

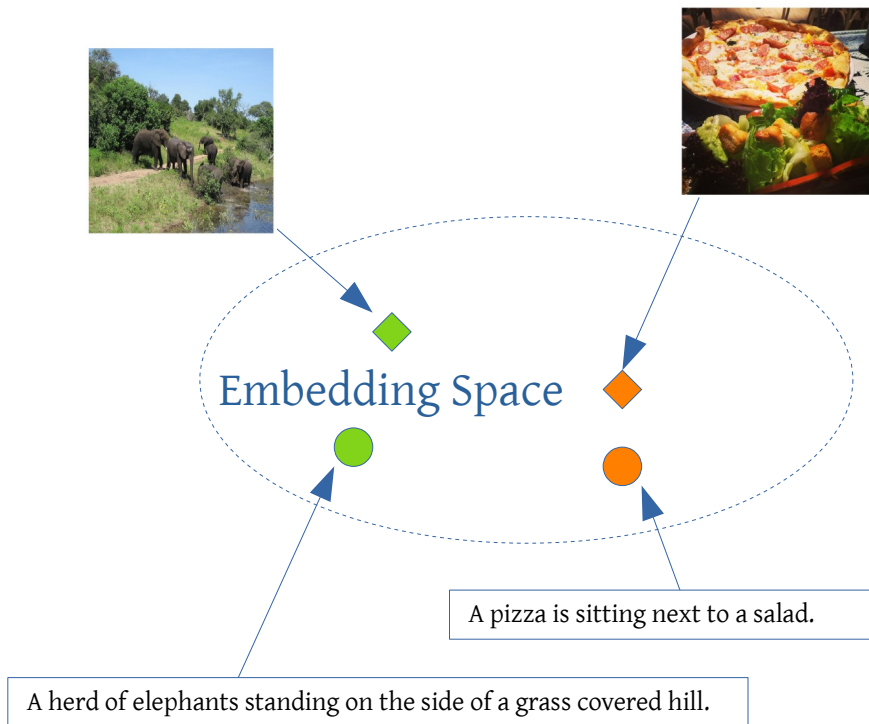
Ladder Loss for Coherent Visual-Semantic Embedding

(AAAI-2020, Feb 7-12, New York, NY, USA)

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Dec 25 2019

Visual-Semantic Embedding

- Cross-Modal Retrieval (image \leftrightarrow text)



WHAT

- * multi-modal joint embedding
- * Map images & texts into a common space
- * Images \rightarrow Convolutional Neural Nets
- * Text \rightarrow Recurrent Neural Nets

WHY

- * Retrieval by comparing embedding distance
- * Image/text generation using embedding vecs
- * Visual question answering

Visual-Semantic Embedding

- How
 - (1) Canonical Correlation Analysis (CCA)
 - (2) Deep metric learning-based embedding space learning
- Deep metric learning-based methods scale better to large scale datasets and achieve better performance

Deep Metric Learning

- Metric

Given a set X , a metric is a (distance function) $d : X \times X \mapsto [0, \infty)$

Visual-Semantic Embedding

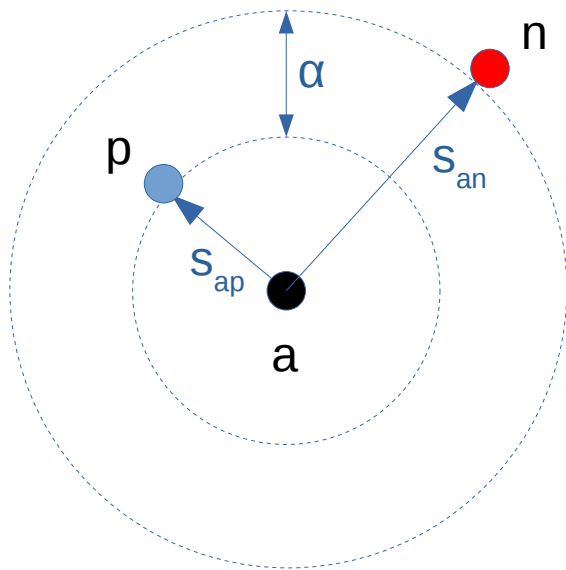
Image & Text embedding vectors $X = \{x_{\text{image},1}, x_{\text{text},1}, \dots, x_{\text{image},N}, x_{\text{text},N}\}$

