



ProductNet: a Collection of High-Quality Labeled Product Datasets for Product Representation Learning

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Search Example

1-18 of 23 results for Grocery & Gourmet Food : Snack Foods : Jerky & Dried Meats : "five spice beef jerky"



cat: Grocery;
subcat: Dried Nuts/Dried Fruit/Jerky

[Golden Island Beef Jerky, Five Spice, All Natural and...](#)

★★★★★ 6

\$29⁹⁹ (\$2.07/ounce)

✓prime

[Add to Cart](#)



[1.25oz SOO Jerky Extra Hot Five Spices Beef Jerky \(Pack...\)](#)

\$8²⁰ (\$6.56/Ounce)

[Add to Cart](#)



cat: Specialty Electrics;
subcat: Dehydrators

[Nesco BJX-5 Jumbo Jerky Works Kit](#)

★★★★★ 826

\$21⁴⁰ (\$0.96/oz)

✓prime

Get it by Saturday, Mar 24

[Add to Cart](#)



ProductNet

A collection of high-quality labeled product datasets for product representation learning.

The two goals of product labeling and representation learning support each other in an iterative fashion by our design.

- Product categories can be used as search indices, partition keys.
- Product embeddings also exhibit improvement on transferability and explanatory power.



Questions to Answer

Labeled product datasets are not new, why ProductNet?

- Label quality
- Flexibility to bring your classification task
- Convenience provided by the labeling toolkit

Product representation learning is not new, would ProductNet help?

- A properly chosen taxonomy is highly recommended.
- High-quality, but small volume could be enough.

Product Representation Learning in Amazon

	Record2vec	Product2vec	Asin2vec	Ours
	unsupervised	weakly supervised	supervised	supervised
Label	N/A	distributional semantics	browse nodes	human annotation
Data size	~1.5 M	~1.2 M	~1 M	~11.6 K
Text/Image	Text	Text	Text	Image+Text



Dataset Construction and Workflow

A naïve way: given a product candidate pool, each product is tagged with a category name by human.

A better way: given a category, search for relevant products from a product pool.

The workflow is based on an iterative loop of human annotation and representation learning.

- The choice of taxonomy
- Human annotation and local models
- Representation learning and master model



Local vs Master Models

Our two-layer hierarchical scheme consists of two models:

- Master model: A deep neural network model for product representation and classification.
- Local model: A shallow binary model at each leaf node for refining classification and active learning.

Feature vectors used by the local model are generated by the master model.

