Building Anime Scene Search Engine

Story of building and running a world-wide popular image search service: "WHAT: What Anime Is This?"

Presented by @soruly

URL of my slides

https://github.com/soruly/slides

About Me

- Graduate from **CUHK** (BSc) Computer Science
- Former committee of **Animation and Comic Society**
- Part-time in **Oursky** before graduate
- Created **whatanime.ga**
- Game Developer in **Derivco Hong Kong** now

https://about.me/soruly

The Motivation

Help Identifying The Anime
Know the anime but can't find the scene
Anime Guessing Game

Image reverse search engines:

- Google Image - Results are limited
- TinEye - never works on anime
- iqdb - tailored for doujin artwork, not anime
- SauceNAO - covers iqdb plus game CG

SauceNAO recently expanded its **database coverage** to recent anime

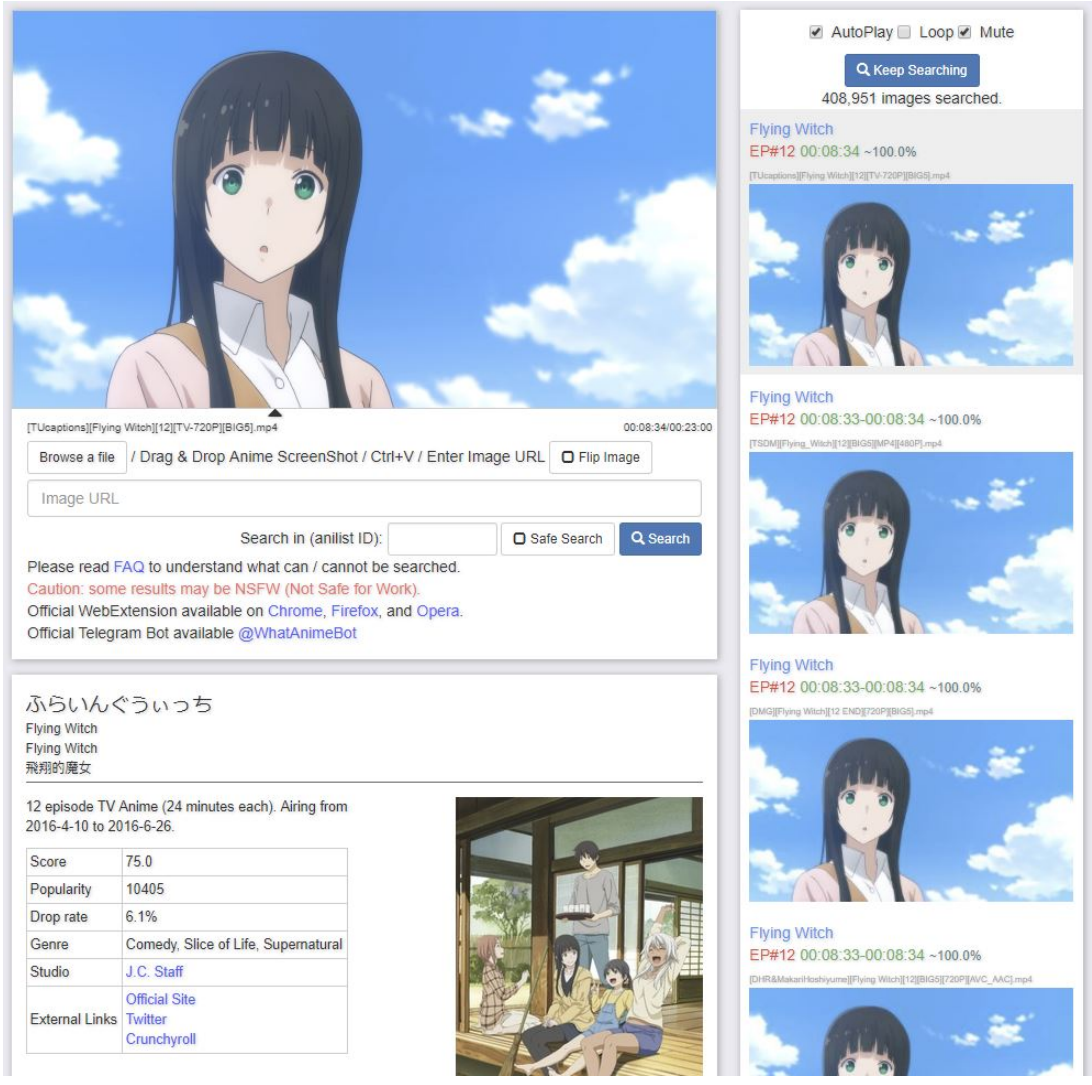
Build_Your_Own_X

CBIR research projects/demos/open source projects [edit]

