System Design: Search – Session 2

Pooja Gada

Agenda

- Speaker Introduction
- Why is search important
- Part 1 - Design a search auto-complete system
- Part 2 - Advanced Search

Speaker Intro

Pooja Gada

Current: Engineering Leader @ 1Password

Previously: Slack, Digit, Qventus

Education: Carnegie Mellon University

Motto: *Lift as we climb*

pooja.s.gada@gmail.com

Who is this meetup for

- Preparing for interviews
  - Software Engineering
  - Engineering Management
  - Technical Product/Project Manager

- Build on System Design Skill set
  - Early in career
  - Expand knowledge on types of challenges
  - Learn how to build scalable systems

Caveats...

- Most System Design Interviews require a bit of prep
    - You have 1 hour to impress the interviewer
    - Instagram / Youtube / Meetup - wasn’t build in an hour - you kinda have to….
- There is no one-perfect-solution
    - There are many ways of designing a system - Leverage your background!
- You will hear names of products - they are just for references

I want you go back to first principles…

What we will and will not cover

We will

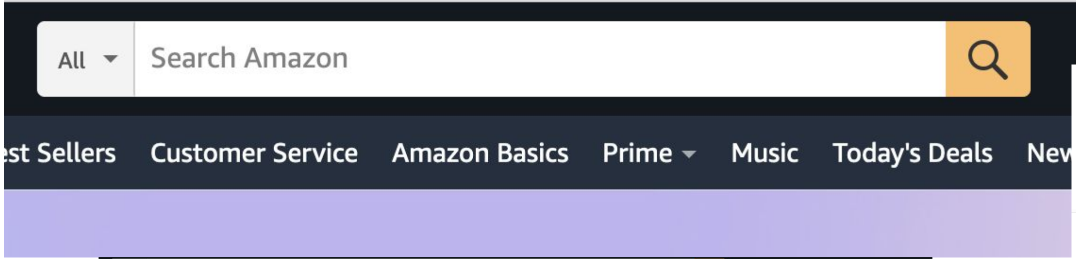
- We will explore some interesting questions centered around Search
- We will explore most popular tech stacks
- Provide useful resources for future

We will not

- We will not be going into algorithms around search such as edit distance
- We will not cover all possible tech stacks(its a lot)

Why is Search Important

Yep, users need to find stuff.



All

Search Amazon

EN

He

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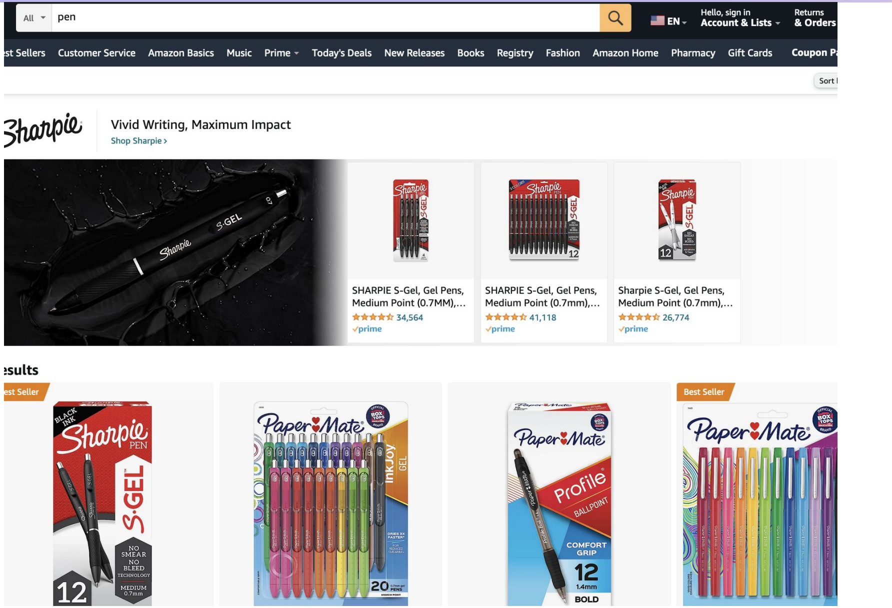

