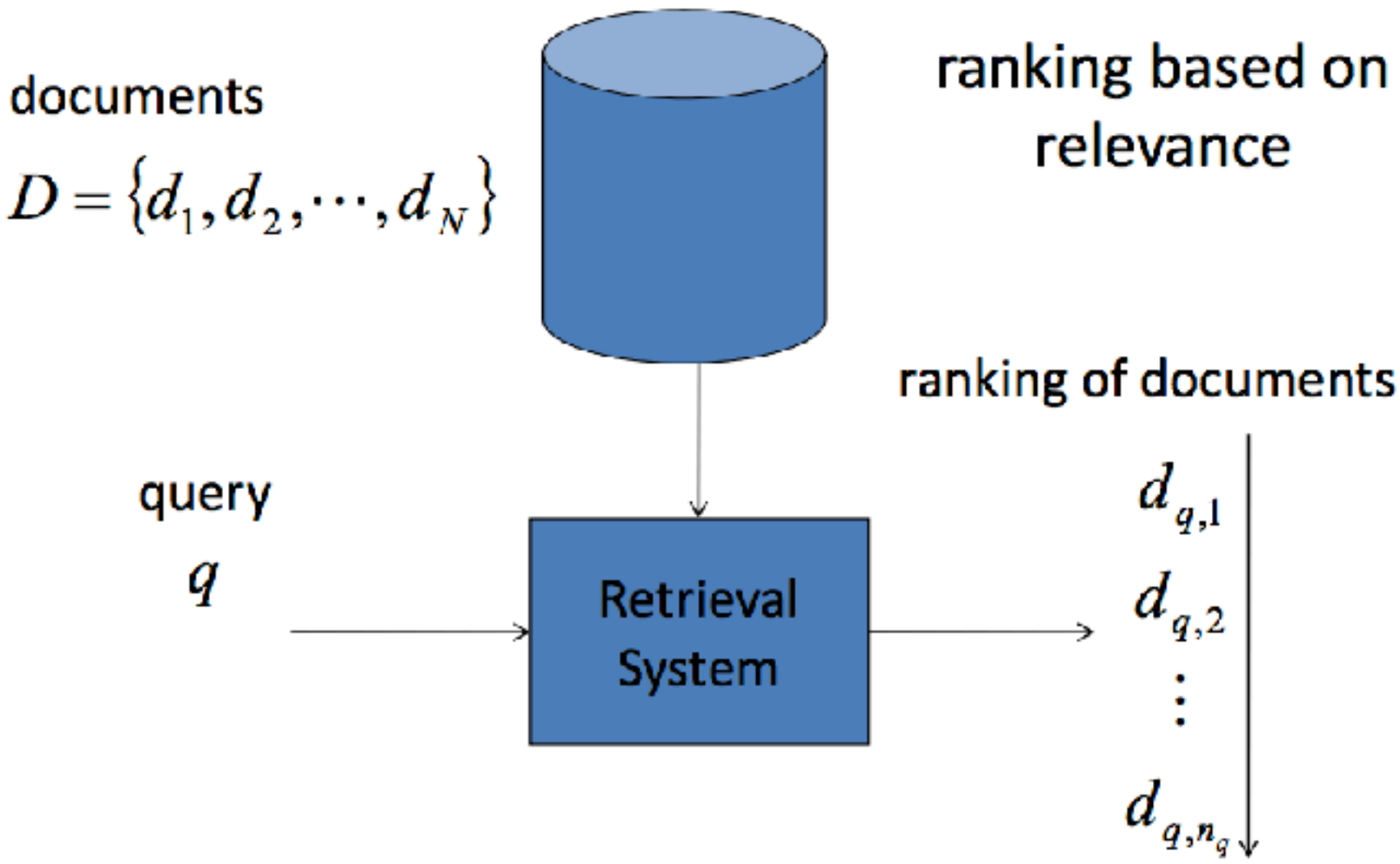
I want top php engineers

How to decide an order for these developers?