Name		External Image Query	Metadata Query	Index Size (Estimate, Millions of Images)	Organization Type	License (Open/Closed)
Windsurf	A general framework where different altern effectiveness and eff	Yes	No		University	Open but not free
Anaktisi	This Web-Solution im accurately retrieving	Yes	No	0.225M	University	Open
FIRE	Open source query b can easily be combin	No	No		University	Open
MIFile	Image similarity sear	No	No	100M	Research Institute	Open
Pastec	C++ LGPL index and	Yes	Yes		Private company	LGPL
BRISC	BRISC is a recursive	Yes	No		University	GPL
digiKam	Extensive photo man detection of duplicate	Yes	Yes	Desktop-based	KDE	GPL
Caliph & Emir	Creation and Retriev	Yes	No	Desktop-based	University	GPL
GNU Image Finding Tool	Query by example im	Yes	No	Desktop-based	GNU	GPL
imgSeek	photo collection man	Yes	No		Individual	GPL
LIRE	Java GPL library for bag of visual words a	Yes	Yes		University	GPL
akiwi	akiwi is a semi-auton	Yes	Yes	15M	University	Closed
ALIPR	Developed by Penn S	Yes	Yes		University	Closed
ISSBP	Similar Image Search	Yes	Yes	free-beta limited to 4k	Private	Closed

https://en.wikipedia.org/wiki/List_of_CBIR_engines

Demo



search results on the right, anime info below is provided by anilist.co

How does it work?

whatanime.ga has nothing to do with:

- AI
- Machine Learning
- blockchain

whatanime.ga is kind of:

- Content-based image retrieval (CBIR) search engine
- computer graphics program
- big data

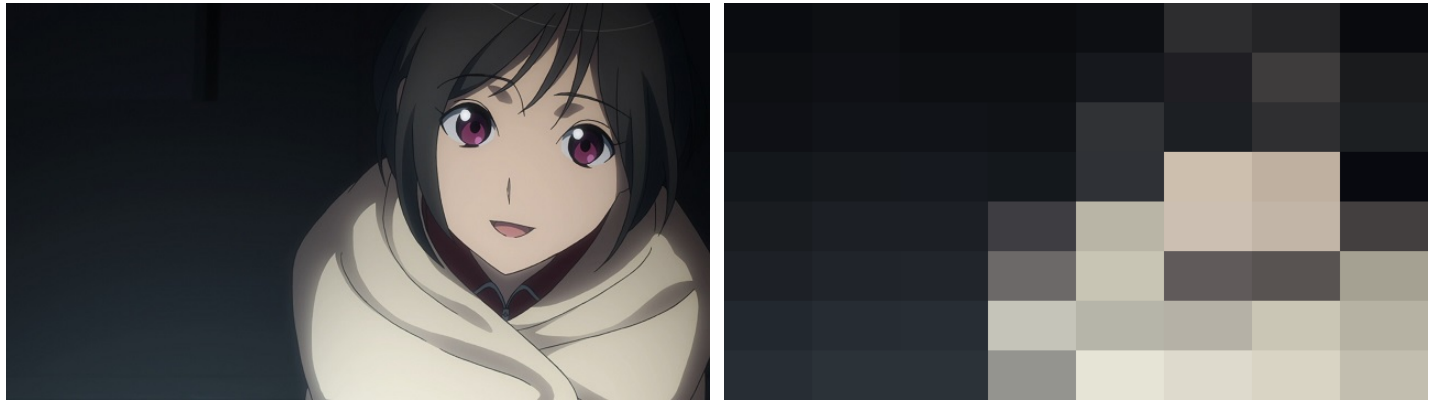
Common image descriptors:

- Color Layout, Edge Histogram, Opponent Histogram, ScalableColor, etc.