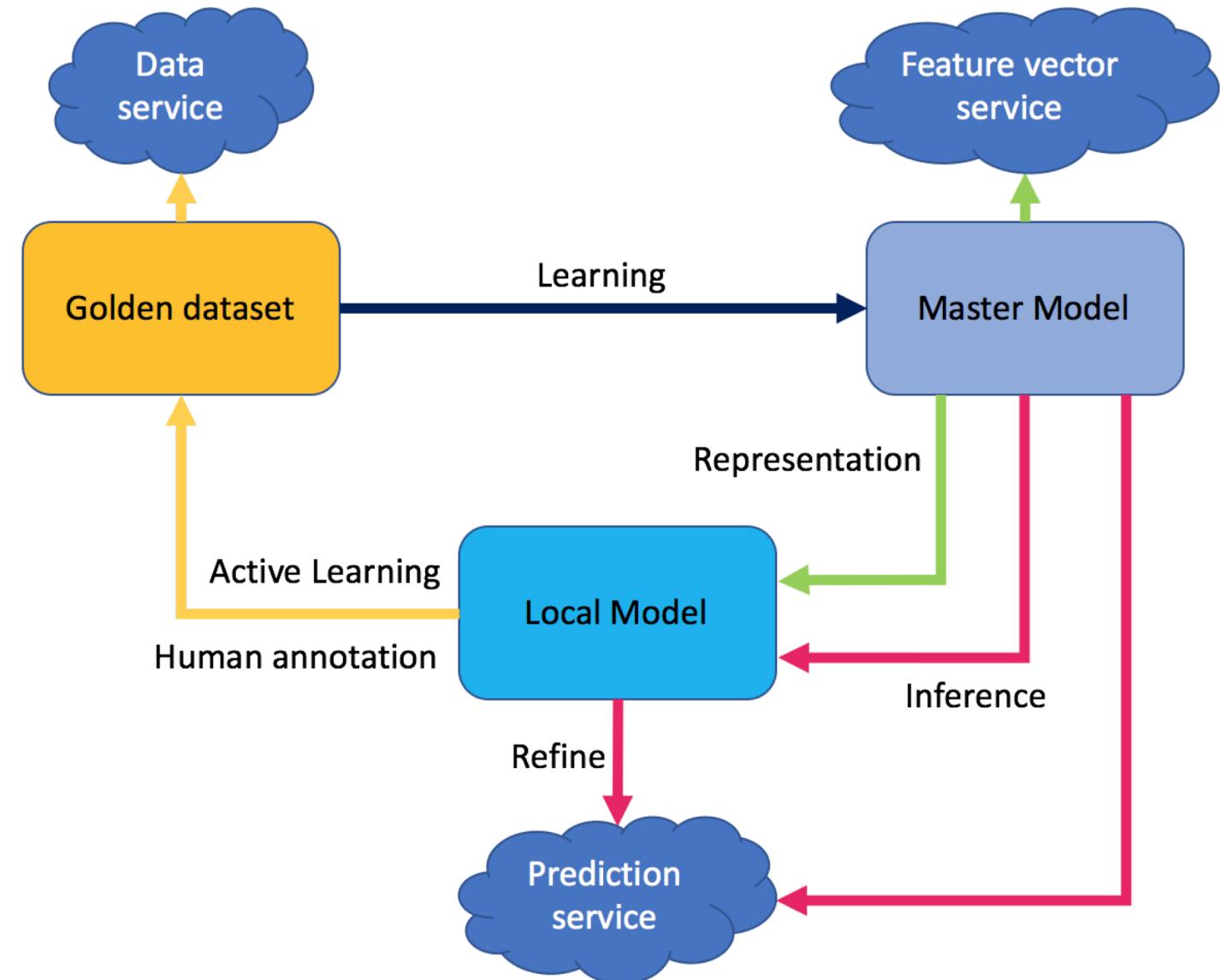
Workflow

Iterative process:

- Gold dataset labeling
- Master model learning

Three services:

- Gold dataset
- Feature vector
- Classification





Choice of Taxonomy

Goals: avoid ambiguity and simplify annotation

Preferences:

- Function-based taxonomy design
- Well-defined nodes with clear scope and boundary
- Non-overlap
- Balanced depth
- “Other” node to complete the partition

UX Design of Annotation Toolkit

The screenshot shows a 'Gold Dataset' interface. On the left, a 'Taxonomy' sidebar lists categories like 'Google PLA' and 'Google Product Taxonomy'. The main area is divided into 'Positive(+)’ and 'Negative(-)’ sections, each displaying a grid of small product images. The 'Positive(+)’ section contains images of various fireplaces, while the 'Negative(-)’ section contains images of household items like a vacuum cleaner and a lamp.

Positive samples

Negative samples

Taxonomy

Product details



WE Furniture 58" Simple Modern Fireplace TV Console - White

ASIN: B072738QJ3

Score: 4.4/1443802547445
58" Simple Modern Fireplace TV Console. Completes your home decor with the simple, yet modern elegance of this 58" fireplace wood TV console. Featuring spacious and adjustable shelving to display and store your media accessories and decorations, this stand offers the perfect blend of fashion and functionality. Sleek, metal legs and an attractive, crystal fireplace insert complete this console's contemporary presence in your living space. An electric plug-in can be used to give off heat if needed, or simply add an aesthetic appeal to your living room with the flip of a switch. Features: Cable management holes to maintain a clutter-free space! Adjustable, open shelving. Constructed of high-grade MDF and durable laminate. Contemporary, crystal fireplace insert included. No electrician required, simple plug-in unit. Steel track legs. Accommodates most TVs up to 60" Weight:

The screenshot shows a 'Search and active learning tools' interface. On the left, a 'Product details' sidebar shows a product image of a fireplace TV console and its ASIN. The main area features a search interface with dropdowns for 'google_pla' and 'method: logistic'. A search results grid shows a grid of fireplace images. Below the grid, a tooltip lists search methods: 'random', 'search: keyword', 'search: KNN', 'method: logistic' (which is highlighted in blue), 'method: NaiveBayes', 'method: MLP', 'method: SVM *', 'method: PAC *', 'method: perceptron *', and 'search: semantic *'. To the right, three sections are shown: 'Negative(-)' with a grid of various household items, 'Uncertain(?)' with a grid of furniture and decor items, and a larger grid of fireplace images under 'Positive(+)'. A 'Small Icon' button is in the top right corner.

Search and active learning tools

Positive(+) Negative(-) Uncertain(?)

Human Annotation

Google_Product_Taxonomy_Version: 2015-02-19 (21-17508)

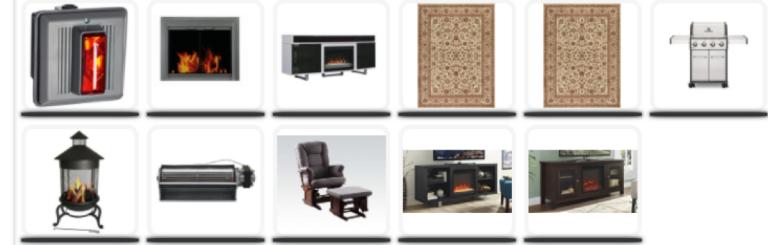
- + Animals & Pet Supplies (2-0)
- + Apparel & Accessories (8-25)
- + Arts & Entertainment (3-0)
- + Baby & Toddler (11-0)
- + Business & Industrial (25-0)
- + Cameras & Optics (4-0)
- + Electronics (19-0)
- + Food, Beverages & Tobacco (3-0)
- + Furniture (25-6915)
- + Hardware (14-0)
- + Health & Beauty (3-156)
- Home & Garden (21-10350)
 - + Bathroom Accessories (21-0)
 - + Business & Home Security (9-0)
 - + Decor (75-0)
 - + Emergency Preparedness (5-0)
 - + Fireplace & Wood Stove Accessories (11-0)
 - + Fireplaces (26)**
 - + Flood, Fire & Gas Safety (8-0)
 - + Household Appliance Accessories (12-0)
 - + Household Appliances (12-1354)
 - + Household Supplies (18-0)

