

Neural Networks

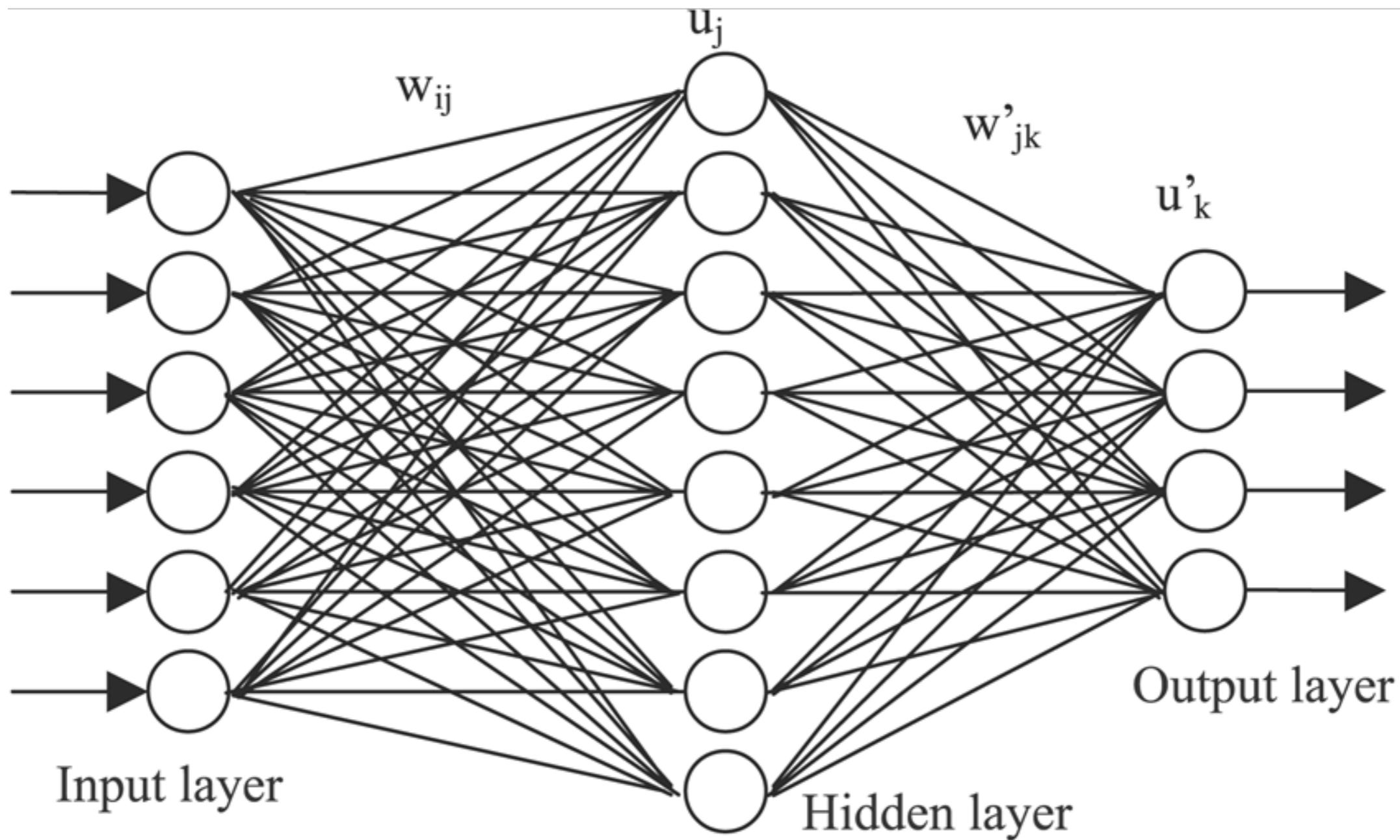
Feed-forward Neural Network

Feed-forward Neural Network

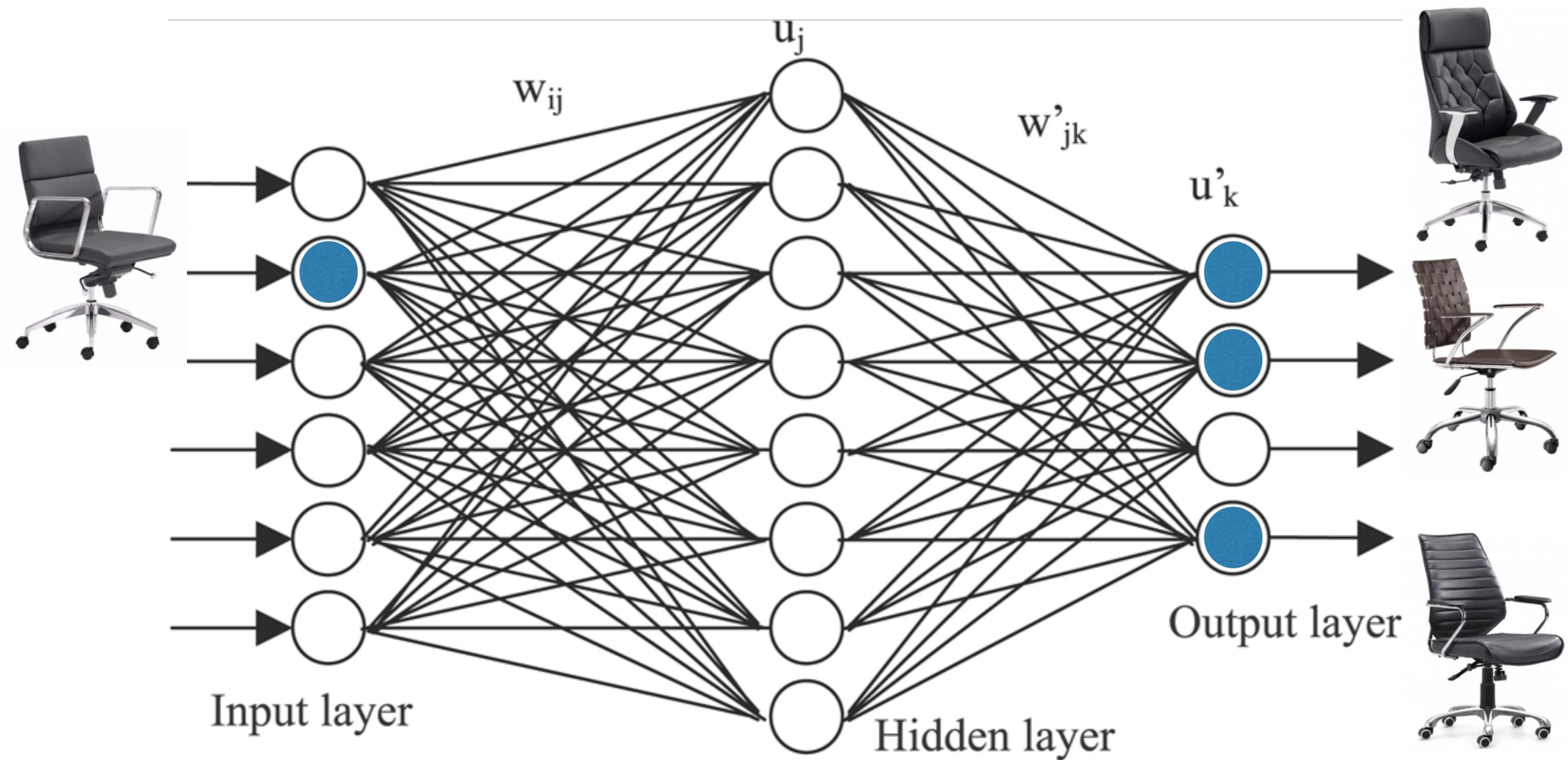


- High Fashion Home browse data
- Divided into product groups per customer
- Subdivided at browsing pauses > 30 min