All pen

EN

Hello, sign in
Account & Lists

Returns
& Orders

st Sellers Customer Service Amazon Basics Music Prime Today's Deals New Releases Books Registry Fashion Amazon Home Pharmacy Gift Cards Coupon P

Sort

Vivid Writing, Maximum Impact

Shop Sharpie ›

SHARPIE S-Gel, Gel Pens, Medium Point (0.7MM),… 34,564 prime

SHARPIE S-Gel, Gel Pens, Medium Point (0.7mm),… 41,118 prime

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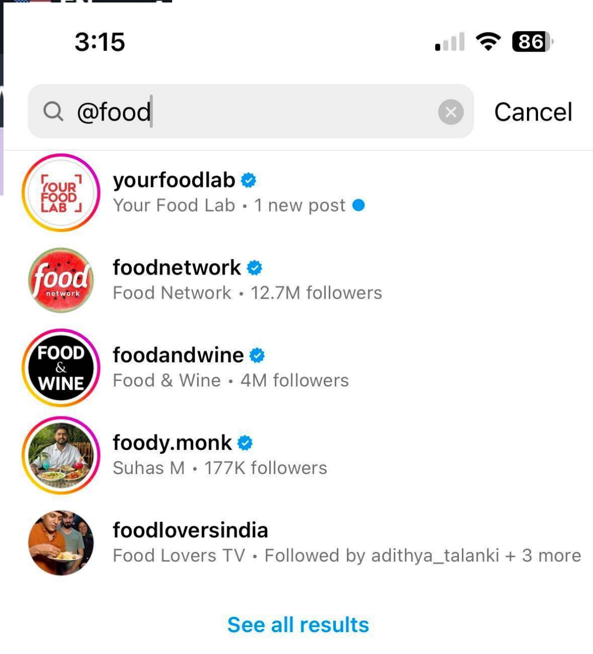
est Seller

Best Seller



3:15

86

@food

Cancel

yourfoodlab
Your Food Lab • 1 new post

foodnetwork
Food Network • 12.7M followers

foodandwine
Food & Wine • 4M followers

foody.monk
Suhas M • 177K followers

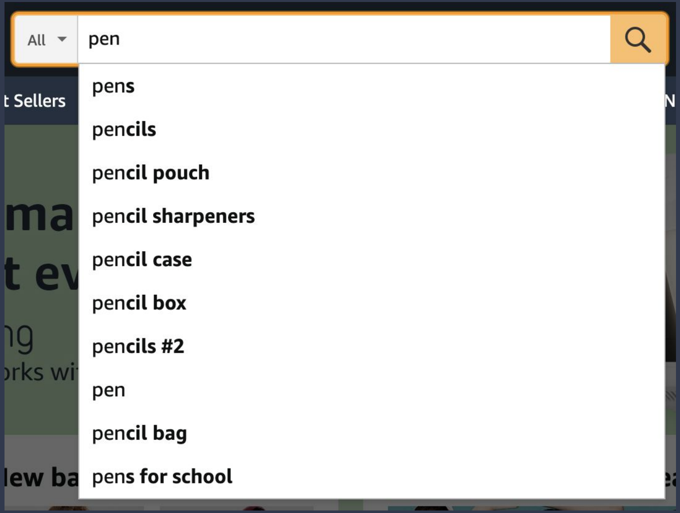
foodloversindia
Food Lovers TV • Followed by adithya_talanki + 3 more

See all results

Search is everywhere!

Let’s Build Something!

Part 1 – Design a search auto-complete system



pen

pens

pencils

pencil pouch

pencil sharpeners

pencil case

pencil box

pencils #2

pen

pencil bag

pens for school

System Design Interview Blueprint

- **Phase 1 - Understand & Define Scope**
  - Functional / Non-Functional Requirements
- **Phase 2 - Plan & Get Buy-in**
  - Focus of time
- **Phase 3 - Deep Dive**
  - Algorithms
  - System Design / Data Flow
  - Why / What / How - with hint of trade-offs
- **Phase 4 - Summarize**

Phase 1 - Understand & Define scope

What are we matching against?

Product names

What is the matching criteria?

Only beginning letters, 2 char min

Spell check or localization or casing support?