Gold Dataset

Positive(+)



Negative(-)

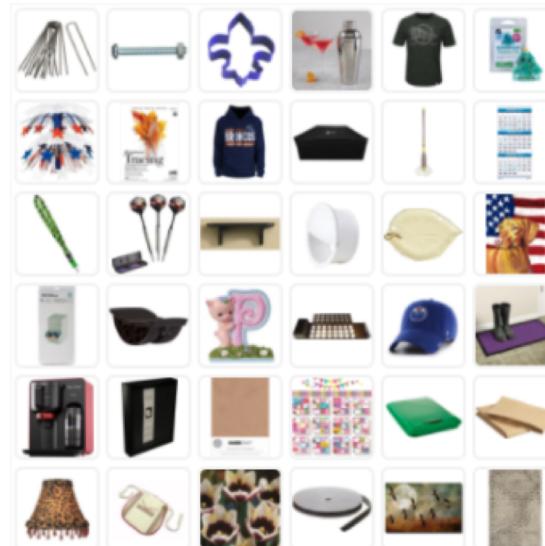


Small Icon

Small icons for navigation and file operations are located in the top right corner of the interface.

Sampling and Search

To directly retrieve relevant candidates



random sampling



keyword search



KNN search

Active Learning (with Local Models)

To accelerate the process and improve relevance



active - logistic regression

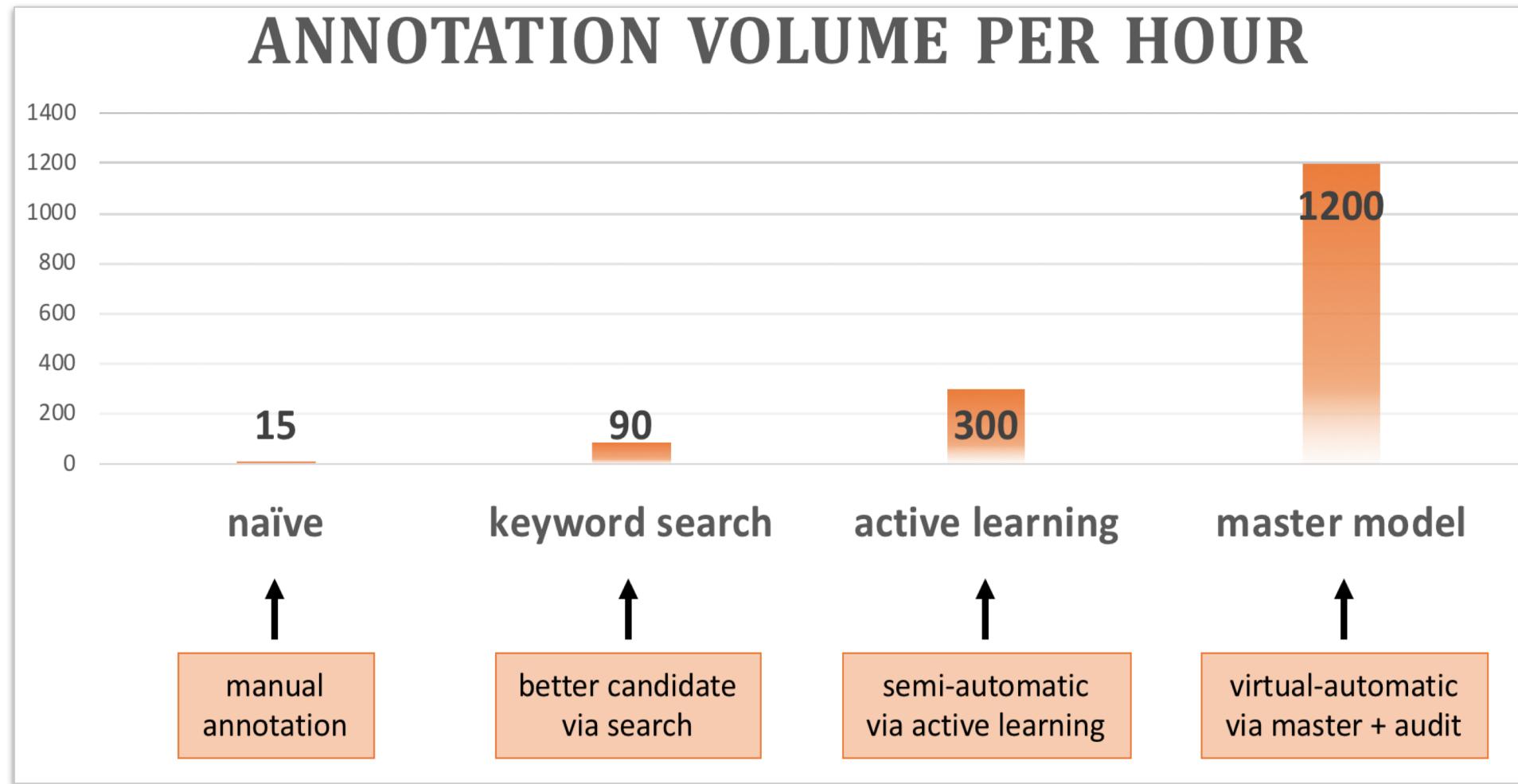


active - naive Bayes



active - MLP

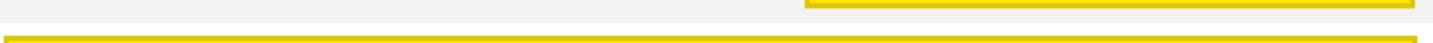
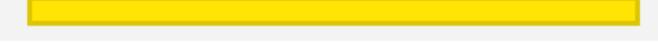
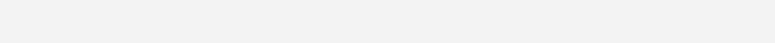
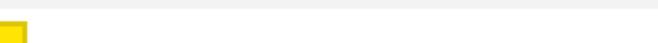
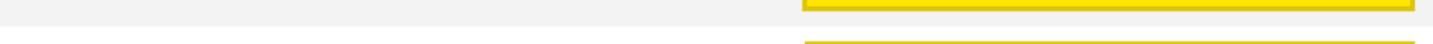
Speedup with Automation



Data Quality

Provenance information may help.

- User login is recorded.