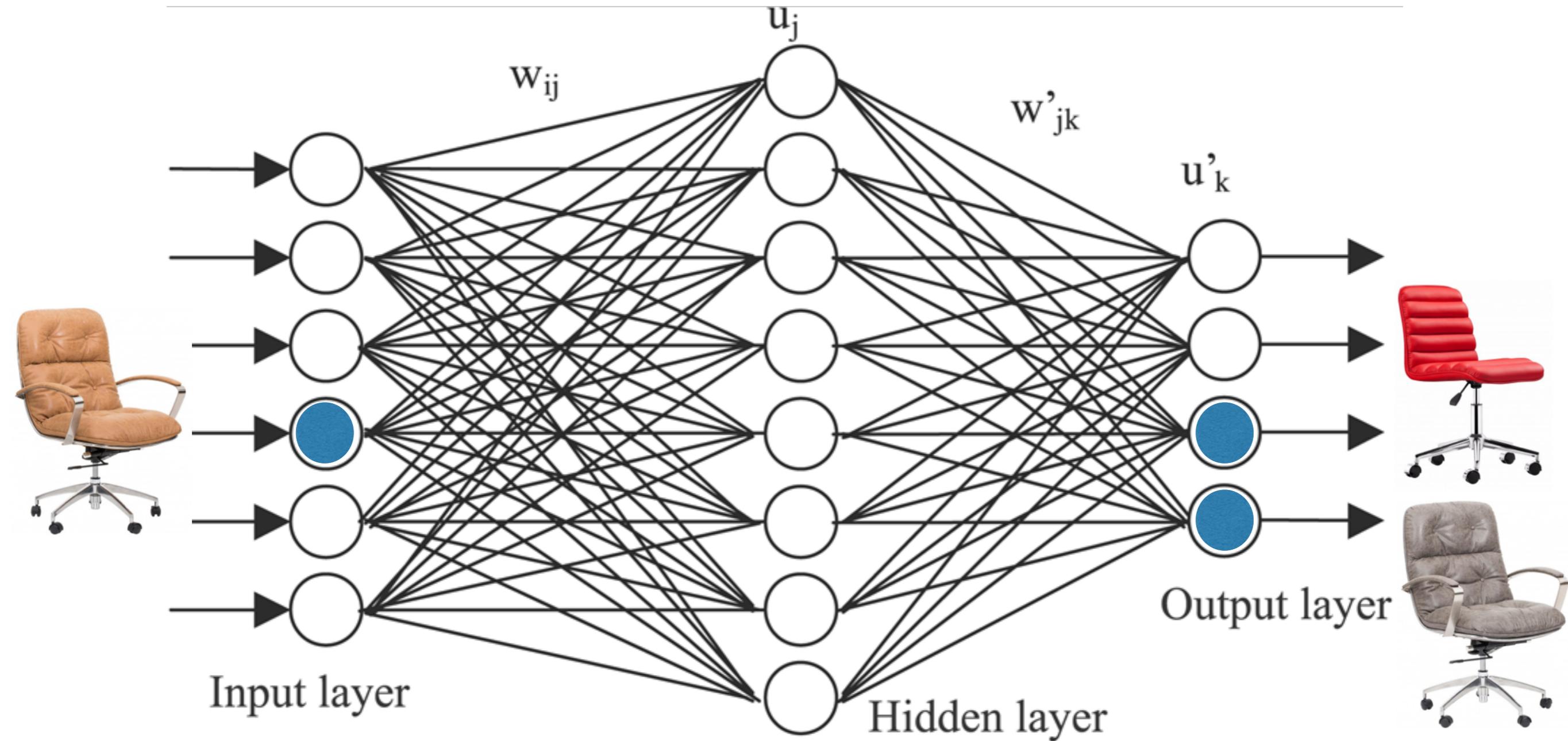
Feed-forward Neural Network



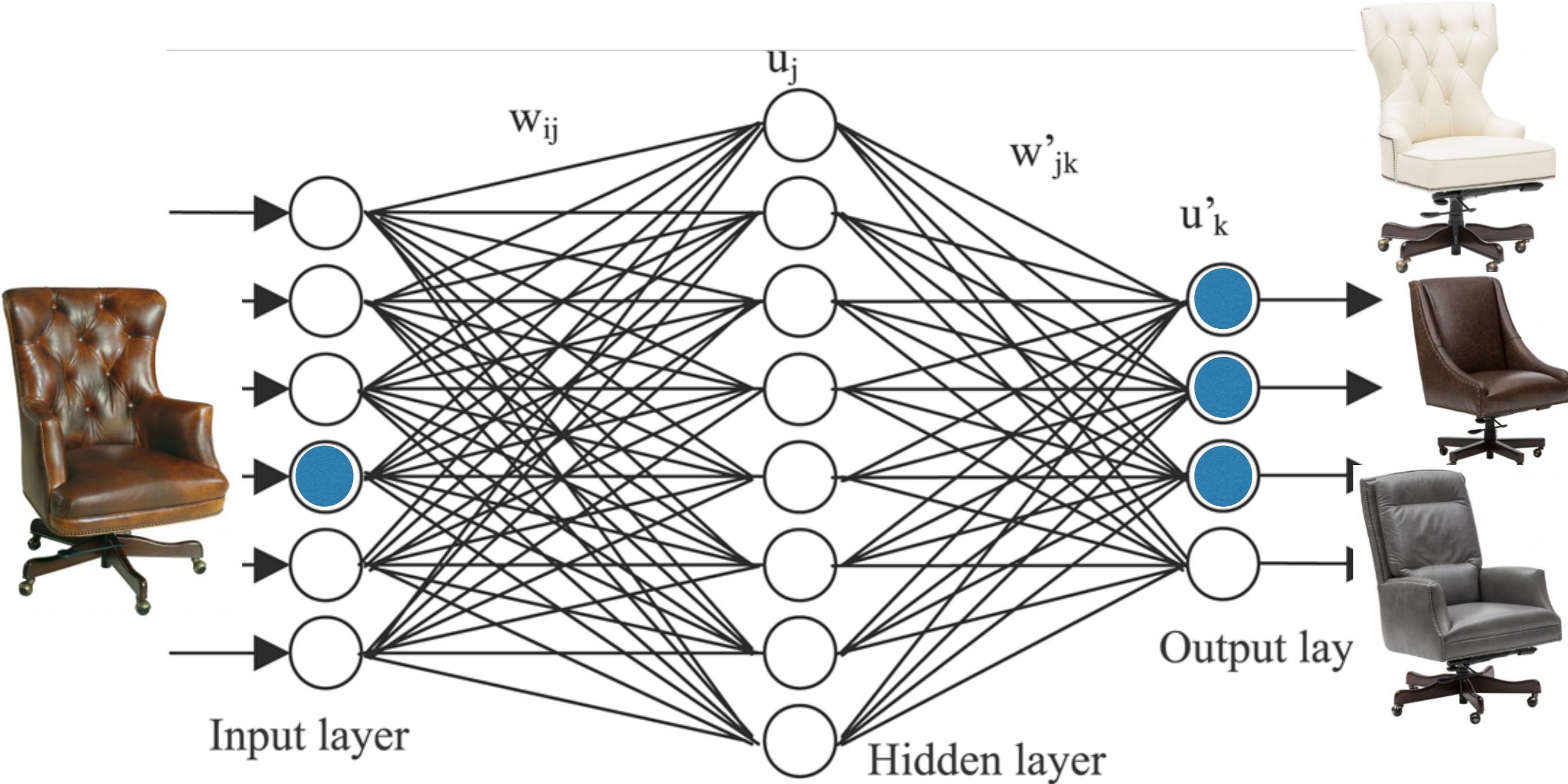
Feed-forward Neural Network

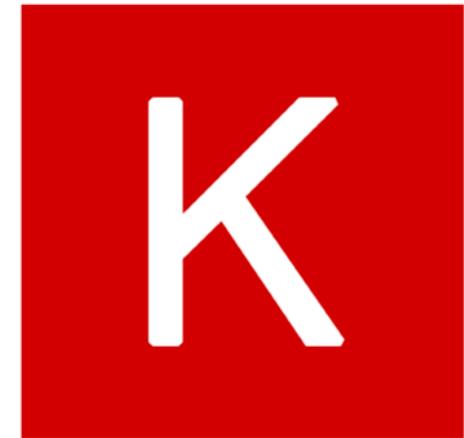


Feed-forward Neural Network

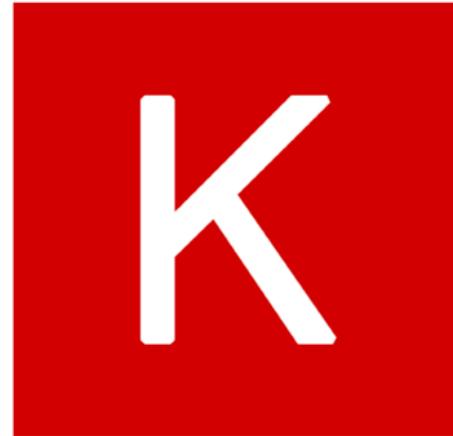


Feed-forward Neural Network



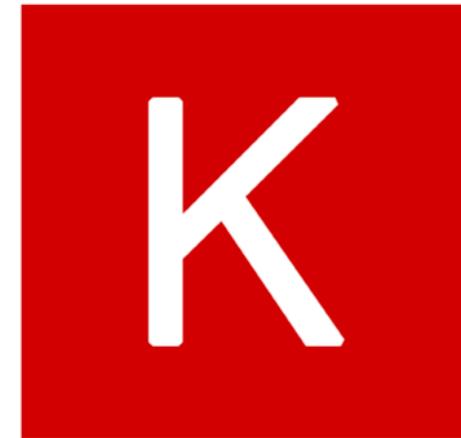


Keras



Keras

- machine learning python package
- API interface for other libraries:
 - Tensorflow, CNTK, Theano