No need to support

Scale - users/product names to search?

1 million DAU / 10 million product names

What type of results should be returned?

Top 5 most **frequently** searched - *frequency is important!*

Phase 2 - Plan & Get Buy in

Database Search

Select * from db_table where name ‘like_txt%’;

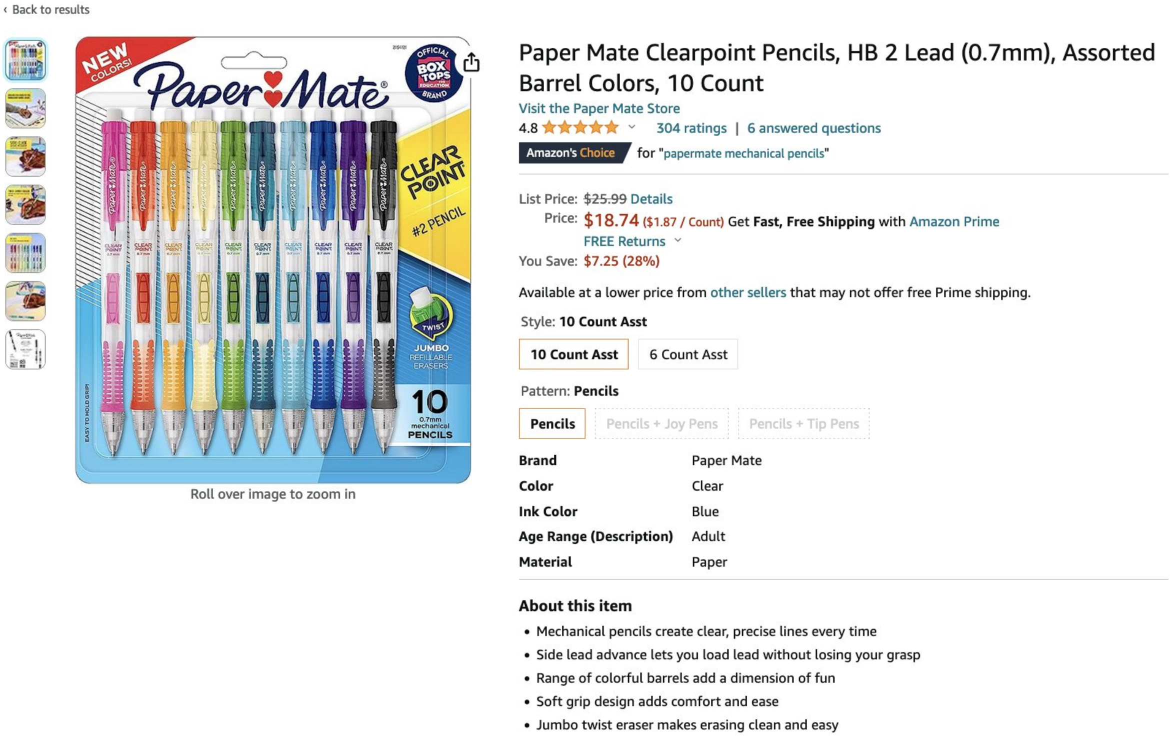
- Begins with ‘a’
  - Select * from db_table where name ‘a%’;
- Ends with ‘a’
  - Select * from db_table where name ‘%a’;

Why can’t we just shoot off this query for every character entered?

Don’t forget scale & performance!

I can just add an index right?

Product Details



Paper Mate Clearpoint Pencils, HB 2 Lead (0.7mm), Assorted Barrel Colors, 10 Count

Visit the Paper Mate Store

4.8 ★★★★★ 304 ratings | 6 answered questions

Amazon's Choice for "papermate mechanical pencils"

List Price: ~~$25.99~~ Details

Price: $18.74 ($1.87 / Count) Get **Fast, Free Shipping** with Amazon Prime

FREE Returns

You Save: $7.25 (28%)

Available at a lower price from other sellers that may not offer free Prime shipping.