- Complete history of gold dataset instances is recorded.

		1/12/2018, 2:07:19 PM	rsml-s
		2/13/2018, 9:06:57 AM	yongning
		2/13/2018, 9:06:57 AM	yongning
		2/13/2018, 9:06:57 AM	yongning
		1/12/2018, 2:07:19 PM	rsml-s
		2/13/2018, 9:02:11 AM	yongning
		2/13/2018, 9:06:57 AM	yongning
		2/13/2018, 9:06:57 AM	yongning
		2/13/2018, 9:02:11 AM	yongning
		2/13/2018, 9:02:11 AM	yongning
		2/13/2018, 9:06:57 AM	yongning
		1/12/2018, 2:07:19 PM	rsml-s

The First Available Gold Dataset

Gold dataset

- Furniture and Home/Garden
- 247 nodes
- 17,500 positive products

Annotators

- 5 active workers
- ~2 hours per week

Equivalent to 17.5 days for a full-time annotator

Toolkit Architecture

Frontend

browse GDS, sample candidates, make/propose GDS change

Backend services

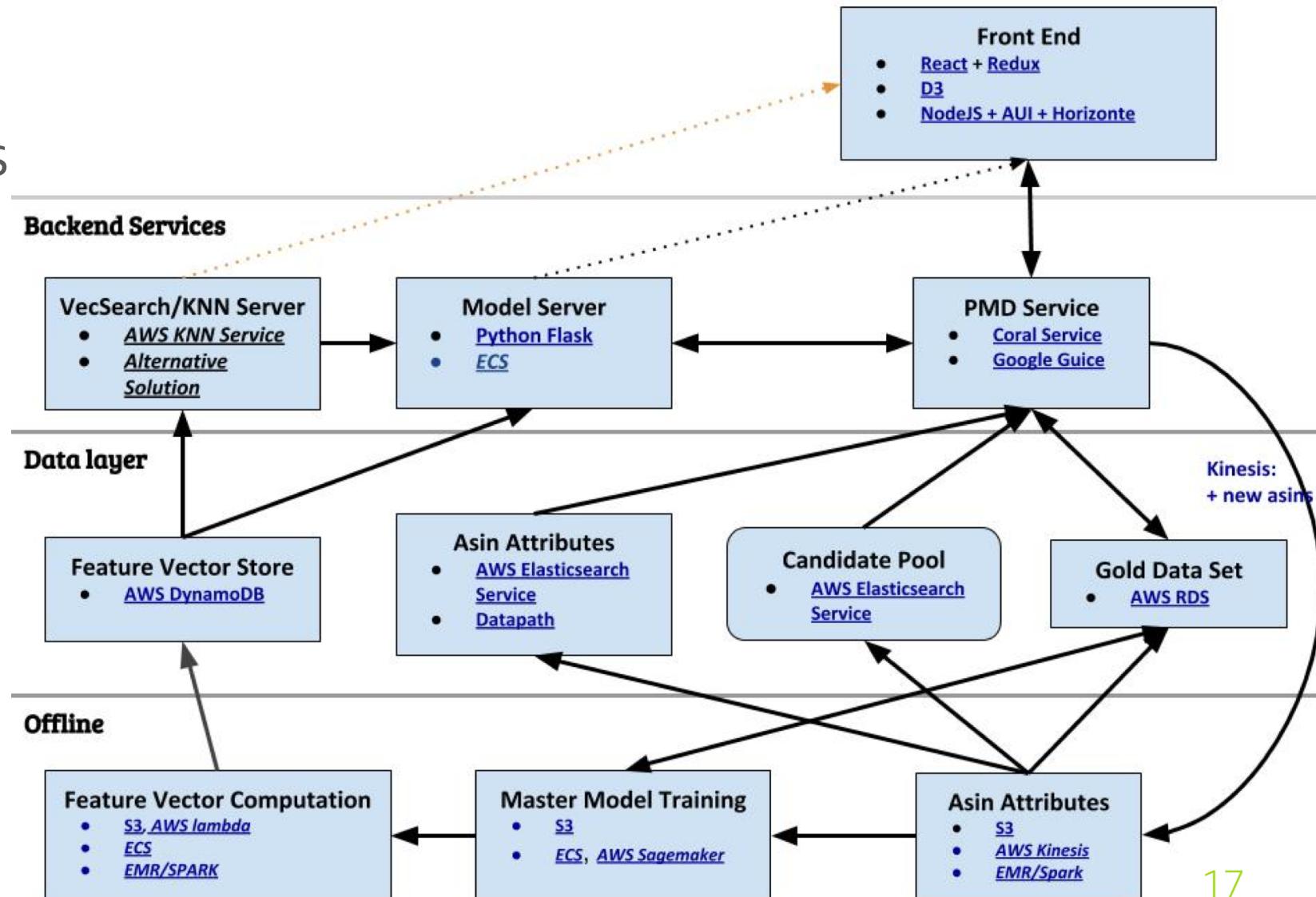
access/manage GDS, sample candidates, model inference