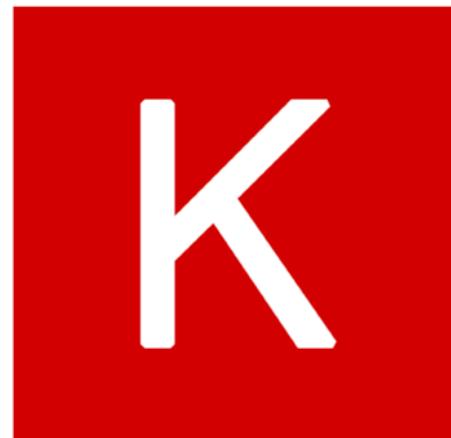


Keras

using



TensorFlow



Keras



TensorFlow

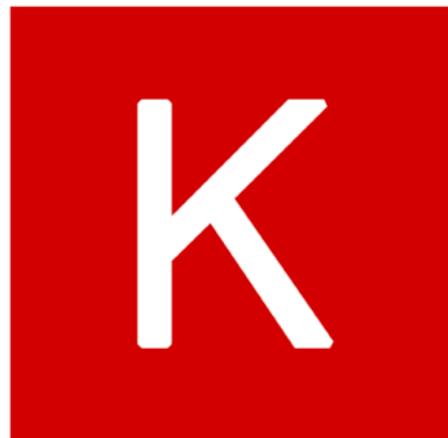
```
from keras.models import Sequential
from keras.layers import Dense

model = Sequential()

model.add(Dense(2 * numProducts,
               input_dim=numProducts,
               activation='relu'))

model.add(Dense(numProducts,
               activation='softmax'))

model.compile(loss='categorical_crossentropy',
              optimizer='rmsprop',
              metrics=['accuracy'])
```

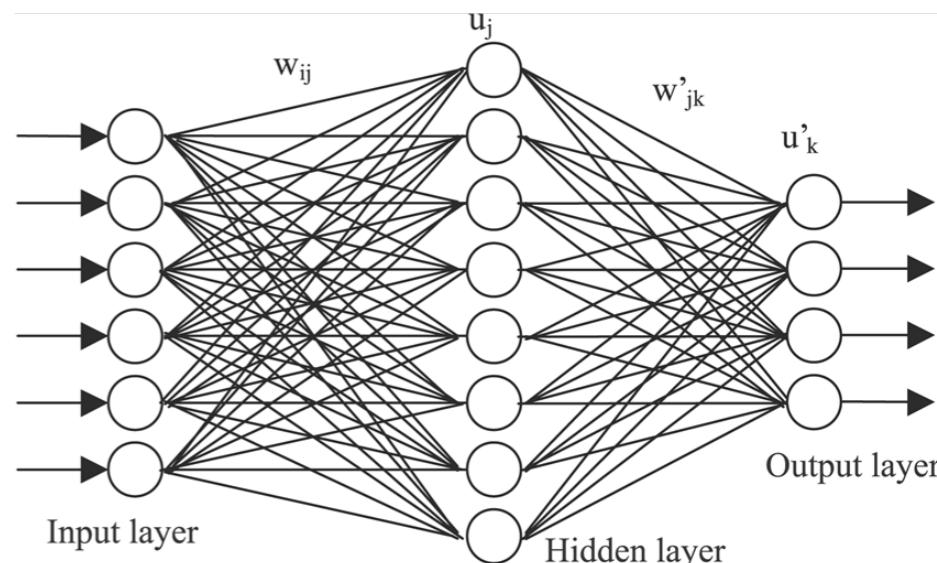


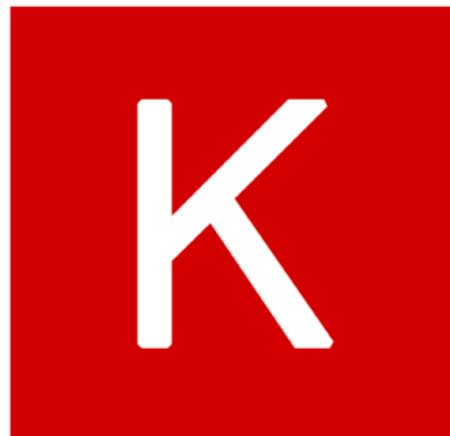
Keras



TensorFlow

```
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from keras.layers import Dense  
  
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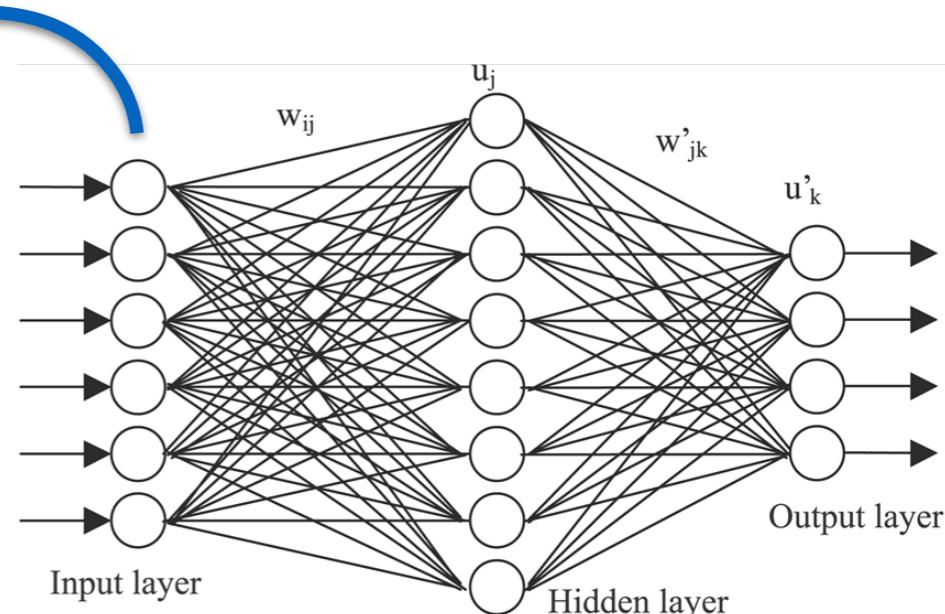


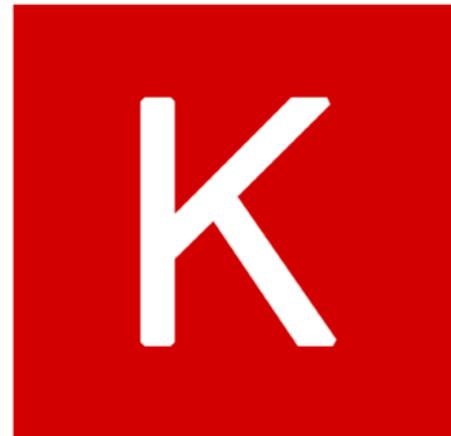
Keras



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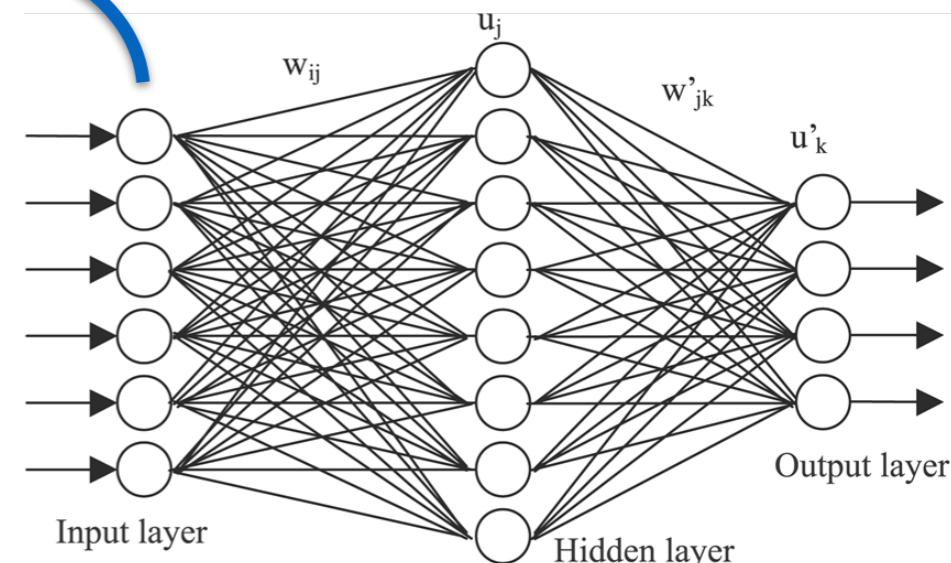


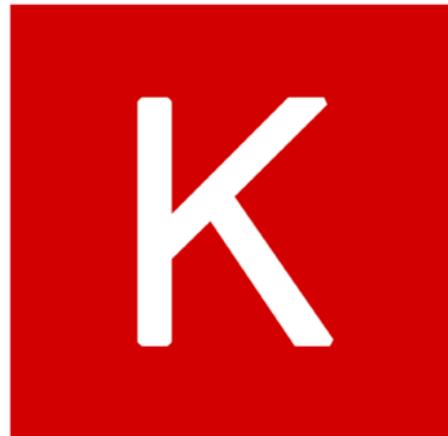
Keras



TensorFlow

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               activation='softmax'))  
  
model.compile(loss='categorical_crossentropy',  
              optimizer='rmsprop',  
              metrics=['accuracy'])
```