Style: **10 Count Asst**

10 Count Asst | 6 Count Asst

Pattern: **Pencils**

Pencils | Pencils + Joy Pens | Pencils + Tip Pens

Brand	Paper Mate
Color	Clear
Ink Color	Blue
Age Range (Description)	Adult
Material	Paper

About this item

- Mechanical pencils create clear, precise lines every time
- Side lead advance lets you load lead without losing your grasp
- Range of colorful barrels add a dimension of fun
- Soft grip design adds comfort and ease
- Jumbo twist eraser makes erasing clean and easy

DB model products

products_table

name	text
seller	FK
price	float
description	text

Indexing in Databases

Most databases use B-Trees for indexing

- May work if size of DB is small enough
- Indexes are expensive
- Indexes are not sufficient
    - For the scope of the question - frequency of the words is important

Keywords + Frequency

keyword_frequency_table

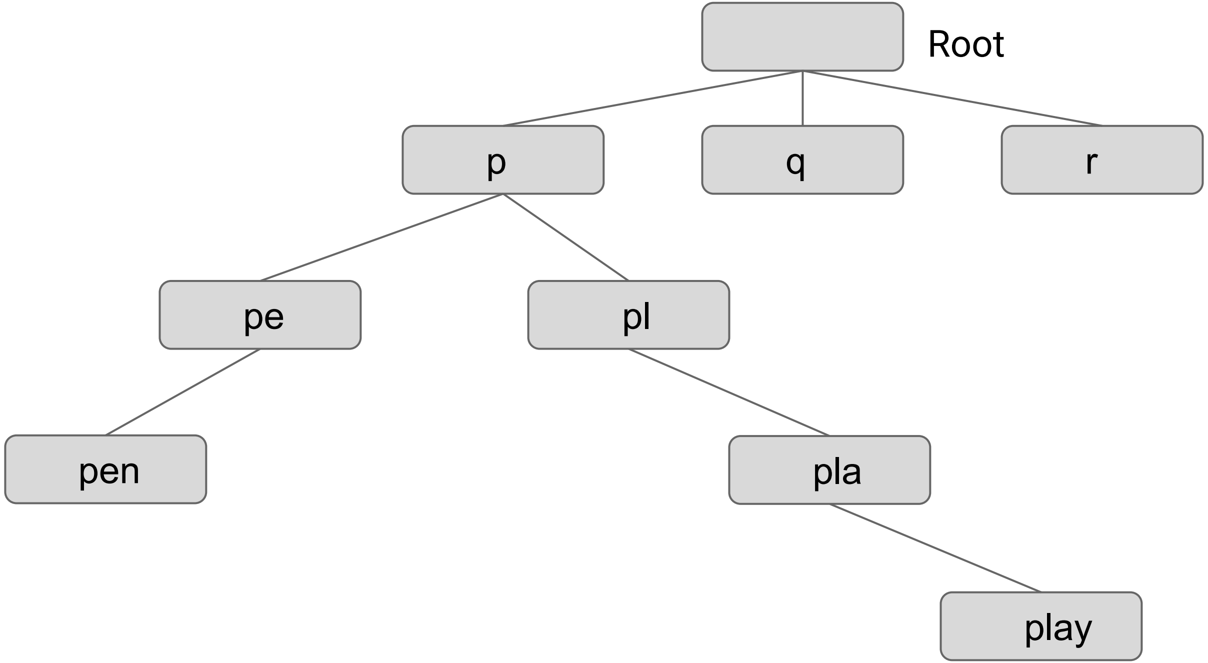
keyword	text
frequency	int

DB Model

keyword	**frequency**
pencil	45
pen	30
pencil case	20
pencil pouch	10
pencil bag	5
pencil eraser	3