whatanime.ga only uses Color Layout due to Hardware limitations

Brief idea of Color Layout

- one of the MPEG-7 standard (I didn't invent this)
- Raw Image -> Partition to 8x8 blocks -> take average color of each block -> convert color space to YCbCr -> DCT transform (quantize) -> Zigzag scanning



- extracted image feature (fingerprint):

```
FQYLBAQRFgoYFBANEBIQDw0QCw0PDxAeEhEQDhAfDQ8PEA8=
```

https://en.wikipedia.org/wiki/Color_layout_descriptor

Color Layout for each frame

Raw Video -> Extract all frames by **ffmpeg** -> Extract image features by **LIRE** -> Deduplicate hashes -> Append timestamp -> Load into **solr** (database)

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  <doc>
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  </doc>
```

`image similarity = similarity of two binary strings`

Comparing image features, at scale

- 30000+ hours of video (~2,600,000,000 frames)
- Deduplicate frames with a running window
- There are still ~804,000,000 images to compare
- Reduce search area by Locality Sensitive Hashing
- Comparing ~800 million strings -> compare ~1 million strings

```
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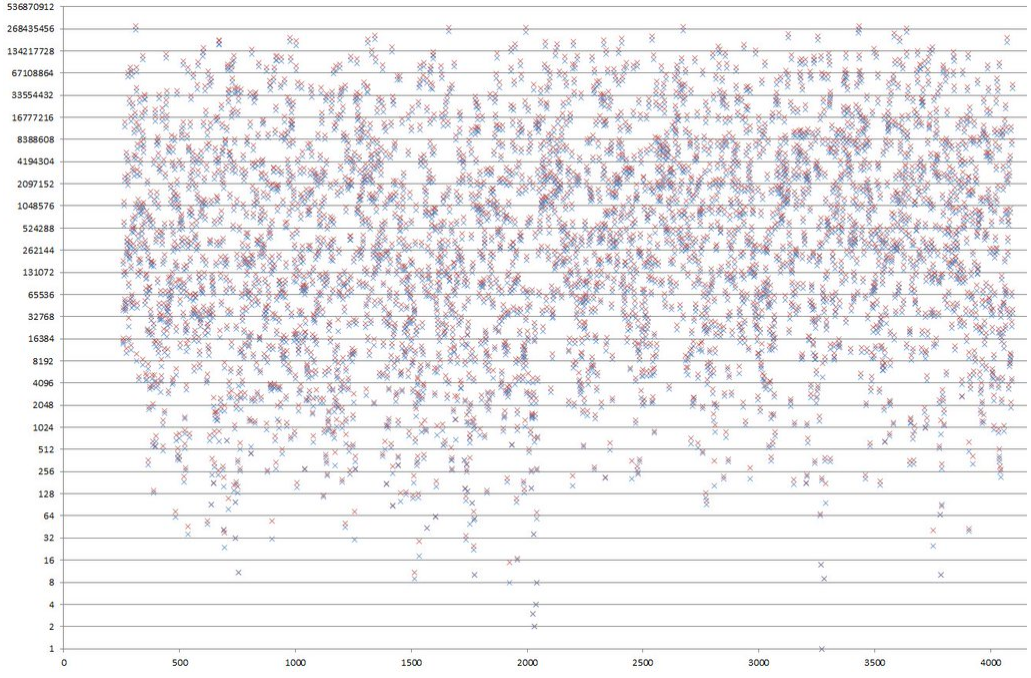
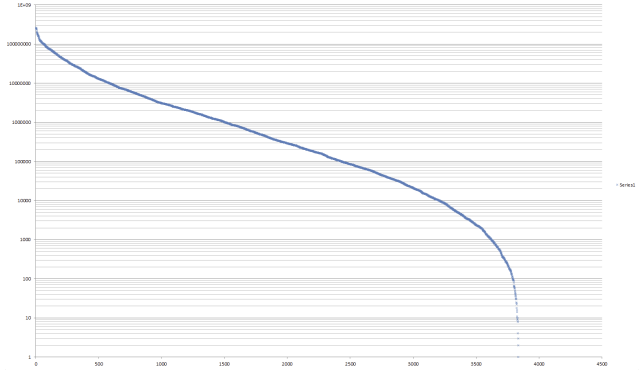