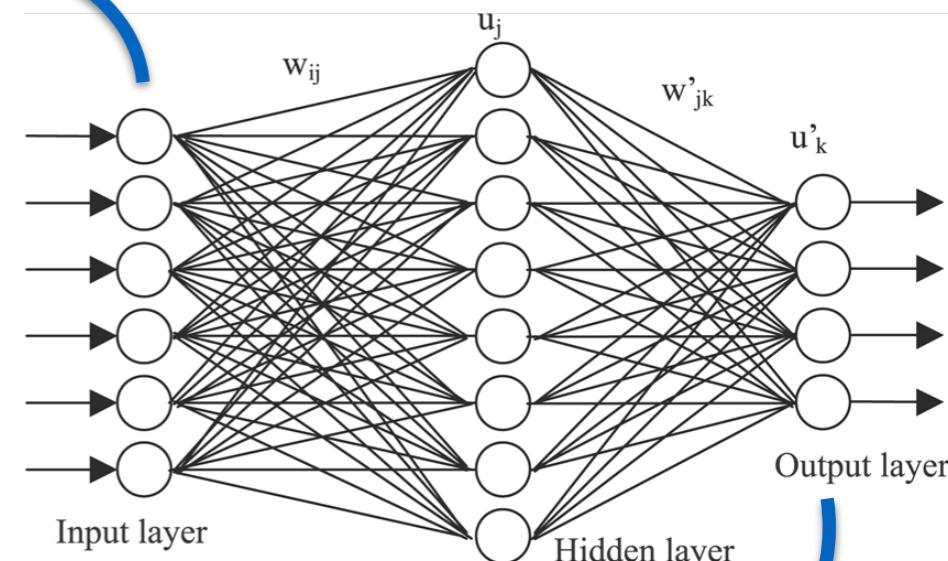


Keras



TensorFlow

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               activation='softmax'))  
  
model.compile(loss='categorical_crossentropy',  
              optimizer='rmsprop',  
              metrics=['accuracy'])
```



K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```

K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```

epoch

- one complete pass through all training data

batch size

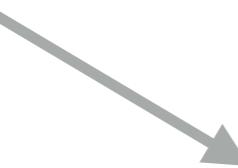
- amount of training data to consider before updating model weights
- higher batch size gives better results, but takes more RAM

K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```

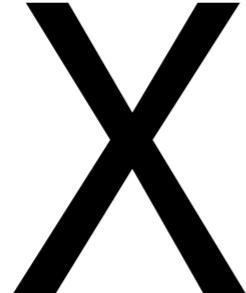


K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```



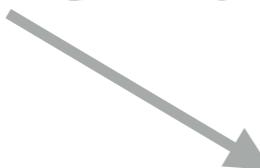
A large, solid black 'X' symbol is centered on the page. A thin grey arrow points from the word 'X' in the code snippet above to this symbol.

K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```



X



0	1	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	0	1
0	0	0	0	1	0	0
0	0	1	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

K Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```



0	1	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	0	1
0	0	0	0	1	0	0
0	0	1	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

training
samples

Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```

X



training
Samples

	0	1	0	0	0	0	0
	0	0	0	1	0	0	0
	0	1	0	0	0	0	0
	0	0	0	0	1	0	0
	0	0	0	0	0	0	1
	0	0	0	0	1	0	0
	0	0	1	0	0	0	0
1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0

Keras



python™

```
model.fit(X, y, epochs=3, batch_size=2000)
```

X

y

training samples



0	1	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	0	1
0	0	0	0	1	0	0
0	0	1	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

```
model.fit(X, y, epochs=3, batch_size=2000)
```

X

y

training samples

	1	0	0	0	0	0
	0	0	1	0	0	0
	1	0	0	0	0	0
	0	0	0	1	0	0
	0	0	0	0	0	1
	0	0	0	1	0	0
	0	0	1	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

	1	0	0	0	0	0
	0	0	0	0	0	0
	0	0	1	1	1	0
	0	0	0	0	1	0
	1	1	0	1	1	0
	0	1	1	0	1	1
1	1	1	0	0	1	1
0	1	1	1	1	0	1
1	1	1	1	1	0	1
1	1	1	0	0	1	0
1	1	0	1	1	0	1

```
model.fit(X, y, epochs=3, batch_size=2000)
```

X

y



training
Samples

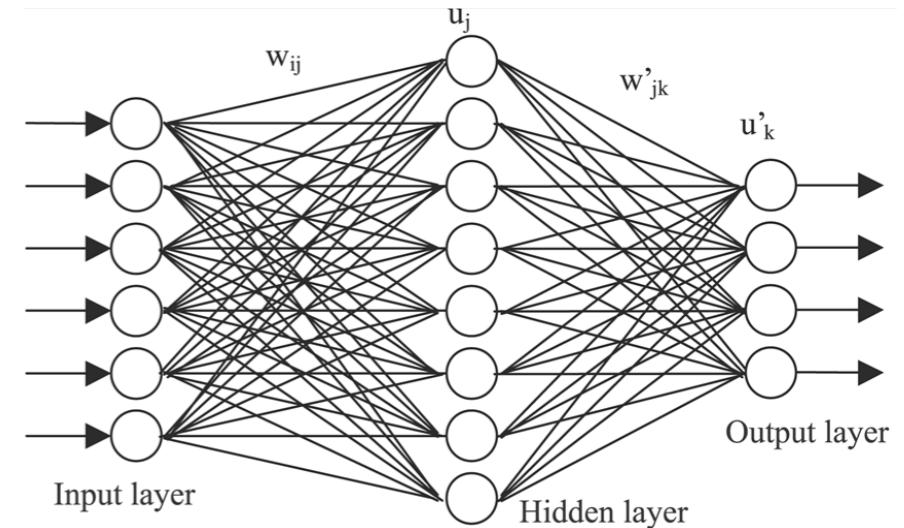
	1	0	0	0	0	0
	0	0	0	1	0	0
	0	1	0	0	0	0
	0	0	0	0	1	0
	0	0	0	0	0	1
	0	0	0	0	0	0
1	0	0	0	0	0	0
	1	0	0	0	0	0
	0	0	0	0	1	0
	0	0	0	1	0	0
	0	0	0	0	0	1

	1	0	1	0	0	0
	0	0	0	0	0	0
	0	0	1	1	1	0
	0	0	0	0	1	0
	0	1	1	0	1	1
	0	1	1	1	1	0
	0	1	0	0	1	1
1	1	1	1	0	0	1
	0	1	1	1	1	0
	1	1	1	1	1	0
	1	1	1	0	0	1
	1	1	0	1	1	0

K Keras