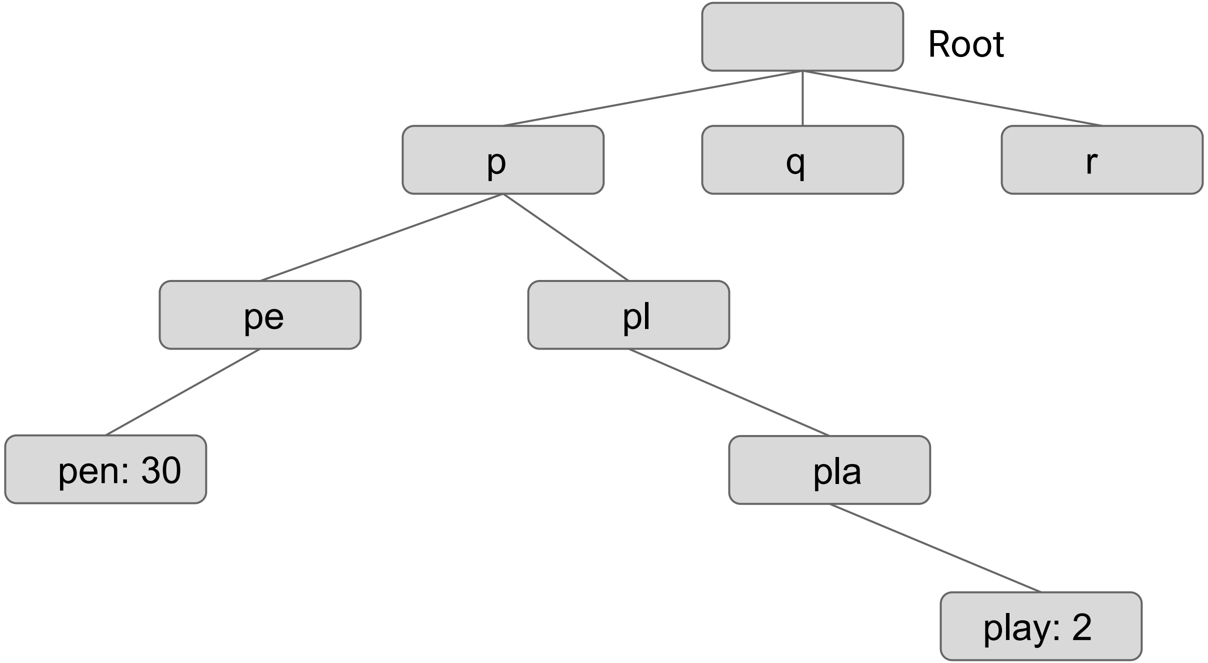
How do we build faster lookup & factor in frequency?

Trie to the rescue



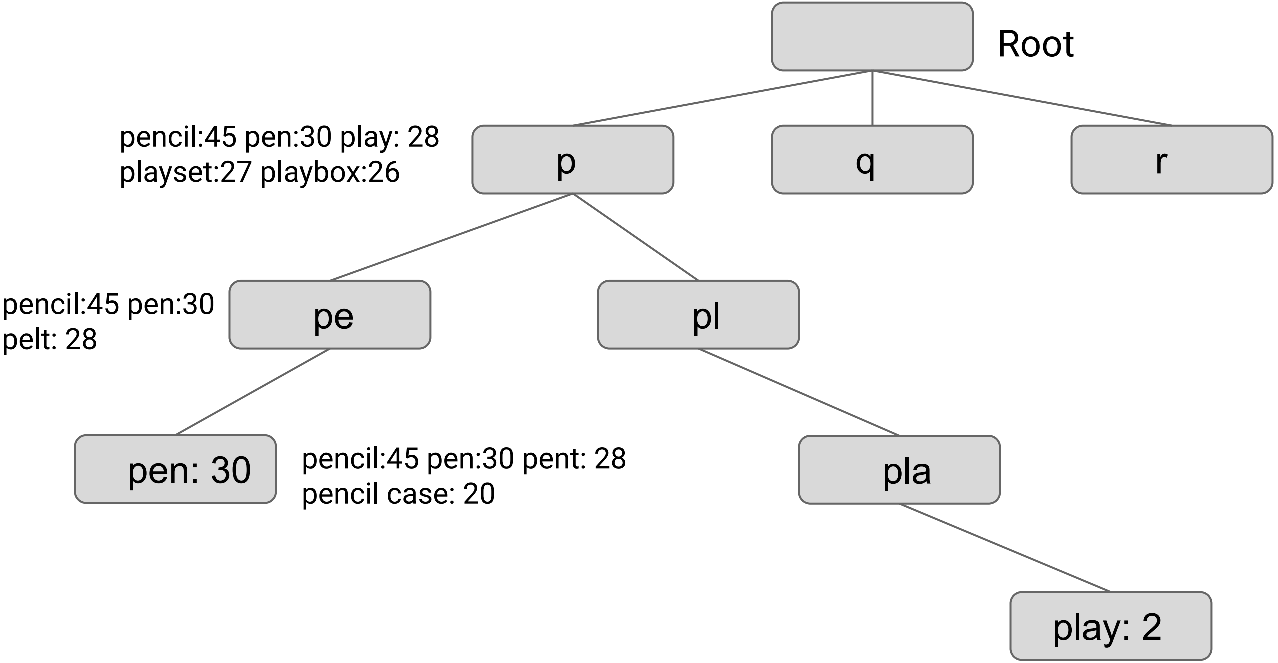
But what about the frequency info?