Data layer

GDS, candidate pool, asin attributes, feature vectors

Offline pipeline

feature processing, model training and evaluation



Representation Learning and Master Model

Challenges:

- multi-modal learning
- choice of models for each field
- very deep neural nets training

image	
(parent) title	Kindle Paperwhite E-reader-Black, 6" High-Resolution Display (300 ppi) with Built-in Light, Wi-Fi - Includes Special Offers
description	<p><i>Page Flip makes it easy to find pictures, charts, maps and even your notes and highlights from different parts of a book. While you swipe to other pages or zoom out to see page thumbnails, Page Flip automatically saves the page you're reading, pinning it to the side of your screen so you'll never lose your place.</i></p>
bullet point	<ul style="list-style-type: none">* Now available in black or white* Higher resolution display (300 ppi) with twice as many pixels* Built-in adjustable light* A single battery charge lasts weeks* Massive selection, low prices* Prime members read free
keywords, brand	Kindle fire, fire, kindle, ipad air, air, 11.6 inch display, display, top, load, loading, top, nexus, samsung, laptop, slim, compact, neoprene, sleeve, prote, ction, 11.6 inches, 11.6 inch, tablet, ipad, kindlefire, fire, kindle

Representation Learning: Image and Text

	Inception-v4	fastText	Attention LSTM	Deep pyramid CNN
Task	classification	word embedding	classification	classification
Dataset	ILSVRC 2012	Wikipedia/ Amazon catalog	Amazon catalog	Amazon catalog
Data Format	image	word/subword	sentence	paragraph

Choice of Text Modules

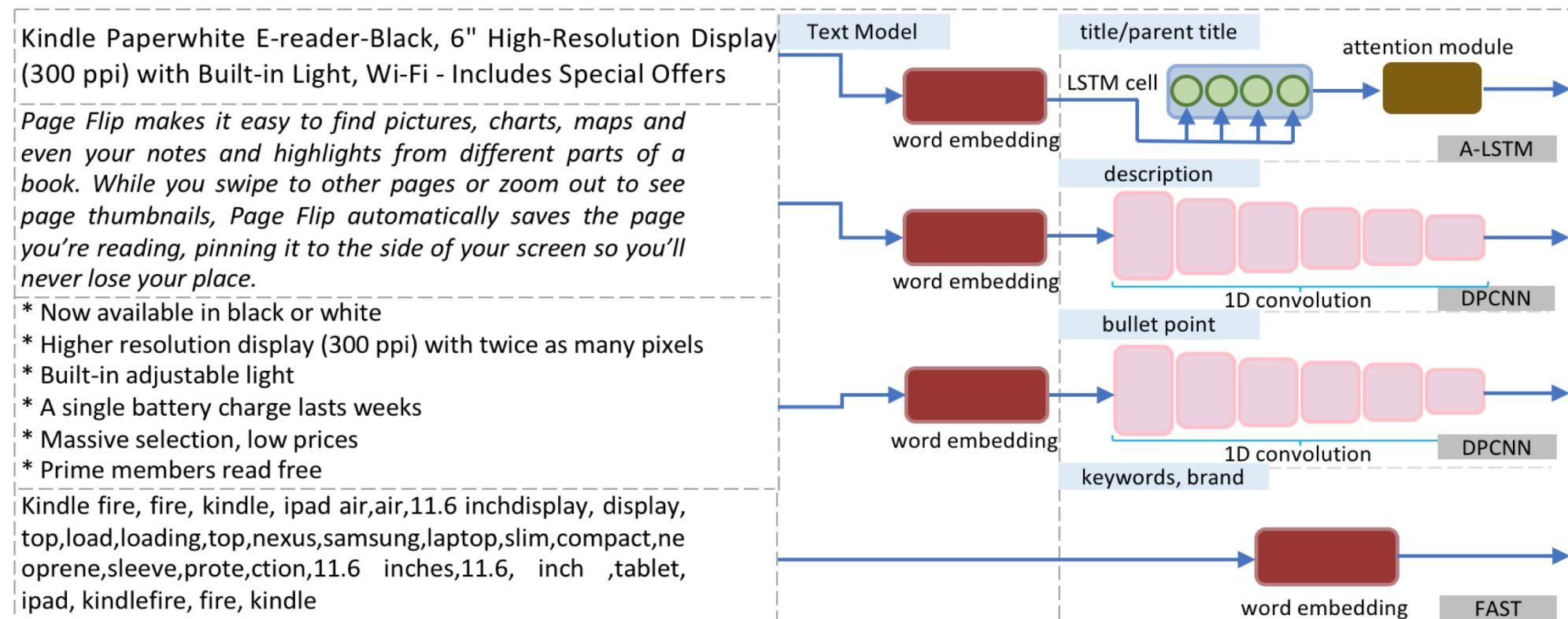
We compare different models over different text fields and choose the best performing one.