```
model.fit(X, y, epochs=3, batch_size=2000)
```



X

y

Visual representation of training samples X , showing seven different office chairs. Below each chair is a row of binary values representing its features. A blue arrow points down to the first row of the table, indicating the corresponding feature vector for the first chair.

orange	brown	red	black	tan	dark grey	light blue
0	1	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	0	1
0	0	0	0	0	1	0
0	0	1	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

Visual representation of training samples y , showing seven different office chairs. Below each chair is a row of binary values representing its target class. A blue arrow points down to the first row of the table, indicating the target class for the first chair.

orange	brown	red	black	tan	dark grey	light blue
0	1	1	0	0	0	0
0	0	0	0	0	0	0
0	0	1	1	1	0	0
0	0	0	0	0	1	0
0	1	1	0	1	1	0
0	1	1	1	1	0	1
0	1	0	0	1	1	0
1	1	1	0	0	1	1
0	1	1	1	1	0	1
1	1	1	1	1	0	1
1	1	1	0	0	1	0
1	1	0	1	1	0	1

training
samples

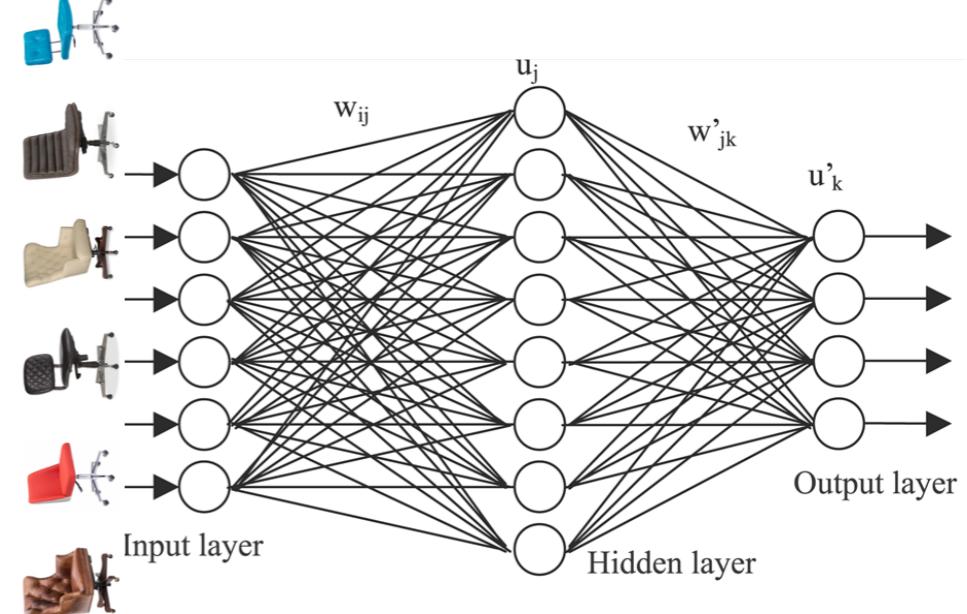
K Keras



```
model.fit(X, y, epochs=3, batch_size=2000)
```

X

y



A grid of 14 rows and 7 columns, representing 14 training samples of chairs. Each row contains a small image of a chair and a 7x7 binary matrix. The matrices show which features are present in each sample. A blue arrow points from the text "training samples" to the first row of the grid.

orange	1	0	0	0	0	0
brown	0	0	1	0	0	0
red	1	0	0	0	0	0
black	0	0	0	1	0	0
tan	0	0	0	0	0	1
dark grey	0	0	0	0	1	0
blue	0	0	0	0	0	1
orange	1	0	0	0	0	0
brown	0	1	0	0	0	0
red	0	0	1	0	0	0
black	0	0	0	1	0	0
tan	0	0	0	0	1	0
dark grey	0	0	0	1	0	0
blue	0	0	0	0	0	1

A grid of 14 rows and 7 columns, representing 14 training labels for chairs. Each row contains a small image of a chair and a 7x7 binary matrix. The matrices show the target values for each feature in each sample. A blue arrow points from the text "training samples" to the first row of the grid.

orange	1	1	0	0	0	0
brown	0	0	0	0	0	0
red	0	0	1	1	0	0
black	0	0	0	0	1	0
tan	0	1	1	0	1	0
dark grey	0	1	1	1	0	1
blue	0	1	0	0	1	1
orange	1	1	1	0	0	1
brown	0	1	1	1	1	0
red	1	1	1	1	0	1
black	1	1	1	0	0	1
tan	1	1	0	1	1	0
dark grey	1	1	1	1	1	0
blue	1	1	1	0	0	1

training
samples

K Keras