Ranking Everywhere

- Article ranking in community search page
- Article Infinite Scroll
  - Once the article opened, how to decide next 10 articles we recommend
- Applicant Quality Score
  - How to select top quality applicants to review first
- Codementor Request Matching
- …

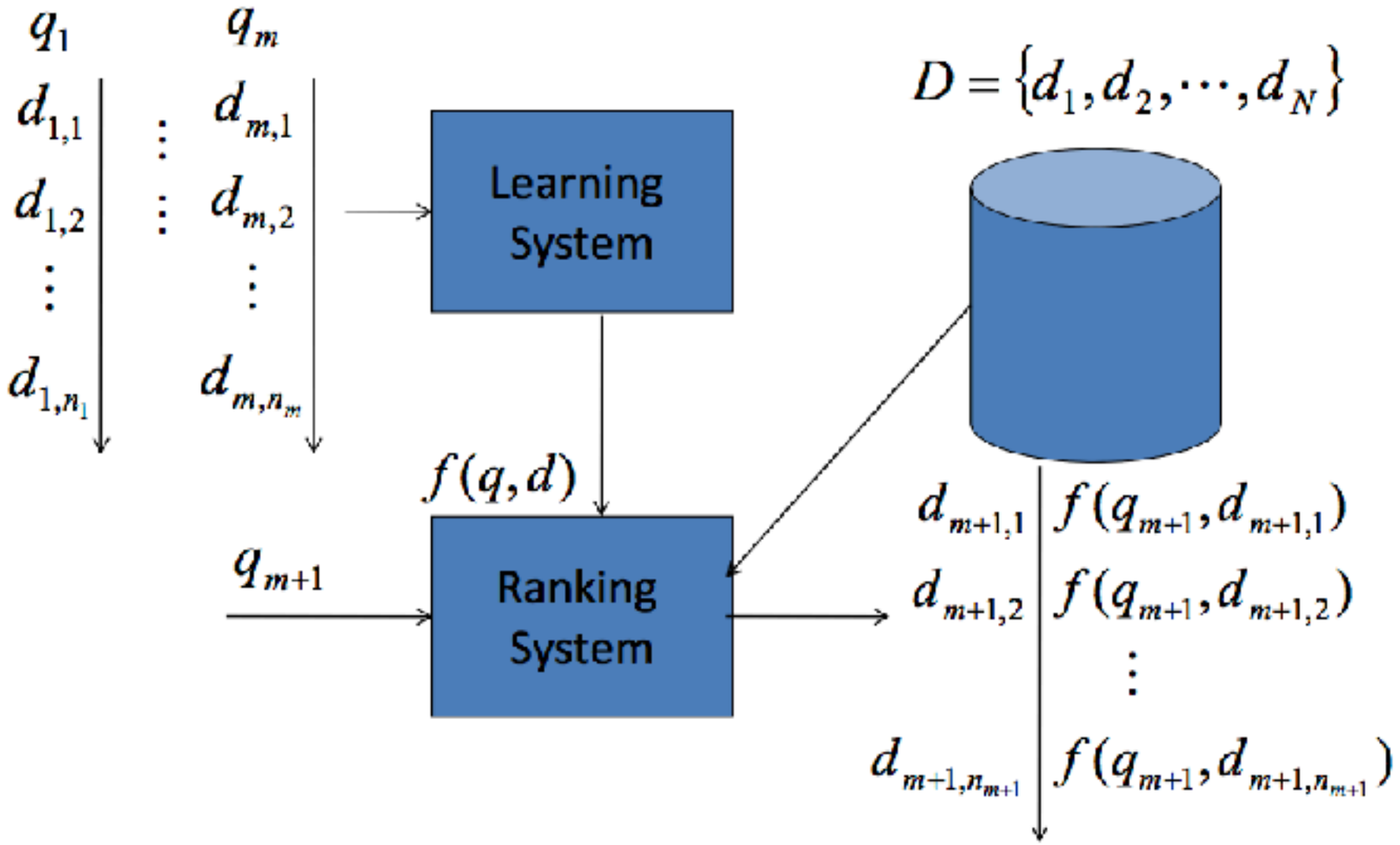
Native Ranking System



Native Ranking Methods

- The ranking expression is human experience
  - Need many time to tuning models
  - Hard to scale out if number of features increases
  - Overfitting problem
- Is it possible to use machine learning to solve ranking problem?