    2b b81 2dd 1bf cc5 c0c 730 78b c6c cb8 d2f d69 dbb a4b ed2 205 eb6 e36 b0c 8aa 3ad a14 661 b0f 88b 5
  </doc>
```

still not fast enough

Comparing image features, at scale

- Choose 1 out of 100 hash terms for search, starting from the least populated one. (image: cluster ID vs population)
- dermotte (author of **LIRE**) accepted this idea and implemented this as IDF into liresolr (see more in semanticmetadata.net)





June 2016: ~1k of daily users, search time varies from 1-40sec

Image search, at scale, with speed

- Cache search results in redis
- Reduce search accuracy
- Disable swap
- Replace SATA SSD with NVMe SSD

June 2017: ~2k of daily users, search time varies from 1-30sec

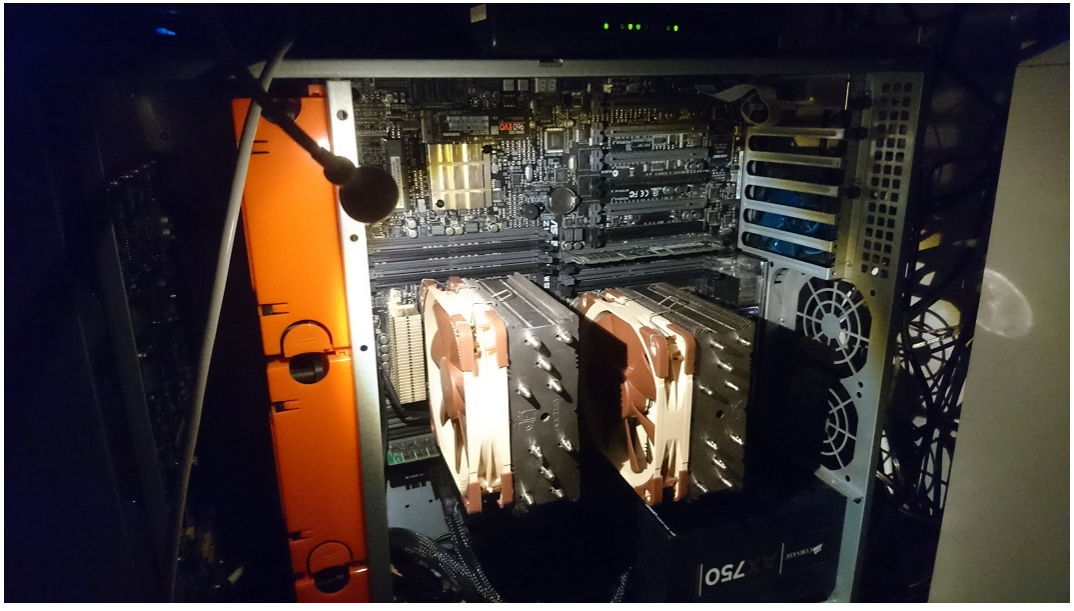
Data keeps growing, Traffic keeps rising

~~"We need to build a wall"~~

Minimum search time becomes 10-30sec, server keeps overloading

More Cores, More RAM

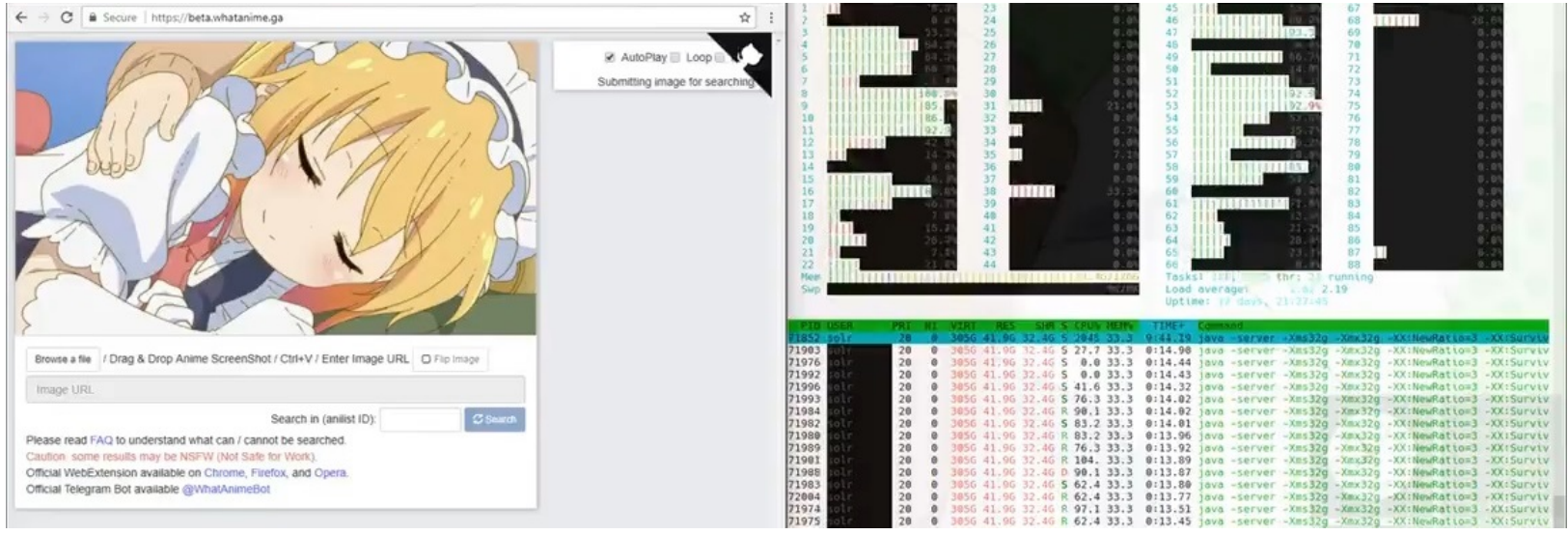
- Old server: just a quad-core Desktop PC with 32GB RAM
- New server: 2 x E5-2696v4 (44 Core 88 Threads), 256GB RAM



Dec 2017: Slightly better, but server still keeps overloading

Squeezing All CPU Powers

- **liresolr** is single thread... and **solrcloud** does not work well with plugin schemas
- Split index into 32 smaller databases (solr cores)