```
model.fit(X, y, epochs=3, batch_size=2000)
```

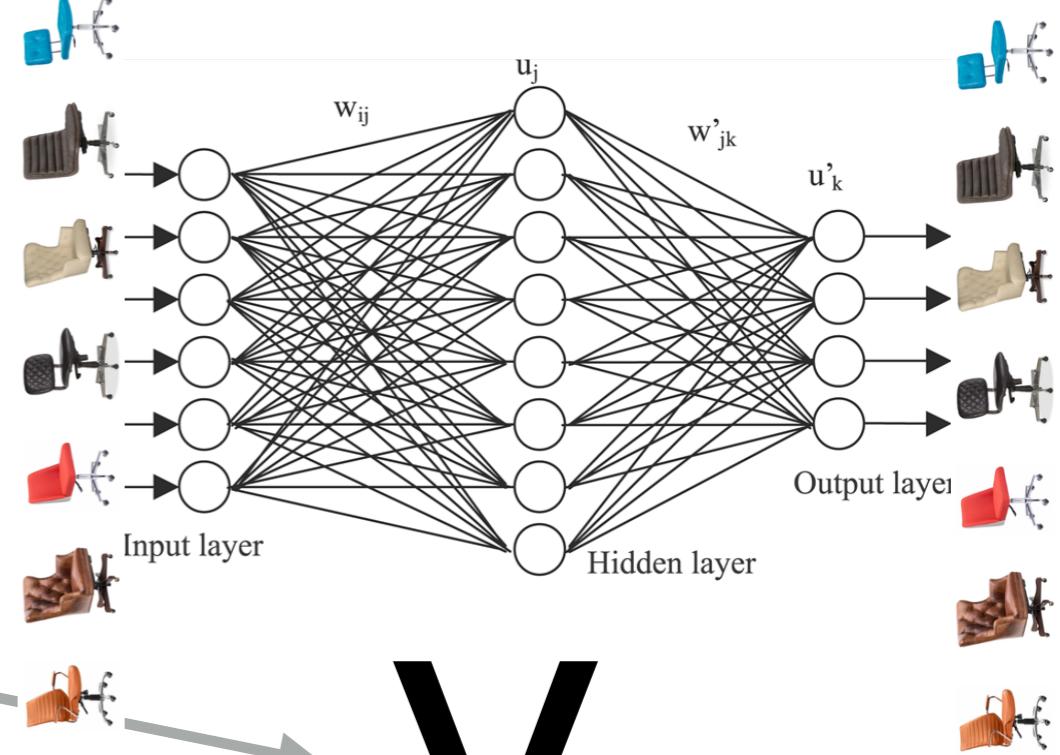
X

y

training
Samples

	1	0	0	0	0	0
	0	0	1	0	0	0
	1	0	0	0	0	0
	0	0	0	1	0	0
	0	0	0	0	0	1
	0	0	0	0	1	0
	0	1	0	0	0	0
1	0	0	0	0	0	0
0	1	0	0	0	0	0
0	0	0	0	1	0	0
0	0	0	1	0	0	0
0	0	0	0	0	1	0

	1	0	0	0	0	0
	0	0	1	0	0	0
	0	0	0	1	1	0
	0	0	0	0	0	1
	0	1	1	0	1	0
	0	1	1	1	1	0
	0	1	0	0	1	1
1	1	1	1	0	0	1
0	1	1	1	1	0	1
1	1	1	1	1	0	1
1	1	1	0	0	1	0
1	1	0	1	1	0	1



should have used: **Word Embeddings**

GloVe word2vec

Co-occurrence Matrix

	man	woman	queen
man	0	3	1
woman	3	0	5
queen	1	5	0

should have used: Word Embeddings

GloVe

word2vec

Co-occurrence Matrix

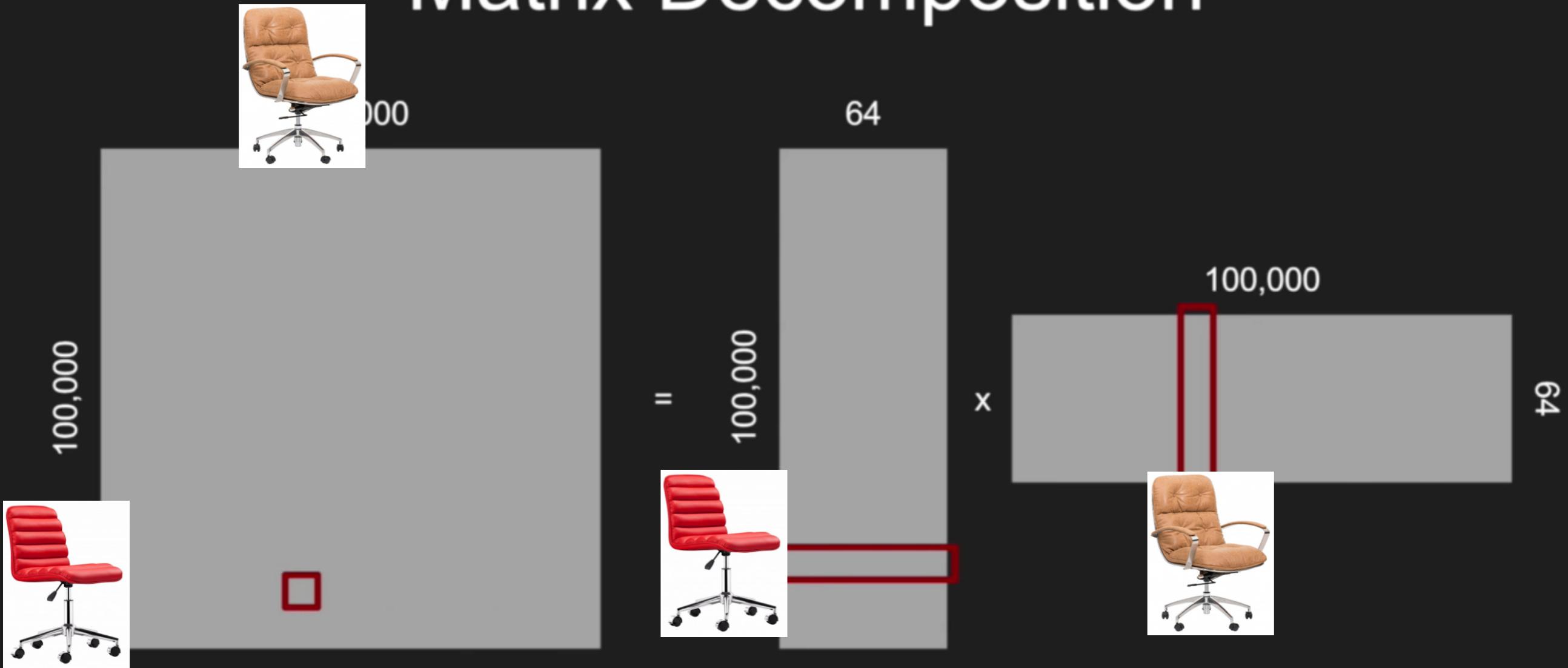
			
0	3	1	
	3	0	5
	1	5	0

should have
used:

Word Embeddings

GloVe
word2vec

Matrix Decomposition



should have Word GloVe
used: Embeddings word2vec



gets you

[0.23, 0.65, 0.12, 0.84, 0.34]

instead of

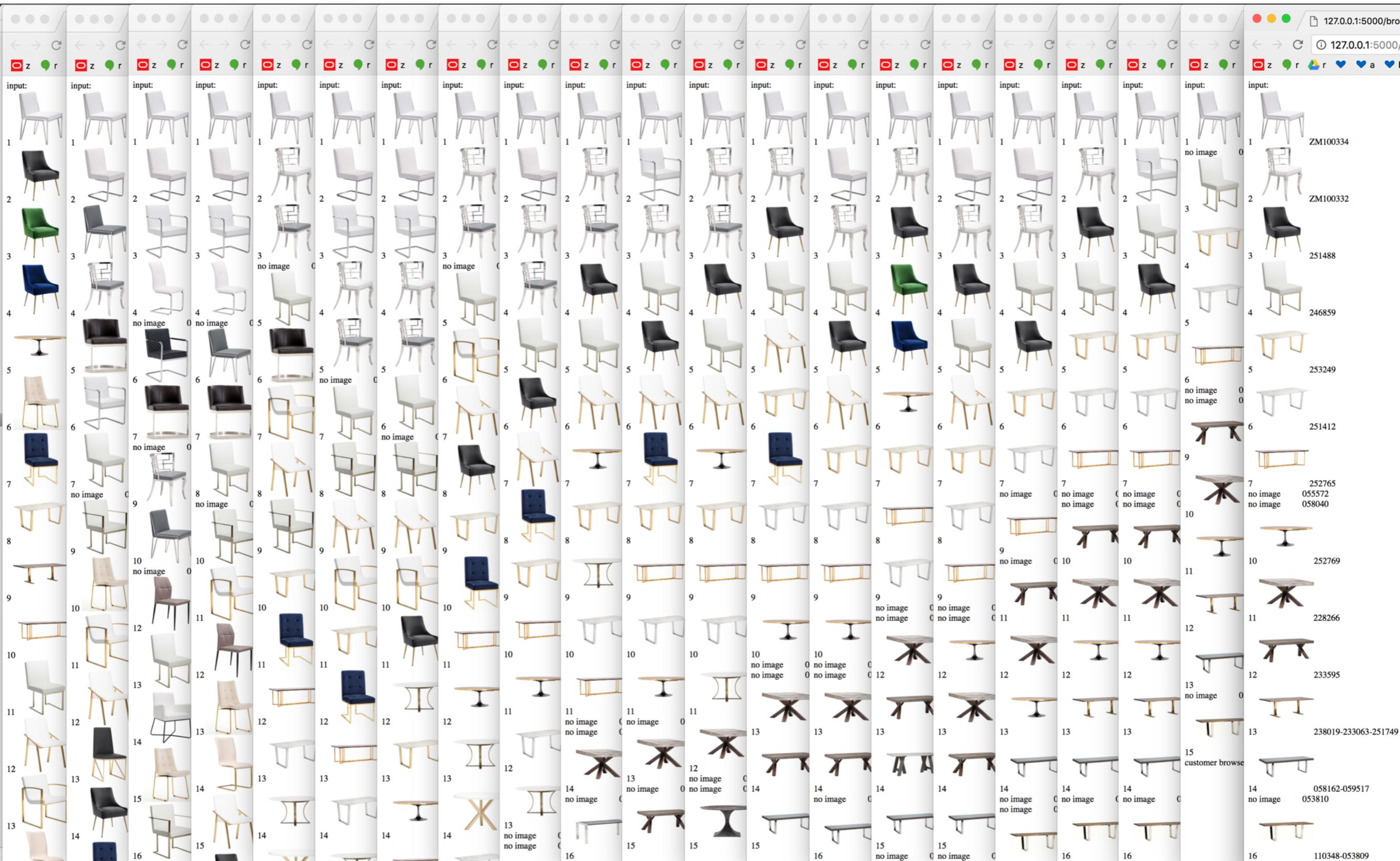
[0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, ... 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]

(for example)

epoch = 1 complete pass through all training data

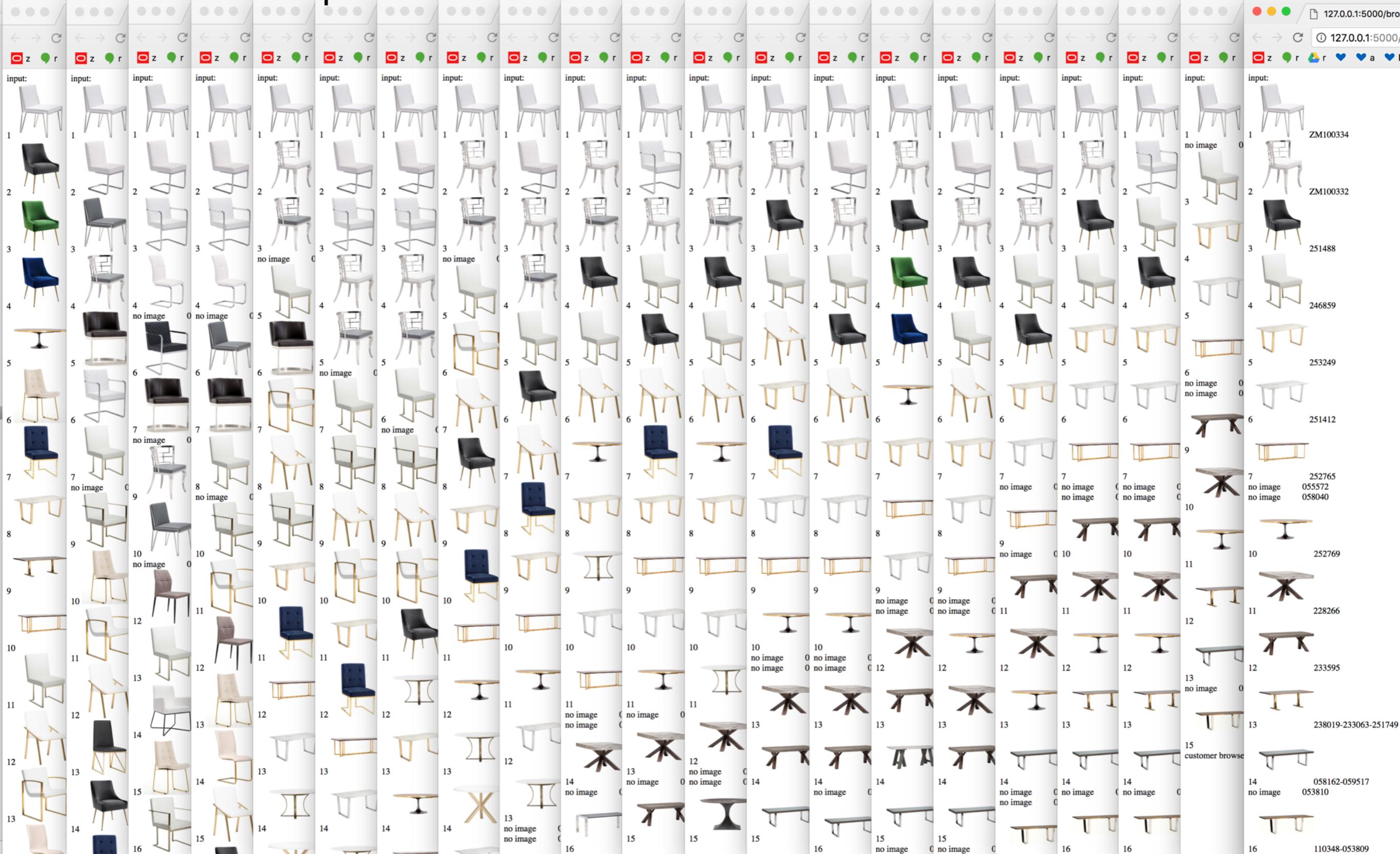
more is better?

epoch = 1 complete pass through all training data



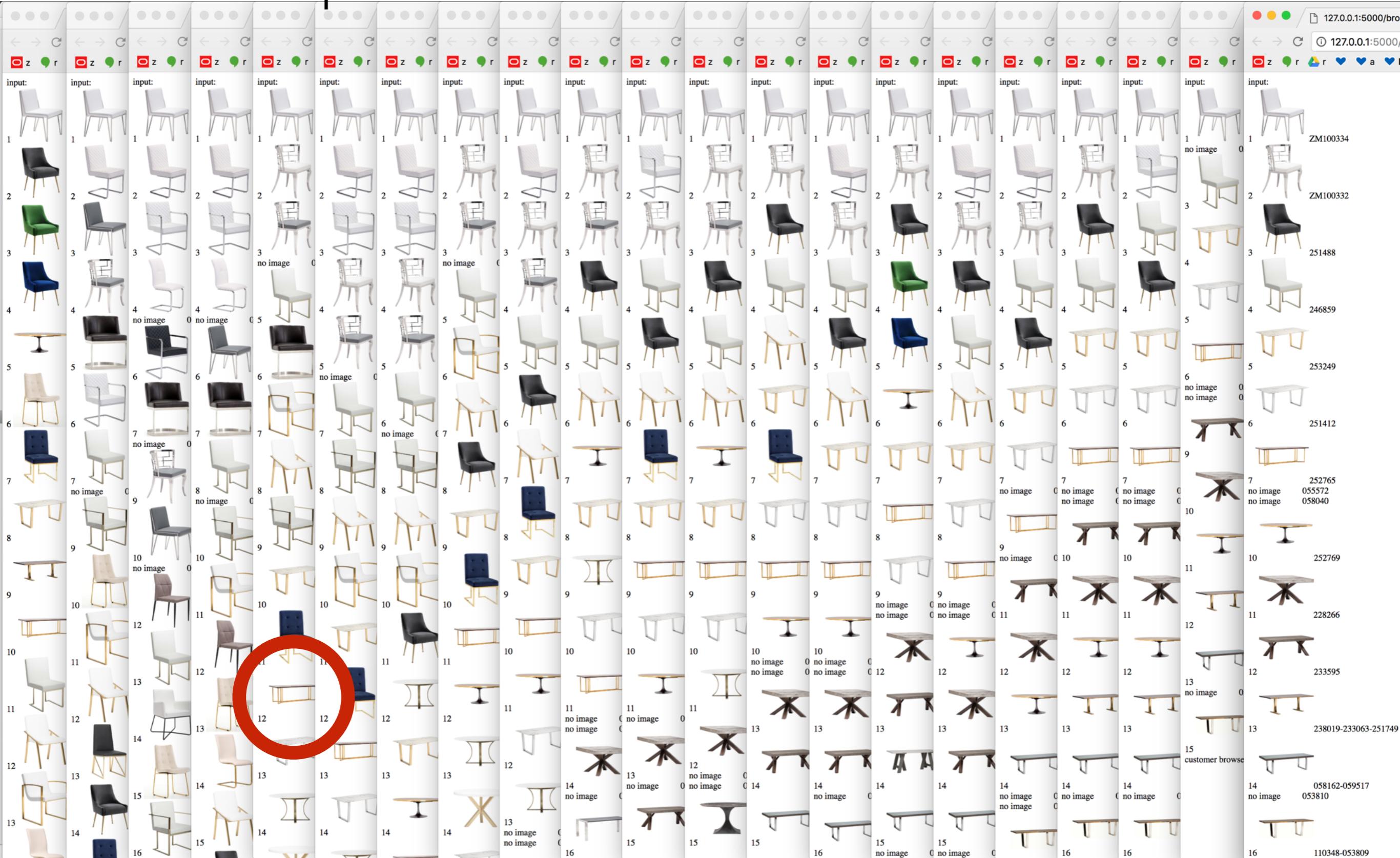
epoch = 1 complete pass through all training data

1 2 3... epochs →



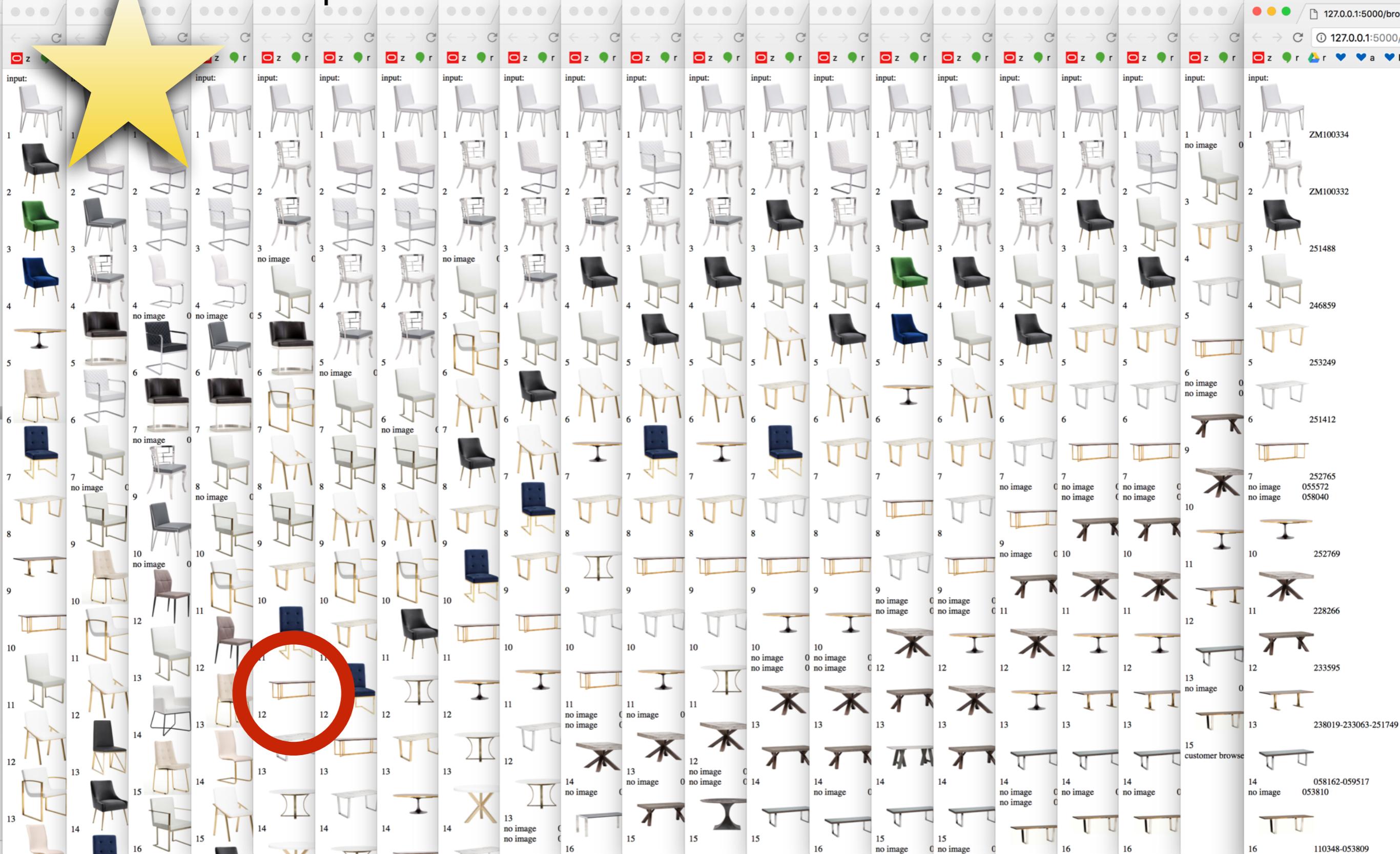
epoch = 1 complete pass through all training data

1 2 3... epochs



epoch = 1 complete pass through all training data

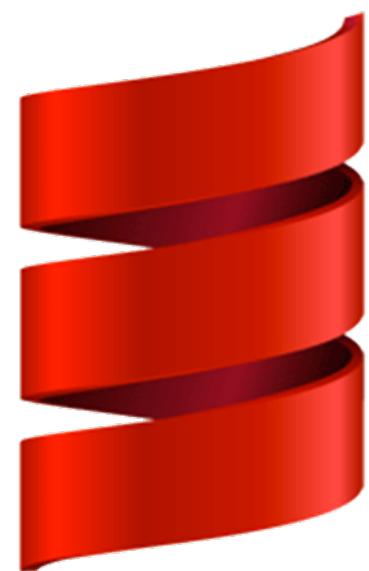
1 2 3... epochs →



neural network model file: **1.2 GB**

(not feasible for production)

maybe using product embedding would
help?



Scala

 Vue.js



pythonTM



elasticsearch

 Solr



Vue.js

thoughts

- Easier than React
- Official routing
- Official state management
- Templates (easier to read/manage than JSX)
- full CSS allowed per component

Joe Colopy, as rendered in spaghetti

RECOLORY
STAR WARS

WEL

010

some screenshots of the recommendations web app

taken after the presentation

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

Not Secure | robinson.brontolabs.local:8081/#/ [hackdays presentation slides](#)

z r a local teams myTickets gitQa style n Email n List n Ctct n SMS n Keywrds n TxtToJoin http://brobot.brontolabs.local:8081/n Wbfrm n Wf

light

Current Product



Atom 3 Light Pendant



Galactic Floor Lamp

Browse History

Current Product and Browse History products used as recommendation inputs

Search Results

Sofa, rey	Fano Barstool, Light Gray	Carter Chair, Light Gray	Tristan 5 Light Pendant	Cosmo Barstool, Light Grey	Allura Bench, Light Grey	Asheville Chair, Light Grey	Napoli Barstool, Light Grey	Nevada Linen, Light Pink	Atom 3 Light Pendant

Bronto Recs

(estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)