Subtle problem: Loss function for DML

- * Contrastive loss (restrictive)
- * Triplet loss (less-restrictive)
- * Variants of Triplet loss, e.g. PDDM, Histogram Loss, quadruplets.
- * n-pair loss
- * lift-structure loss

Existing Problem

- Relevance → **Binary** Variable. e.g. Triplet loss



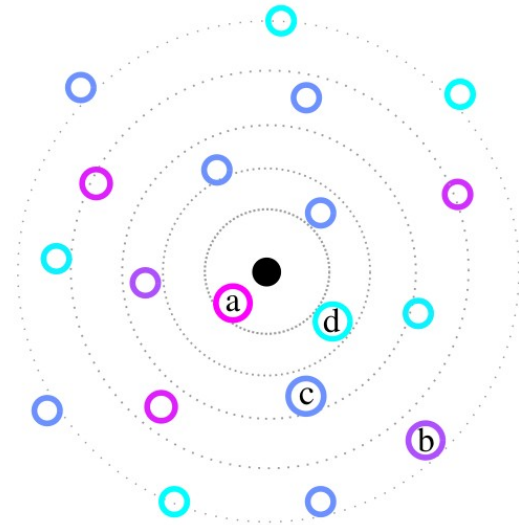
$$s(v_q, h_q) - s(v_q, h_p) > \alpha$$

$$L_{tri}(q) = \sum_{p \in \mathcal{N}^{-q}} [\alpha - s(v_q, h_q) + s(v_q, h_p)]_+,$$

Existing Problem

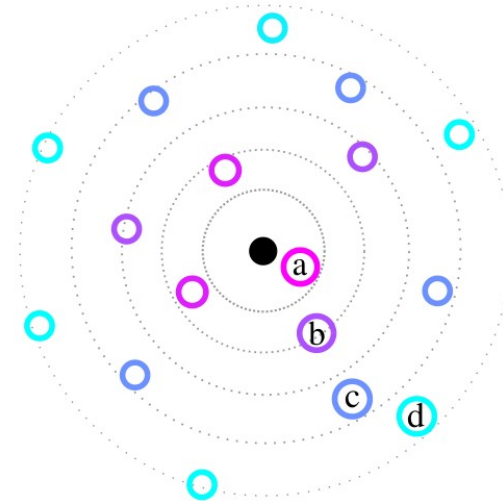


- a** A herd of elephants standing on the side of a grass covered hill.
- b** An elephant stands near water and a stone wall.
- c** A pair of elephants with their trunks entwined.
- d** A group of four skiers posing for a picture.



Retrieval Result: (a)→(d)→(c)→(b)

Typical
Ideal



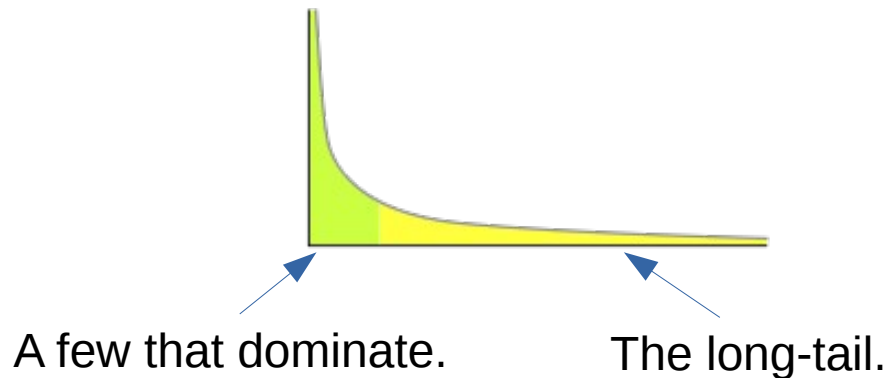
Retrieval Result: (a)→(b)→(c)→(d)

Relevant

Irrelevant

Long-Tail Query

- Where a matching candidate may not necessarily exist in the database.

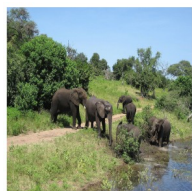


Typical embedding models will fail to retrieve the “[most relevant](#)” candidates.

Our Approach

- Relevance Degree (Continuous Variable)
- Ladder Loss (Extended form of Triplet Loss)
- Coherent Score (Evaluate Ranking Coherence)

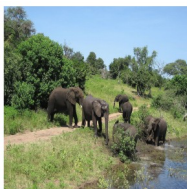
Relevance Degree



Relevance?