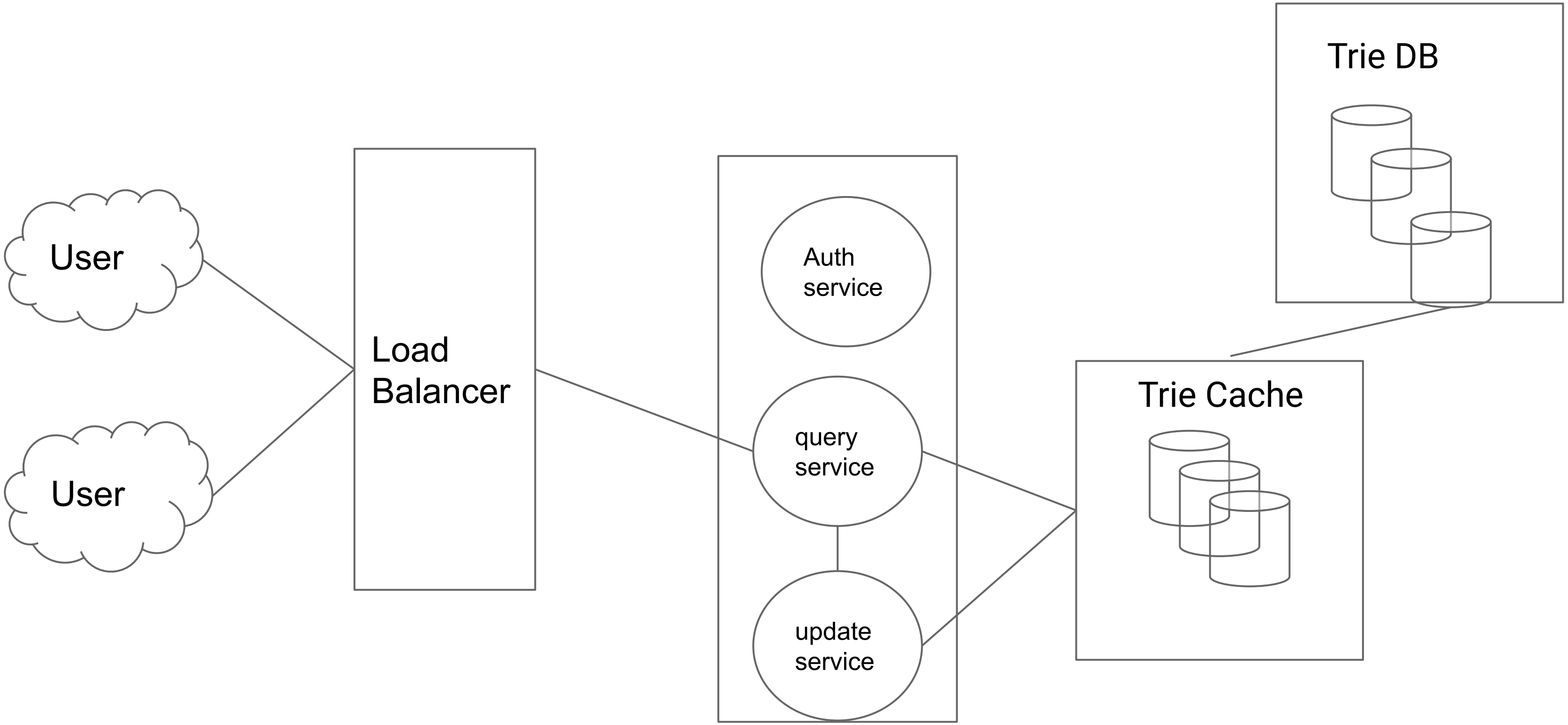
Add frequency to the child nodes!