--	--	--	--	--

Neural Network Recs

--	--	--	--	--	--	--

Atom 8 Light Pendant Atom 10 Light Pendant, Grey Atom 10 Light Pendant, Clear Atom Pendant, Clear Atom Pendant, Grey Particles Chandelier, Small Flake Chandelier

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

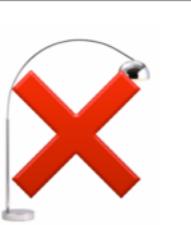
Not Secure | robinson.brontolabs.local:8081/#/ n Email n List n Ctct n SMS n Keywr n TxtToJoin http://brobot.brontolabs.local:8081/n Wbfrm n Wf

light [hackdays presentation slides](#)

Current Product

 Flake Chandelier

 Atom 3 Light Pendant

 Galactic Floor Lamp

Browse History

clickable red X appears on mouse-over for product removal

Search Results

scrollable

 Sofa, rey

 Fano Barstool, Light Gray

 Carter Chair, Light Gray

 Tristan 5 Light Pendant

 Cosmo Barstool, Light Grey

 Allura Bench, Light Grey

 Asheville Chair, Light Grey

 Napoli Barstool, Light Grey

 Nevada Linen, Light Pink

 Atom 3 Light Pendant

Bronto Recs (estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)

 Trion Floor Lamp

 Swift Floor Lamp

 Rush Floor Lamp

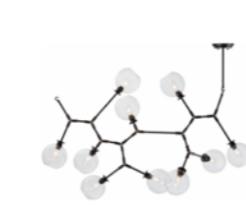
 Derecho Floor Lamp

 Cosima Floor Lamp, Large

Neural Network Recs

 Atom 8 Light Pendant

 Atom 10 Light Pendant, Grey

 Atom 10 Light Pendant, Clear

 Atom Pendant, Clear

 Atom Pendant, Grey

 Particles Chandelier, Small

 Particle Chandelier Antique Brass, Small

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

Not Secure | robinson.brontolabs.local:8081/#/ n Email n List n Ctct n SMS n Keywr n TxtToJoin http://brobot.brontol... n Wbfrm n Wf

open hand [hackdays presentation slides](#)

Current Product



Piedmont Hands Vase

Browse History

click a result to select it

Search Results

								
Open Hand, Brass	Bird In Hand	Truss Bottle Opener	Roll Bottle Opener	Cement Hand Decor	Piedmont Hands Vase	Ronan Hand Statuaries	Hold My Hand	Helping Hand Bookend

Bronto Recs

(estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)

				
Ian Sectional, Tyler Dove-Tyler Charcoal	Fritz Rope Ottoman	Felix Side Table, Antique Brass	Handloom Woven, Celadon	Handloom Woven, Dune

Neural Network Recs

					
Celfie Vase, Vanilla	Donburi Face Bowl	Celfie Vase, Caramel	Celfie Vase, Chocolate	Cacti Pot	Carry About Vase

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

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open hand [hackdays presentation slides](#)

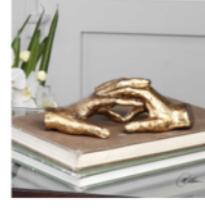
Current Product



Open Hand, Brass



Piedmont Hands Vase



Hold My Hand

Browse History

Search Results



Open Hand, Brass



Bird In Hand



Truss Bottle Opener



Roll Bottle Opener



Cement Hand Decor



Piedmont Hands Vase



Ronan Hand Statuaries



Hold My Hand



Helping Hand Bookend

Bronto Recs

(estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)