A pizza is sitting next to a salad.

Ideal ground-truth: Human Annotation | Combinatorial Explosion



Single-modal (image) similarity.

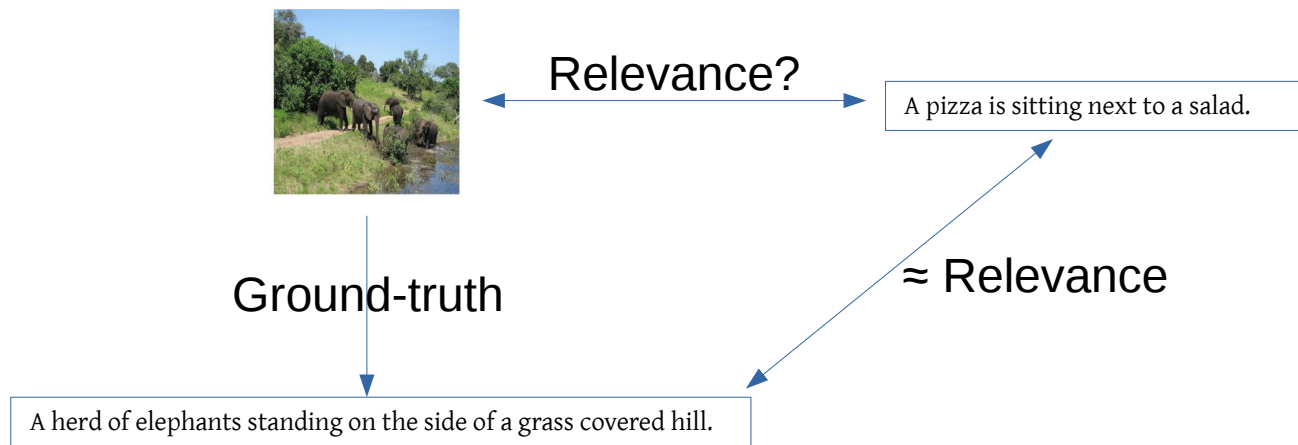
A pizza is sitting next to a salad.



A herd of elephants standing on the side of a grass covered hill.

Single-modal (text) similarity.

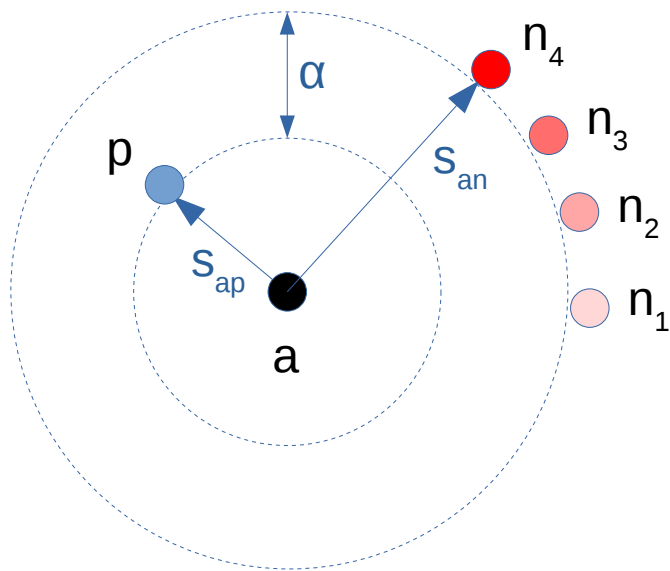
Relevance Degree



$$R(i_q, t_p) = R(t_q, t_p) = \text{BERT}(t_q, t_p).$$

Ladder Loss

- Triplet Loss



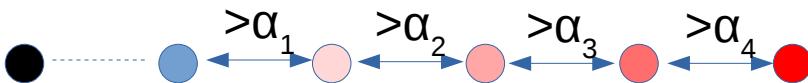
$$s(v_q, h_q) - s(v_q, h_p) > \alpha$$

Problem:
treats candidates in a bipolar way.

