Production Scale Visual Search and Image Recognition

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CTO and Co-founder of ViSenze
About ViSenze

- Started as Spin off from NExT (NUS-Tsinghua Research centre); Raised 14M USD funding from VCs
- Based on computer vision and deep learning research, ViSenze provides visual search and image recognition solution for some of the largest companies in the world
- Customers include the top fast fashion retailer, sports brand and mobile phone manufacturer
- Office in SF, London, Beijing and Singapore

ViSenze has been recognized amongst:

- Top 5 deep learning companies - VentureBeat 2017
- Top AI Product AI (Retail) – CogX London 2017
- Top 40 global Breakthrough Brands - InterBrand 2017
Under the Hood

• Built by Computer Vision scientists and software development experts (40+ R&D in CV, ML, Infra)
• 4 patent applications (granted and pending) in various stages
• Global scale distributed architecture supporting over 1 Billion
• Low latency and high-throughput architect design
• In-house distributed GPU training platform and tool development
• Independent validations: ImageNet, client evaluations
The rise & rise of Visual Content..

Gen Z prefers to communicate with Images

Image Growth - More than 3B photos per day

**Generation Z (Ages 1-20) = Communicates with Images**

<table>
<thead>
<tr>
<th>Attributes – Millennials vs. Gen Z</th>
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</thead>
<tbody>
<tr>
<td><strong>Millennials</strong></td>
</tr>
<tr>
<td>Tech Savvy: 2 screens at once</td>
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<tr>
<td>Communicate with text</td>
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<tr>
<td>Curators and Sharers</td>
</tr>
<tr>
<td>Now-focused</td>
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<tr>
<td>Optimists</td>
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<tr>
<td>Want to be discovered</td>
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</tbody>
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**Image Growth Remains Strong**

**Daily Number of Photos Shared on Select Platforms, Global, 2005 – 2015**

- Snapchat
- Facebook Messenger (2015 only)
- Instagram
- WhatsApp (2013 onward only)
- Facebook
Visual Search: Major players are already driving this shift

- Amazon Visual Search
- Pinterest Lens
- Samsung Bixby Vision
- Google Lens

250 Million Searches - Pinterest May 2017
360 Million Searches - Taobao July 2017
Visual Search Solutions and Use Cases

- Image Search is now a common feature on leading retailer apps
- H&M, ASOS and UNIQLO Visual Search powered by ViSenze
Recommendation Solutions and Use Cases

You May Also Like
Recommendations based on what shoppers are viewing

Out of Stock Alternatives
Suggest visually similar products when shopper is viewing an out of stock item
Tagging Solutions and Use Cases

Automated Tagging

Improve discoverability and conversions

Color

Pattern

Fashion Attributes*

Custom Attributes**

*Q3 2017 Availability
** Subject to requirements analysis
Shoppable UGC and Moderation

1. Collect and Curate
2. Filter and Moderate
3. Tag Products

Showcase
Continuous Improvement for Deep Learning Computer Vision Tasks
Visual Search at ViSenze

- **Query time**
  - Offline training
  - Index time
  - Reference images

- **Detection model**
  - Embedding models
  - Objects

- **Extract features**
  - Compression codebook
  - Hash model

- **Search Index**

- **Ranked results**
  - Re-ranking

- **Nearest neighbours**
  - Extract features

- **Objects**
  - Embedding models

- **Query time**
  - Offline training
  - Index time
  - Reference images
Visual Embedding

- Similarity:
  - Exact match (the exact same item)
  - Different variations of the same product
  - Same category
  - Similar category
  - ...
Visual Embedding

- Exact-match Embedding
  - Siamese training
    - Triplet loss

\[
L_{\text{triplet}} = \sum_{j=1}^{|D|} \max\{0, m + d(x_j, x_j^+) - d(x_j, x_j^-)\},
\]

positive anchor negative

positive

anchor

negative
Training data

- Positive: UGC and product images of the same item
- Negative: Different products
Hidden Facts for Production Deep Learning Development

Continuous Improvement

- Hard to come from methodology improvement
- Usually come from data-based improvement

Key winning formula

- Transfer domain expertise into clear Requirement
- Computing Resource to support the product iteration
- Large-scale high quality training data and data management
- Intensive and faster product and user feedback
Training Data issue - Classification

- Challenging: Training data coverage

  Easy case: Long-sleeves
  Easy case: three-quarter
  Korean-style t-shirt
  ???
  How about rolled up sleeves?
Overfitting Issue - Classification

- Challenge: Overfitting. How naïve is CNN?

Training

Testing

Book 0.9989
Life of A ML pipeline: Continuous Data Cleaning
The Gap between Deep Learning Software and an Industry Grade Production DL System

Deep learning framework is a small component for production level deep learning development

Data Preparation

Data Requirement is critical
- Definition of taxonomy
- Looking for external data sources to complement training data
- More data not necessarily good

Example
- For the left image, the length of the rectangle is > 4-5 times the height. (i.e. The stripe is slim.)
  But for the right image, the height of the rectangle is large.
- In terms of color, color of stripe pattern usually repeat several times. But for the right image, each of the color only show once.
Data Analysis

- Statistics based analysis
- Feature based analysis
  - Metadata analysis
  - CV-aided profiling

Facets (https://pair-code.github.io/facets/)
- Statistics and Visualization
Data Validation

- Duplication, empty
- Mis-coding issue
- Missing of feature
- min/max value
- auto-recommendation/alerting
- etc

Model Validation - Safety

- Taxonomy check
- Latency check
- Memory profiling check
- Pre/post release monitoring and alerting
Model lifecycle Management

Reproducibility
- Model related metadata
- Evaluation related metadata
- Training Dataset metadata
- Algorithm related metadata
- Training task metadata
- Training environment metadata

Metadata
- Versioning
- Persistent storage

Roles Involved into Running day-to-day AI Development
Topics we are working on

- Metric learning
- Interpretation and visualization of CNN model
- Robust fine-tuning and Incremental learning
- Model compression
- Advanced methods for training data generation
- Training/test data bias discovery
- Large-scale product category and attribute classification
- Machine learning system development

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