fields/models	fastText	A-LSTM	DPCNN
title	87.2	93.4	91.8
parent title	85.4	91.2	86.1
description*	70.0	73.9	74.1
bullet points*	56.0	63.4	64.7

* The low accuracy of description and bullet points is from low coverage (not low explanatory power)

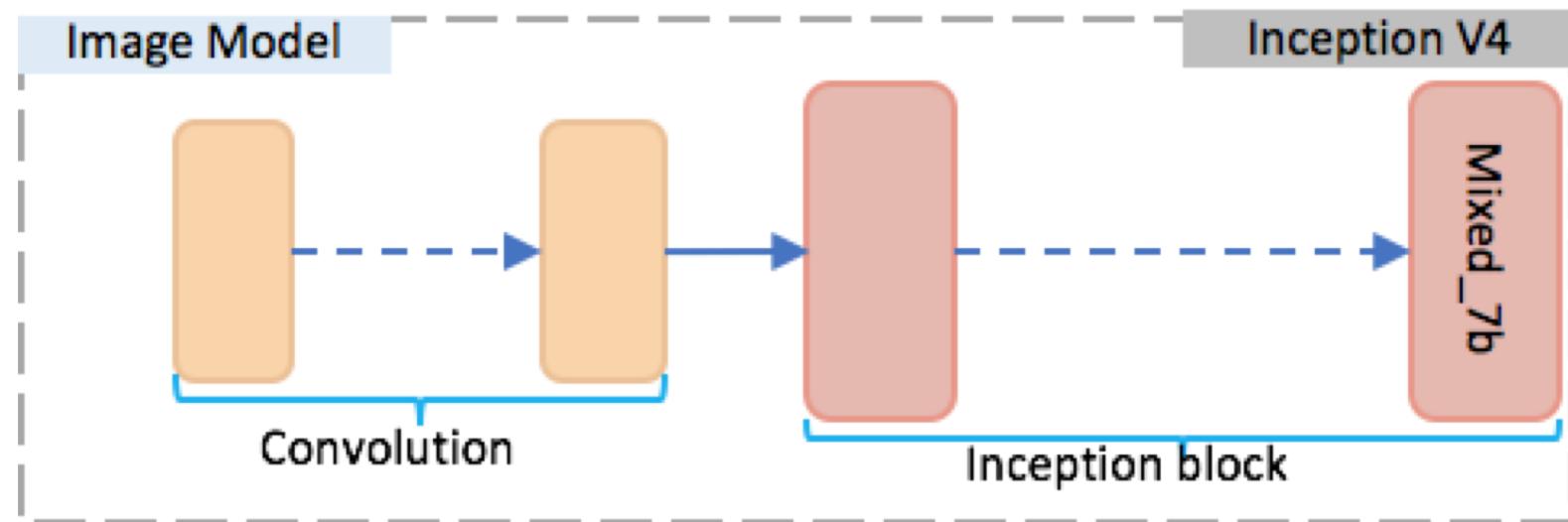
Choice of Text Modules

- We train fastText word embedding over 3 billion U.S. buyable products (title/description/bullet point) and fine-tune it during training: 
- A-LSTM and DPCNN are trained from scratch:   



Choice of Image Module

- We adopt Inception-v4 with residual mechanism.
- fix the bottom convolutional layers, which represent texture and textons: 
- fine-tune all inception blocks, which represent composition parts of objects: 
- The output of the image model is a 1536-dimensional vector.