Learning to Rank System



Supervised Methods

Methods
Pointwise Approach

5

1

5

4

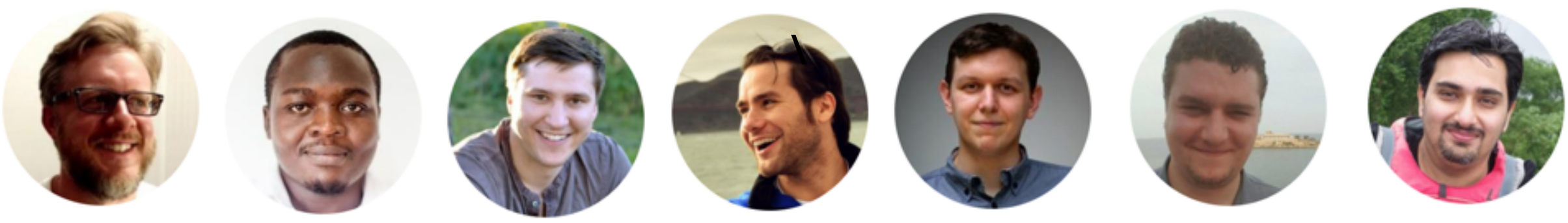
3

2

2

Methods
Pointwise Approach

5 5 4 3 2 2 1



Top

Low

Methods
Pointwise Approach

- Model Complexity: O(|q|*n_q)
  - |q|: number of queries
    - n_q: number of matched documents of query q
- Algorithms
  - SVM, McRank, SLR …

Methods
Pointwise Approach

- Pros
  - Easy and intuitive to implement
  - Fast modeling
- Cons
  - Cannot consider ordering
  - Labeling is hard

Methods
Pairwise Approach



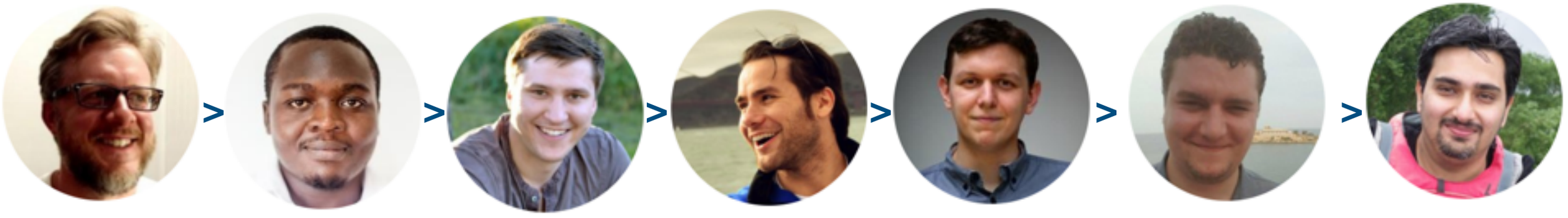









Methods
Pairwise Approach



Top

Low

Methods
Pairwise Approach

- Model Complexity: O(|q| * n^2)

- Algorithms

  - RankNet, IR-SVM, RankBoost

Methods
Pairwise Approach

- Pros
  - Consider relative order
  - Most popular concept in real world
- Cons
  - Need to generate O(n^2) tags, high cost
  - Not consider the relevance between query and document