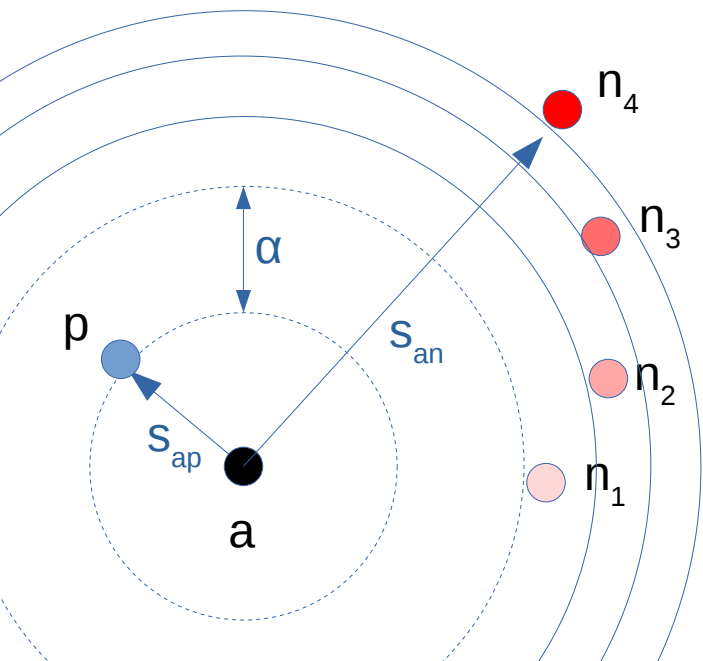
Goal:
leverage the continuous relevance degree
and learn coherent embedding space.

Ladder Loss

- Ladder Loss



$$s(i_q, t_q) > s(i_q, t_{n1}) > s(i_q, t_{n2}) > \dots > s(i_q, t_{nl})$$



$$s(v_q, h_q) - s(v_q, h_i) > \alpha_1, (i \in \mathcal{N}_1^{-q}),$$

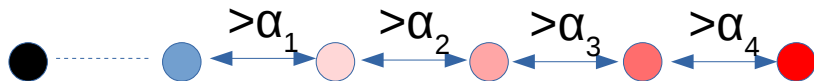
$$s(v_q, h_i) - s(v_q, h_j) > \alpha_2, (i \in \mathcal{N}_1^{-q}, j \in \mathcal{N}_2^{-q}),$$

$$s(v_q, h_j) - s(v_q, h_k) > \alpha_3, (j \in \mathcal{N}_2^{-q}, k \in \mathcal{N}_3^{-q}),$$

$\dots,$

Ladder Loss

- Ladder Loss



$$L_{lad}(q) = \beta_1 L_{lad}^1(q) + \beta_2 L_{lad}^2(q) + \beta_3 L_{lad}^3(q), \quad (6)$$

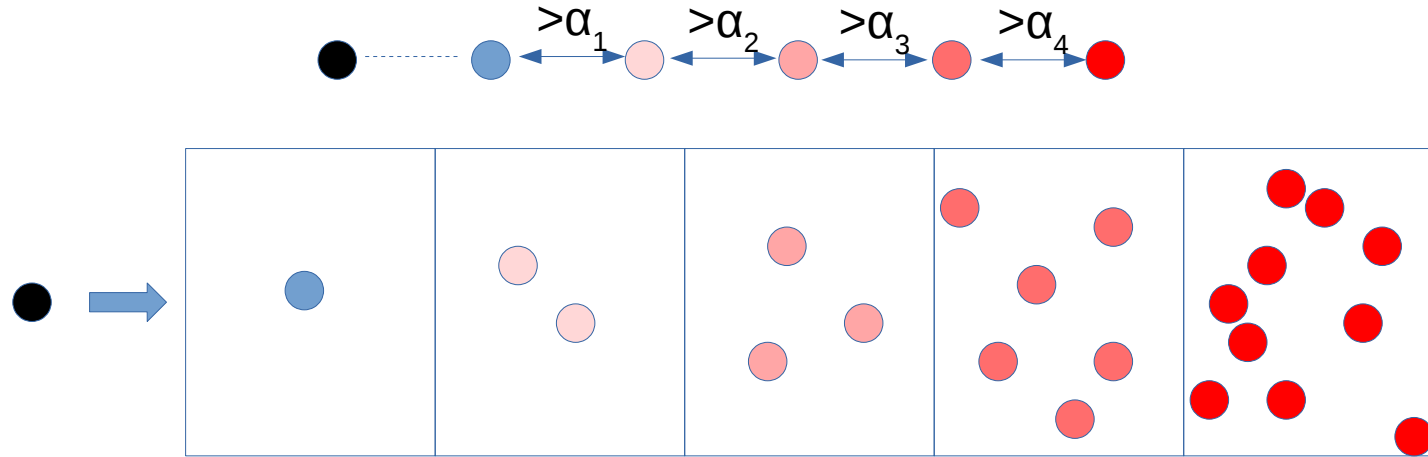
$$L_{lad}^1(q) = \sum_{i \in \mathcal{N}_{1:L}^{-q}} [\alpha_1 - s(v_q, h_q) + s(v_q, h_i)]_+,$$