- Balance cores by loading hashes into least populated cores
- Search all databases in parallel, and combine results
- All database (solr cores) are hosted in one server



April 2018: See how it utilize all cores

More RAM

- Database size (index) is 150GB now
- Use vmtouch to keep the database in RAM

https://twitter.com/soruly/status/1030122636725051392

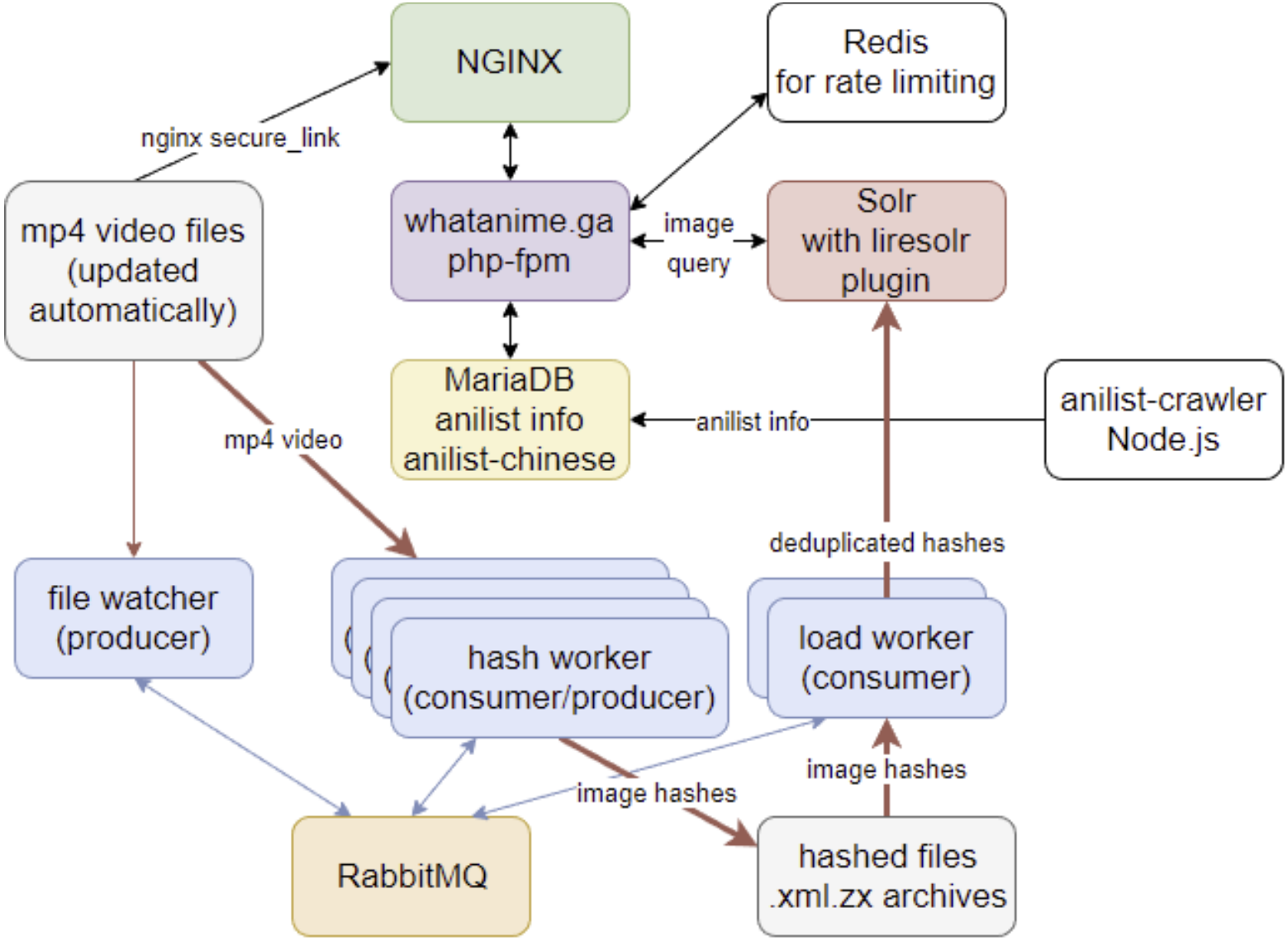
Aug 2018: Search time consistantly 0-2sec

Auto black border detection and crop

- Using findContours from OpenCV to crop black borders

similarity: with black border 89.4%, without border 96.3%

System Overview



All parts of whatanime.ga are open source!

https://github.com/soruly/whatanime.ga
https://github.com/soruly/whatanime.ga-WebExtension
https://github.com/soruly/whatanime.ga-telegram-bot
https://github.com/soruly/anilist-crawler
https://github.com/soruly/anilist-chinese
https://github.com/soruly/liresolr
https://github.com/soruly/sola

API Docs:

https://soruly.github.io/whatanime.ga

「你不需要很厲害才能開始，但不開始就沒辦法很厲害」

It's time to build your own Anime/Video Scene Search Engine!

Future Plans

whatanime.ga will not:

- cover comics / artworks
- allow search by timecode
- increase duration of preview
- add ads to websites

whatanime.ga will:

- Increase database coverage (fill in missing anime and maybe crawling from youtube)