Gold Zebra Cowhide Pillow-18" x 18"



Wedge Bar Stool, White (Set of 2)



Glitter Votive



Gold Zebra Cowhide Pillow



His Mask, Matte White

Neural Network Recs



Donburi Face Bowl



Celfie Vase, Vanilla



Celfie Vase, Caramel



Celfie Vase, Chocolate



Cacti Pot



Carry About Vase



OK Sign, Brass

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[lamp](#) [hackdays presentation slides](#)

Current Product

Derecho Floor Lamp

Browse History

Galactic Floor Lamp Byron Floor Lamp

Search Results

Tipton Lamp Valdez Lamp Silver Soda Lamp Aragonite Ceiling Lamp Penelope Silver Lamp Byron Floor Lamp London Table Lamp Tensdale Table Lamp Galactic Floor Lamp

Bronto Recs (estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)

Swift Floor Lamp Trion Floor Lamp Rush Floor Lamp Cosima Floor Lamp, Large Tumble Floor Lamp

Neural Network Recs

Double Shade Floor Lamp Llewyn Antique Brass Floor Lamp Lucille Floor Lamp Tivat 2 Floor Lamp Lucca Floor Lamp Laiton Floor Lamp Valdez Lamp Manhattan Lamp

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

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hackdays presentation slides

chair

Current Product



Suza Chair

Browse History

Search Results

									
Chair	Owen Chair	Alice Chair	Copley Chair	Oh Chair	Chase Chair	Metz Chair	Stella Chair, Nobletex	Suza Chair	Isaac Chair

Bronto Recs (estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)

					
Ian Sectional, Dove-Tyler Charcoal	Tyler Dove-Tyler Charcoal	Camden Lantern, Brass	Hale Chandelier	Canbrio Chair, Smoke Black	Norwich Dining Chair, Brown (Set of 2)

Neural Network Recs

			
Cosway Chair	Meredith Chair	Corbin Chair, Bella Jasper	Elle Chair, Beige

MoonPie (@Moon ... deck by stuartcro ... robinson.brontolabs.local:8081/#/ EC2 Management solr tutorial 7.1 - Solr Tutorial | Apache Solr Search results for Hackdays2017 Stuart

Not Secure | robinson.brontolabs.local:8081/#/ z r a local teams myTickets gitQa style n Email n List n Ctct n SMS n Keywrds n TxtToJoin http://brobot.brontolabs.local:8081/ n Wbfrm n Wf

hackdays presentation slides

chair

Current Product



Draper Chair, Cream

Browse History



Mott Eco-Leather Chair, Pearl



Elle Chair, Beige



Suza Chair

Search Results



Chair



Owen Chair



Alice Chair



Copley Chair



Oh Chair



Chase Chair



Metz Chair



Stella Chair,
Nobletex



Suza Chair



Isaac Chair

Bronto Recs

(estimated by search Bronto's "viewed this / viewed that" indicator lists in Solr)



Avery Chair, Mauve Avery Chair, Textured Gold Avery Chair, Navy Corbin Chair, Bella Jasper Corbin Chair, Bella Smoke

Neural Network Recs



Avery Chair,
Mauve Baxter Chair,
Cream Magnolia Chair, Navy with Gold
Base Magnolia Chair, Sea Blue with Gold
Base Corbin Chair, Bella
Jasper Elle Chair, Grey Avery Chair, Navy