$$L_{lad}^2(q) = \sum_{i \in \mathcal{N}_1^{-q}, j \in \mathcal{N}_{2:L}^{-q}} [\alpha_2 - s(v_q, h_i) + s(v_q, h_j)]_+, \quad (7)$$

$$L_{lad}^3(q) = \sum_{j \in \mathcal{N}_2^{-q}, k \in \mathcal{N}_{3:L}^{-q}} [\alpha_3 - s(v_q, h_j) + s(v_q, h_k)]_+,$$

Ladder Loss

- Hard Contrastive Sampling



Number of inequality chain: combinatorial explosion.

Coherent Score

Ground-truth:



Model output:



(How Coherent?)

- * Traditional performance metric Recall @ K: Only cares about the rank of ●
- * Coherent Score: Kendall's Ranking Correlation Coefficient τ

Experiments

- MS-COCO (120k images, each with 5 annotations)
- Flickr30k (30k images, each with 5 annotations)

- BERT STS Acceleration

CBoW < threshold → relevance degree (coarse)

CBoW > threshold → relevance degree (fine)

Hybrid model with threshold set to 0.8 achieves 0.79 in pearson correlation on STS-B.

Visualization ($T \rightarrow I$)



Visualization (I→T)



VSE++:

A herd of elephants on the grassy plains.
A herd of elephants standing on the side of a grass covered hill.
Large group of elephants with men dressed in blue riding them.
An elephant drinking water while the rest of the herd is walking in ...
A group of men riding on top of elephants.
A large elephant is shown walking through the terrain.
A group of four skiers posing for a picture.
An elephant standing on top of a lush green hillside.
A cluster of small boats in shallow water.
A herd of cows is in the meadow.
a pair of elephants with their trunks entwined
Zebras and wort hogs living together on the plains.
three black cows are standing in a field
A group of stuffed bears are arranged in a display.
a variety of old school show cars lined in a row
a long buffet length table covered in many dishes of different foods
cherry tomatoes and various food dishes on a table top
there are many cars that are waiting for the light to turn green
Three plates of toasted sandwiches are on a counter.
A compact car is parked beside many motorcycles.
Three pizzas are sitting in the windows a small red car.
There are two toilets and a sink in this bathroom.
A gray couch sitting on top of a rug in a living room.
A living room is shown with tables and seating.
An elephant stands near water and a stone wall.
A busy intersection filled with traffic under traffic lights.
Three zebras stand camouflaged in the wide open plains.
Four giraffes are standing in front of a small puddle.
Many cars in a desert area with planes in the back.
A living room with ample lighting from windows and lamps and brown ...

CVSE++:

A herd of elephants standing on the side of a grass covered hill.
A herd of elephants on the grassy plains.
An elephant drinking water while the rest of the herd is walking in ...
Large group of elephants with men dressed in blue riding them.
A large elephant is shown walking through the terrain.
An elephant standing on top of a lush green hillside.
A group of men riding on top of elephants.
a lawn cut out of a big elephant in a yard outside
A herd of cattle is shown in an open field next to a river.
An elephant stands near water and a stone wall.
An elephant with a red cloth over it.
a pair of elephants with their trunks entwined
Four giraffes are standing in front of a small puddle.
Zebras and wort hogs living together on the plains.
a number of cows in a field near a tree
A man on a horse corralling a herd of cattle.
three black cows are standing in a field
A group of birds drinking from a puddle
Many sheep and goats cross a road between grassy fields.
An elephant walks behind another elephant holding it's tail with it's ...
A couple of animals that are in the grass.
there are two very tall giraffes that are in the wild
A herd of cows is in the meadow.
THREE ZEBRA ARE STANDING TOGETHER IN THE OPEN LAND
Men on horses are driving many other horses in a group.
A group of stuffed bears are arranged in a display.
Horses walking in meadow with trees and buildings in background.
Two red and white cows in a pasture with a pond.
Several cows standing in a row on a large open farm.
A couple of bears sitting on a coach, one is holding a book.