- Reduce duplicates in database
- Support multiple image descriptors like FCTH (Fuzzy Color and Texture Histogram)
- Rebuild web front-end for language and mobile support
- move to a new domain (considering trace.moe)

Get Involved!

If you love whatanime.ga , share it!

Report bugs on GitHub, Telegram or Discord

Support soruly on Patron

- https://www.patreon.com/soruly

Support soruly via PayPal

- https://www.paypal.me/soruly

Join official pages / channels:

- Discord Channel
- Telegram Channel
- Facebook Page
- Google+

Credit

- Dr. Mathias Lux for LIRE Project and liresolr
- Josh for providing anilist.co info via Anilist API
- bちゃん, Desmond, FangzhouL, Snadzies, WelkinWill, yuriks, and 16 other Patrons
- ccd0 for integrating whatanime.ga into 4chan-x
- Xamayon for integrating whatanime.ga into saucenao.com
- egoist for docute that makes API docs
- bestshow for reporting an XSS issue regarding CVE-2017-6390
- fans that help me to answer questions on discord
- whoever shared, complained and made suggestions
- whoever bring anime to this world ❤

Thank you!

https://about.me/soruly

https://twitter.com/soruly

https://telegram.me/soruly

https://www.instagram.com/soruly

See more awesome ACG projects:

https://github.com/soruly/awesome-acg