Master Model Structure

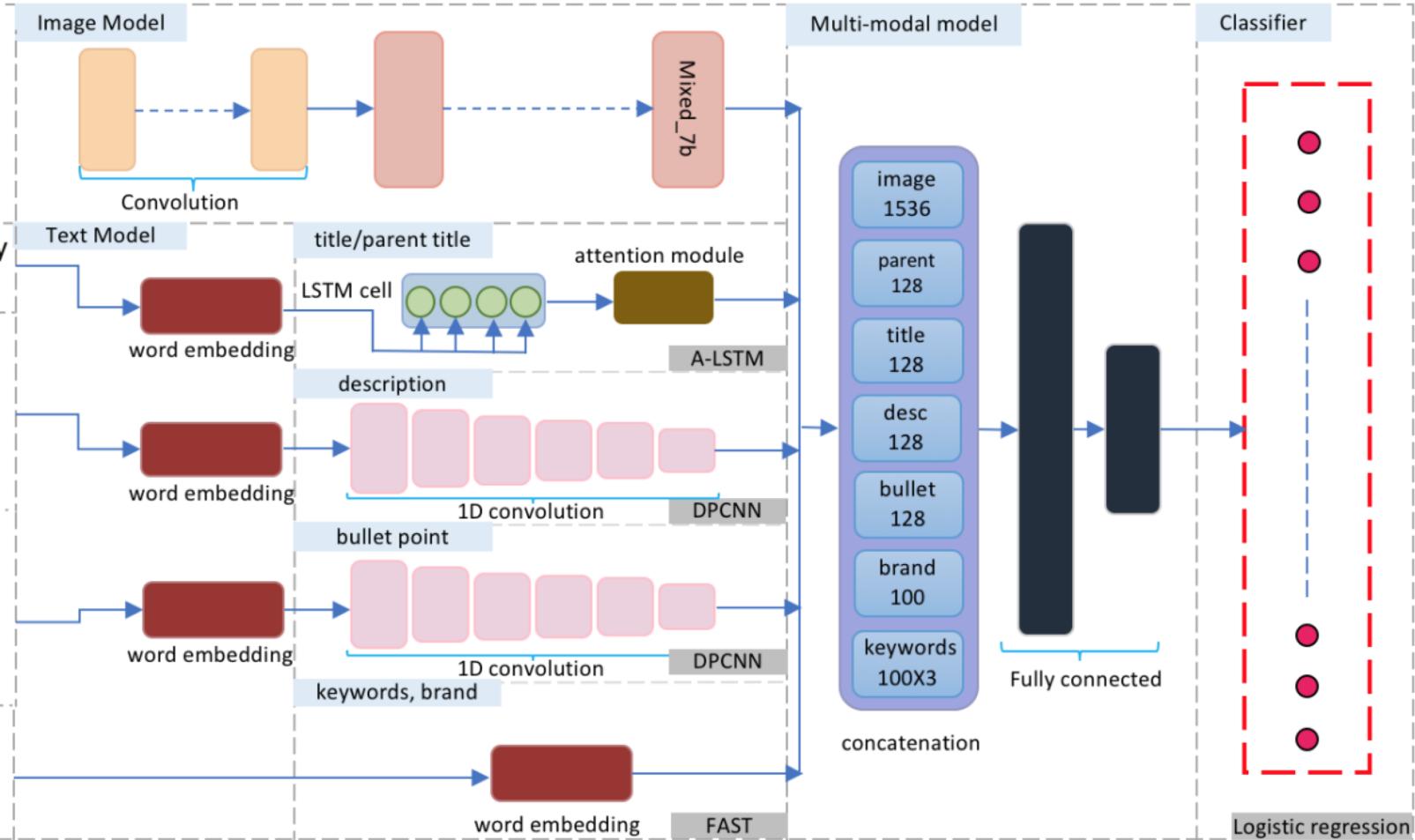


Kindle Paperwhite E-reader-Black, 6" High-Resolution Display (300 ppi) with Built-in Light, Wi-Fi - Includes Special Offers

Page Flip makes it easy to find pictures, charts, maps and even your notes and highlights from different parts of a book. While you swipe to other pages or zoom out to see page thumbnails, Page Flip automatically saves the page you're reading, pinning it to the side of your screen so you'll never lose your place.

- * Now available in black or white
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Kindle fire, fire, kindle, ipad air, air, 11.6 inch display, display, top, load, loading, top, nexus, samsung, laptop, slim, compact, neoprene, sleeve, protec, tion, 11.6 inches, 11.6 inch, tablet, ipad, kindlefire, fire, kindle