But wouldn’t traversing the nodes to find top 5 results still take time?

Cache upto top 5 results at each node





High level system design

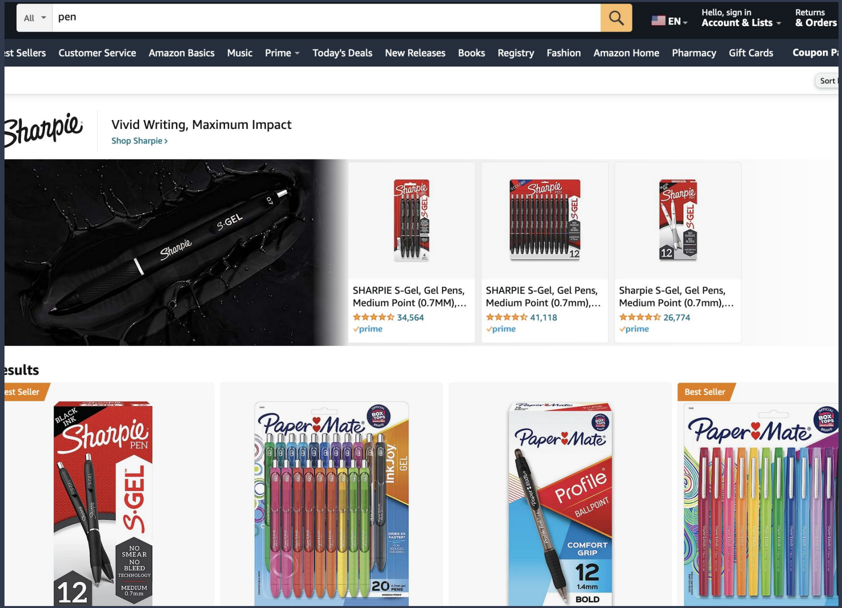
Trie DB

- Can either be
  - Document store
    - MongoDB
  - Key-value store
    - DynamoDB

Other potential questions/follow-ups

- Browser caching
- In-memory trie-db
- Sharding strategies
- Localization
    - Vary auto-complete suggestions by country
- Recency bias
    - Trending topic

Part 2 – List all products that match keyword



Vivid Writing, Maximum Impact

SHARPIE S-Gel, Gel Pens, Medium Point (0.7MM),... 34,564

SHARPIE S-Gel, Gel Pens, Medium Point (0.7mm),... 41,118

Sharpie S-Gel, Gel Pens, Medium Point (0.7mm),... 26,774

esults

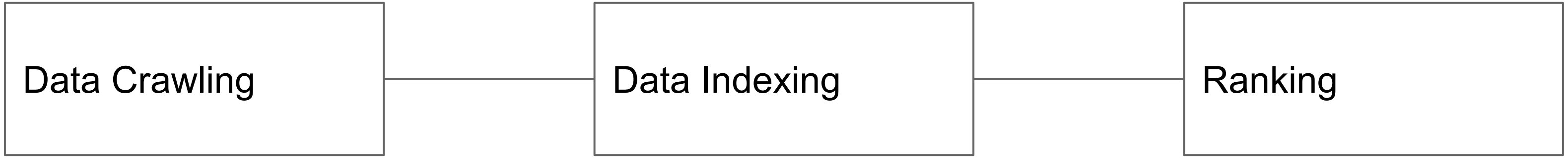
We need a way to tie back keywords to product

keyword	prod1	prod2	prod3
pen	x		x
pencil		x	x
pencil case		x	

- Inverted index!
- This is the algorithm that solr/elastic search actually use under the hood

Other potential questions/follow-ups

- How would you build a inverted index
    - Database table
    - Binary bits 01101



References

- System Design Interview Volume 1 & 2
  - Alex Xu & Sahn Lam
- Educative.io
- Tryexponent

What would you like to see in the next session?

Upcoming sessions:

- News Feed System
- Chat application
- Nearby

What else would you like to learn?