Numerical Methods

Methods
Listwise Approach

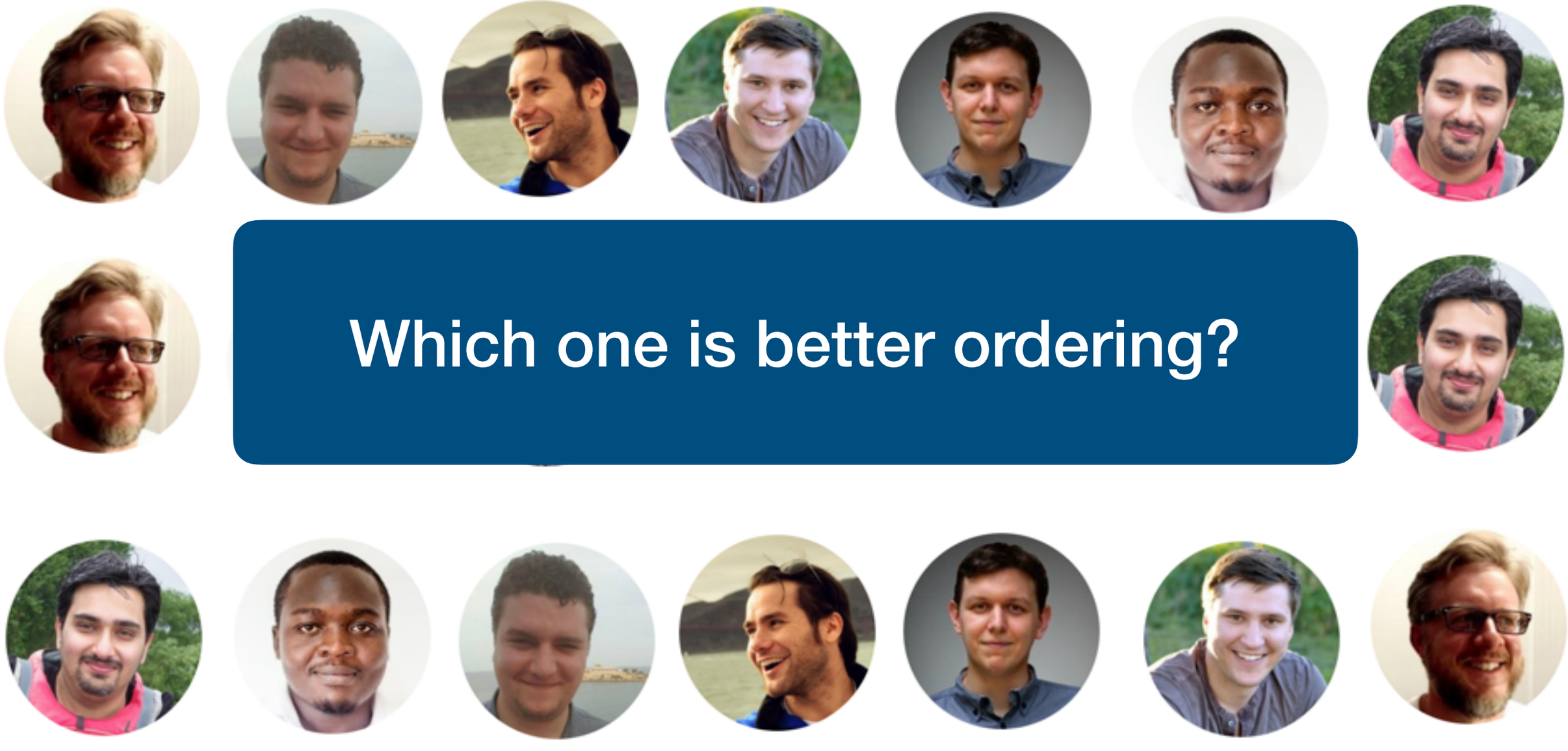
Top

Low

Methods
Listwise Approach

Top

Low



Which one is better ordering?

Methods
Listwise Approach

Best Order

Measure the difference with best orders

One of the orders

Methods
Listwise Approach

- Model Complexity: O(|q| * n!)
  - Many researches focus on reducing model complexity by numerical methods
- Algorithms
  - AdaRank, ListNet, SVM-MAP …

Methods
Listwise Approach

- Pros
  - Consider all situations
  - Based on the origin problem definition
- Cons
  - O(n!) permutations (hard to implement and time bound)
  - Hard to optimize (objective functions not always continuous)

Practical Issues

- What is the objective metrics we pursue?
- How to generate labels?
- Cold-start problem

Objective Metrics

- Based on application
- Search
    - Most page views
    - Click Through Rate (CTR)
- CMX Job match
    - Contract Conversion Rate (CCR)
    - Interview Conversion Rate (ICR)