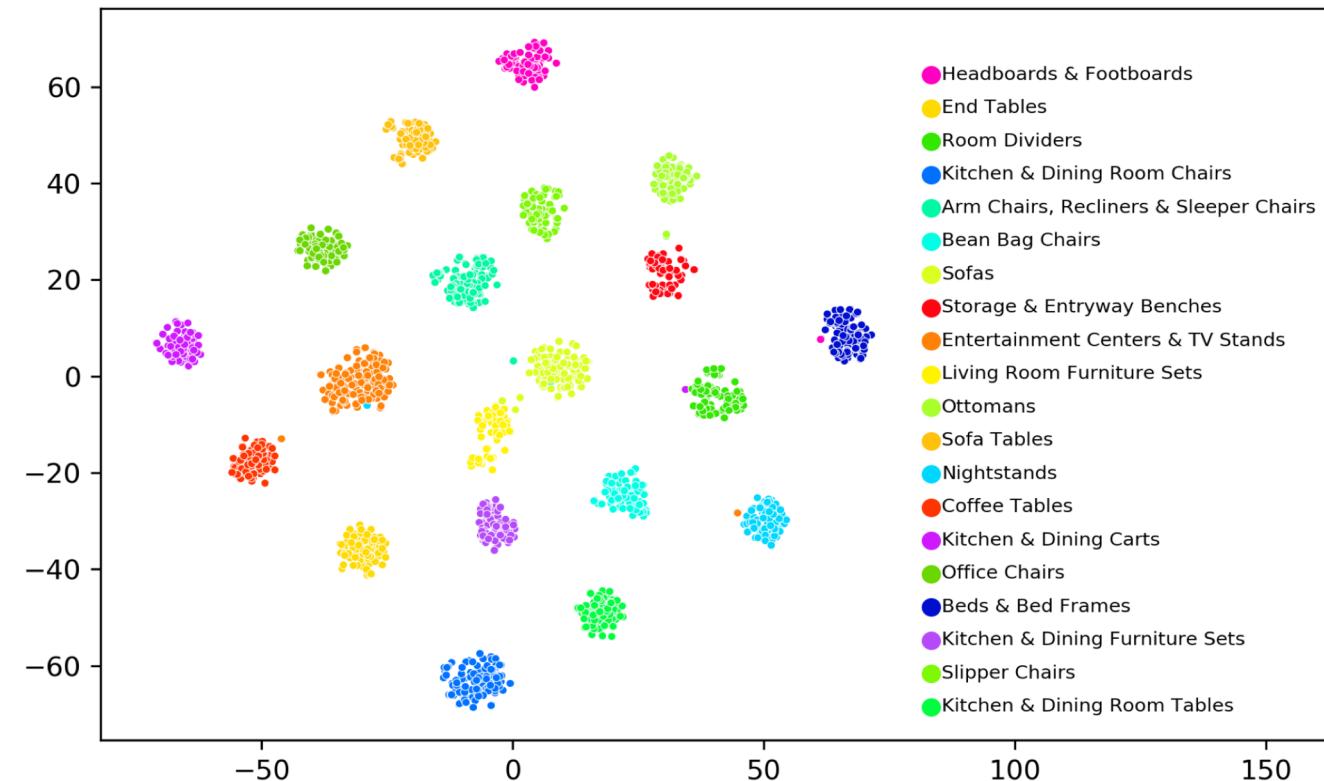
Dataset and Master Model Accuracy

- 11,600 ASINs over 154 different categories (as of 03/02/18)
- 80% randomly selected as training and the rest for testing

accuracy/model	Inception-v4	BOW	Master: text	Master: text+image
Top-1	74.7	87.6	94.8	97.1
Top-2	84.7	93.0	98.1	99.2
Top-3	88.5	94.7	98.7	99.6
Top-4	90.4	95.5	99.2	99.7
Top-5	92.3	96.1	99.3	99.7

Product Representation

- The last hidden layer is extracted as product representation.
- A mixture of Gaussians is desired for feature vectors, and T-SNE helps visualize such data in 2D (20 leaf nodes, dim: 512).



Comparison of Product Vectors

- We use subcat as the prediction target to compare vectors.
- The experiment is on 47 subcats from Product Listing Ads.
- We train classifiers based on different product vectors.

	Product2Vec (dim-128)	Asin2Vec (dim-512)	ProductNet-128	ProductNet-512	ProductNet (dim-2448)
KNN	52.09	63.55	65.75	66.30	66.41
Logistic	56.82	62.11	64.21	67.40	69.05
L2-SVM	50.22	58.59	56.28	60.90	66.85
Naive Bayes	41.08	56.17	60.79	61.45	64.65



Subcat Classification

Business goal: automatically assign subcat label for a new product based on its title, description, and other text data.

Two approaches:

- Design an appropriate function-based taxonomy and a mapping to subcat. Train a master model and utilize the mapping.
- Train the same master model directly on available subcat labels.

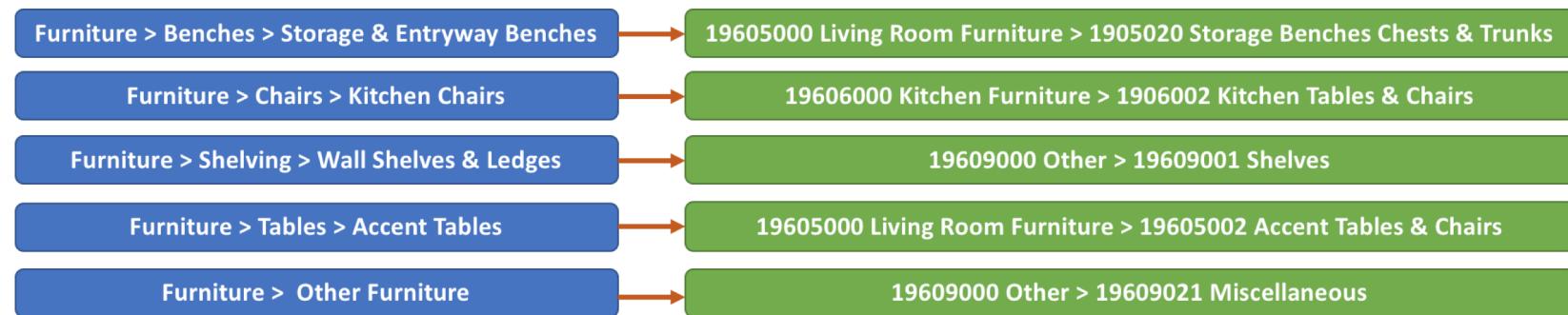
Result on Furniture

There are 63 well-populated subcats in GL_furniture. We take the top-400 active products of each subcat for experiment.

- The directly trained model yields **61.5%** accuracy.

We defined a new taxonomy of 111 leaf nodes and annotate 9K products. The master model achieves 93.1% accuracy.

- Further processed with subcat mapping, we achieve **78.1%** accuracy.



Mapping examples



Conclusion

- Accumulating high-quality labeled data could be labor intensive but achievable.
- Efforts may be well paid off for your applications.
- Collaborative efforts from category owners can contribute to the benchmark dataset and serve the ML community for model development and validation.



Insist on the Highest Standards

“Building a culture of high standards is well worth the effort, and there are many benefits.”

“And finally, high standards are fun! Once you've tasted high standards, there's no going back.”

-- from Jeff's Letter to Shareholders 2017

A High Standards Team