VSE++:

a pizza is sitting next to a salad
Three pizzas are sitting in the windows a small red car.
Two photos, each with pizzas, one ham and cheese, one supreme.
A black pan holds several small, cooked pizzas.
A pan filled with meat and vegetables cooking on a stove top.
A slice of pizza with a bunch of vegetable toppings
A pizza and tea kettle sitting on a stove.
the pizza has cheese, tomato sauce, and olives
A pizza with two slices missing from it.
a person is eating a pizza with a fork
A homemade pizza is waiting to be cooked.
Two pieces of bread with sauce on them next to a bowl of chicken ...
A thin crust pizza is topped with olives and onions.
This meal has beans and three slices of pita bread.
a fresh baked pizza with piping hot cheese
A woman puts spices on a skillet of food that is cooking.
an image of two people on skis going down the slope
A person cutting a pizza on top of parchment paper.
A white plate topped with a vegetables salad.
A herd of elephants standing on the side of a grass covered hill.
An arrangement of orchids and greenery in a flower pot.
A loaded open sandwich at a dinner table.
A plate with a hamburger and a salad on it
a hot dog topped with tomatoes and peppers with a side of fries
there are many fire trucks and-fire cars in this garage
A child's bedroom has plenty of storage space and a small chair.
A toilet is in a tiled bathroom with a large window looking out on ...
Man about to bite into hot dog with many toppings.
Several buses and cars sitting at a traffic light on a road.
A kitchen with a stove, microwave, telephone, table and chair.

CVSE++:

a pizza is sitting next to a salad
A black pan holds several small, cooked pizzas.
Two photos, each with pizzas, one ham and cheese, one supreme.
A homemade pizza is waiting to be cooked.
A pan filled with meat and vegetables cooking on a stove top.
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Two pieces of bread with sauce on them next to a bowl of chicken ...
A slice of pizza with a bunch of vegetable toppings
A thin crust pizza is topped with olives and onions.
A pizza and tea kettle sitting on a stove.
Three pizzas are sitting in the windows a small red car.
A pizza with two slices missing from it.
a person is eating a pizza with a fork
A very tasty looking dish with some broccoli and other items.
A plate with a hamburger and a salad on it
A person cutting a pizza on top of parchment paper.
a meat dish with broccoli and peppers on a white plate
A white plate topped with a vegetables salad.
Two meat sandwiches with potato salad on a white plae
A woman puts spices on a skillet of food that is cooking.
A loaded open sandwich at a dinner table.
A plate of hotdogs, lettuce and tomatoes next to a cup of beer.
a table with many different vegetables and fruit
A metal platter topped with fish and vegetables.
A simple meal of chicken and a large serving of broccoli.
Two small trays filled with an assortment of food items
a cheese pizza cut into slices on a table
This meal has beans and three slices of pita bread.
cherry tomatoes and various food dishes on a table top

Experiments: MS-COCO

MS-COCO (1000 Test Samples)												
Model	Image→Sentence						Sentence→Image					
	CS@100	CS@1000	Mean R	R@1	R@5	R@10	CS@100	CS@1000	Mean R	R@1	R@5	R@10
Random	0.018	0.009	929.9	0.0	0.3	0.5	0.044	0.005	501.0	0.1	0.5	0.9
VSE++ (VGG19)	0.235	0.057	5.7	56.7	83.9	92.0	0.237	0.057	9.1	42.6	76.5	86.8
CVSE++ (VGG19)	0.256	0.347	4.1	56.8	83.6	92.2	0.257	0.223	7.3	43.2	77.5	88.1
VSE++ (VGG19,FT)	0.253	0.047	2.9	62.5	88.2	95.2	0.246	0.042	6.5	49.9	82.8	91.2
CVSE++ (VGG19,FT)	0.256	0.419	2.8	63.2	89.9	95.0	0.251	0.287	5.3	50.5	83.6	92.8
VSE++ (Res152)	0.238	0.079	2.8	63.2	88.9	95.5	0.236	0.080	7.3	47.4	80.3	89.9
CVSE++ (Res152)	0.265	0.358	2.8	66.7	90.2	94.0	0.256	0.236	6.1	48.4	81.0	90.0
VSE++ (Res152,FT)	0.241	0.071	2.4	68.0	91.9	97.4	0.239	0.068	6.3	53.5	85.1	92.5
CVSE++ (Res152,FT)	0.265	0.446	2.4	69.1	92.2	96.1	0.255	0.275	4.7	55.6	86.7	93.8
MS-COCO (5000 Test Samples)												
Model	Image→Sentence						Sentence→Image					
	CS@500	CS@5000	Mean R	R@1	R@5	R@10	CS@500	CS@5000	Mean R	R@1	R@5	R@10
VSE++ (Res152)	0.227	0.078	10.6	36.3	66.8	78.7	0.224	0.084	30.9	25.6	54.0	66.9
CVSE++ (Res152)	0.253	0.354	9.7	39.3	69.1	80.3	0.246	0.239	25.2	25.8	54.0	67.3
VSE++ (Res152,FT)	0.231	0.073	7.7	40.2	72.5	83.3	0.228	0.073	25.1	30.7	60.7	73.3
CVSE++ (Res152,FT)	0.255	0.439	7.4	43.2	73.5	84.1	0.242	0.280	18.6	32.4	62.2	74.6