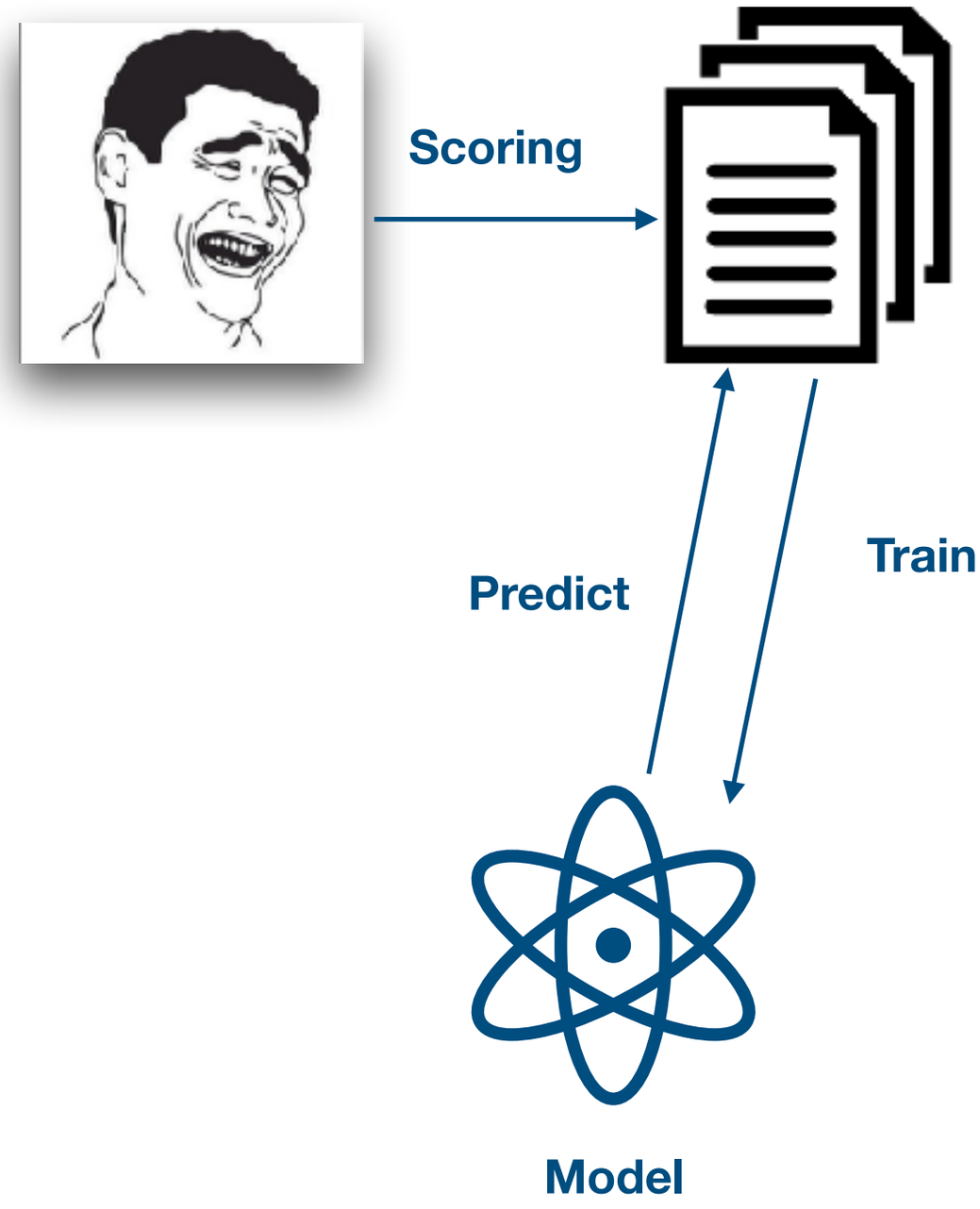
Labeling Problem

- How to label data if we have nothing
  - Small dataset - human labeling is ok
  - Large dataset
    - Semi-supervised learning
    - Matrix factorization

Labeling Problem
Semi-supervised

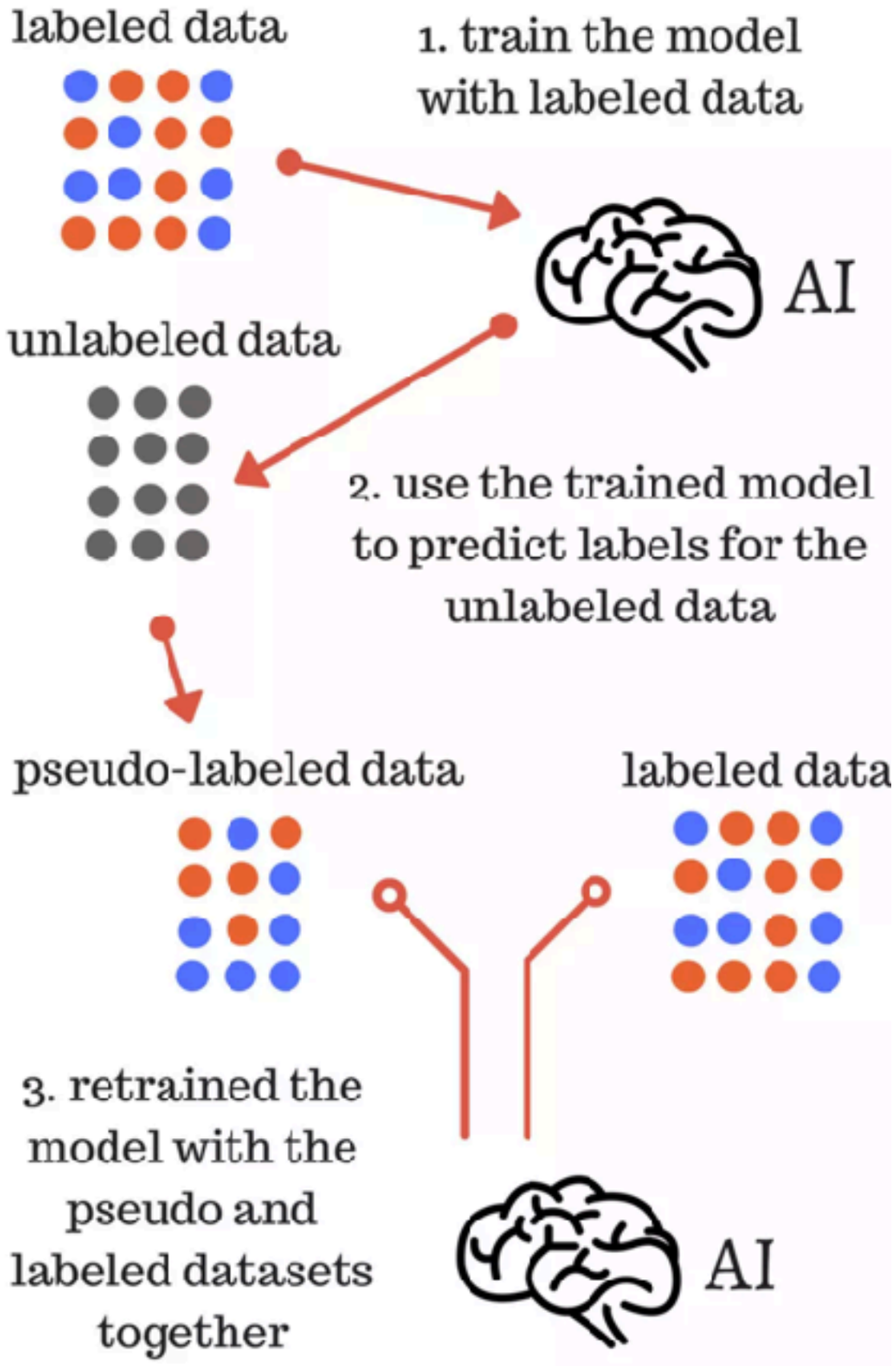
Iterative training with relevance Labels

- Rule-based models
- Human ranking expressions



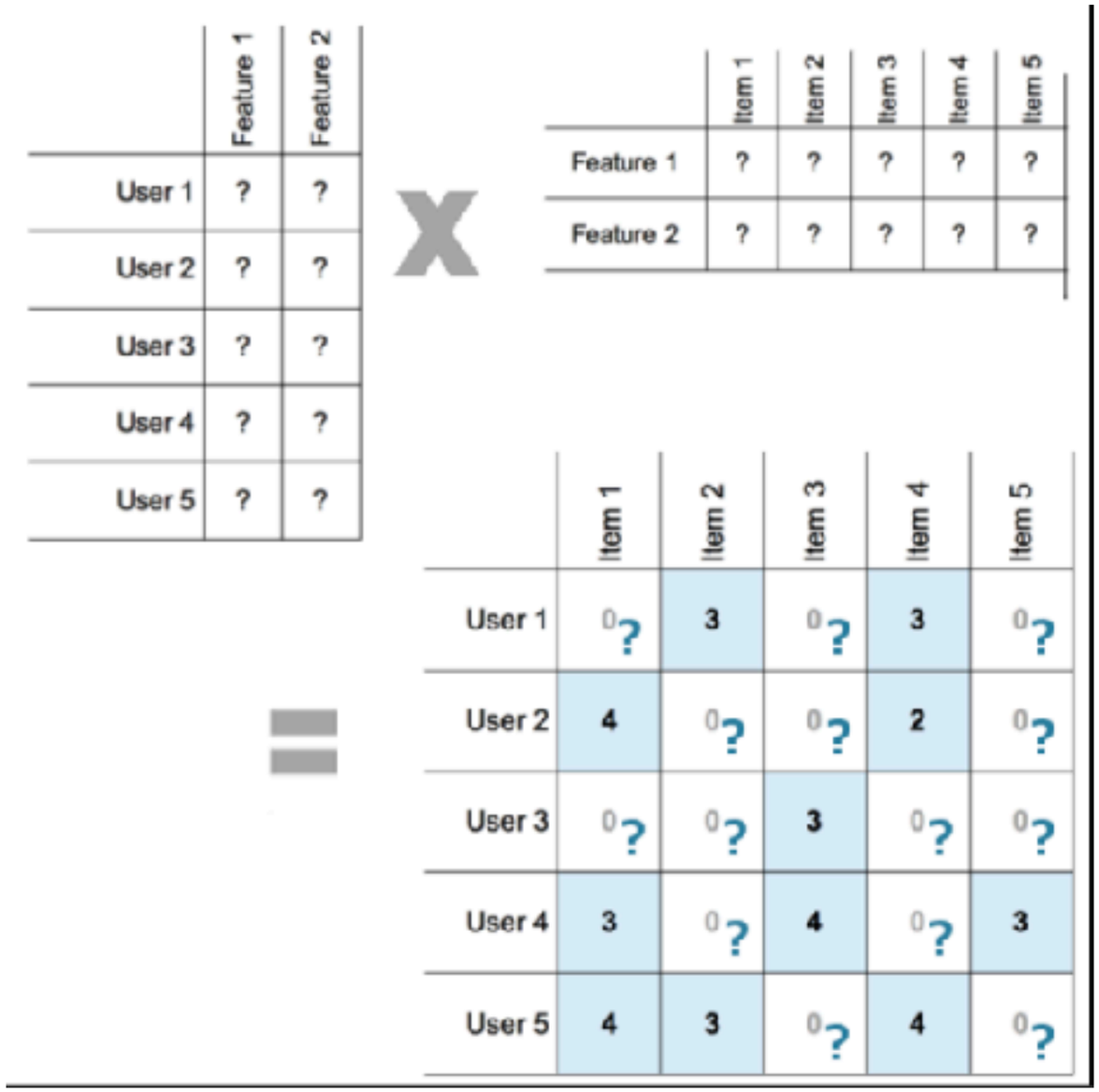
Labeling Problem
Semi-supervised

Pseudo Labeling



Labeling Problem - Matrix Factorization

- When data size is large, we can label part of pairs



Cold-start Problem

- Occurs in using some online metrics as features
  - Click count
  - View count
- How to handle new items?
  - Find similar items based on static features

Reference

- Ranking
  - http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.222.6261&rep=rep1&type=pdf
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