Table 1: Comparison between VSE++ and CVSE++ in terms of CS@K and R@K on MS-COCO.

Experiments: Flickr30k

Model	Image→Sentence						Sentence→Image					
	CS@100	CS@1000	Mean R	R@1	R@5	R@10	CS@100	CS@1000	Mean R	R@1	R@5	R@10
Random	0.02	-0.005	988.3	0.0	0.3	0.4	-0.033	-0.003	503.0	0.2	0.6	1.1
VSE++ (VGG19)	0.116	0.139	18.2	40.7	68.4	78.0	0.115	0.124	26.9	28.7	58.6	69.8
CVSE++ (VGG19)	0.129	0.255	16.4	42.8	69.2	78.9	0.127	0.144	26.4	29.0	59.2	71.1
VSE++ (VGG19,FT)	0.128	0.130	14.7	44.6	73.3	82.0	0.125	0.110	22.8	31.9	63.0	74.5
CVSE++ (VGG19,FT)	0.133	0.260	13.0	44.8	73.1	82.3	0.131	0.160	20.8	33.8	63.9	75.1
VSE++ (Res152)	0.126	0.127	10.2	49.3	78.9	86.4	0.115	0.112	20.0	35.9	65.9	75.6
CVSE++ (Res152)	0.133	0.247	9.3	50.2	78.8	87.3	0.120	0.147	20.0	37.1	66.9	76.4
VSE++ (Res152,FT)	0.130	0.122	7.8	54.1	81.0	88.7	0.122	0.114	16.2	39.8	70.0	79.0
CVSE++ (Res152,FT)	0.141	0.273	7.4	56.6	82.5	90.2	0.126	0.172	15.7	42.4	71.6	80.8

Table 2: Comparison between VSE++ and CVSE++ in terms of CS@K and R@K on Flickr30K.

Discussion: Balancing Factor

β_2	Image→Sentence						Sentence→Image					
	CS@100	CS@1000	Mean R	R@1	R@5	R@10	CS@100	CS@1000	Mean R	R@1	R@5	R@10
0.0	0.238	0.079	2.8	63.2	88.9	95.5	0.236	0.08	7.3	47.4	80.3	89.9
0.25	0.265	0.358	2.8	66.7	90.2	94.0	0.256	0.236	6.1	48.4	81.0	90.0
1.0	0.266	0.417	3.9	64.0	88.2	93.1	0.259	0.264	6.2	47.4	79.0	88.9

Table 3: Performance of the proposed CVSE++(Res152) with respect to the parameter β_2 (On MS-COCO dataset).

Discussion: Scope-of-Interest

L	Image→Sentence							Sentence→Image						
	CS@100	CS@200	CS@1000	Mean R	R@1	R@5	R@10	CS@100	CS@200	CS@1000	Mean R	R@1	R@5	R@10
1	0.238	0.188	0.079	2.8	63.2	88.9	95.5	0.236	0.189	0.08	7.3	47.4	80.3	89.9
2	0.265	0.252	0.358	2.8	66.7	90.2	94.0	0.256	0.253	0.236	6.1	48.4	81.0	90.0
3	0.267	0.274	0.405	3.2	65.7	89.3	94.1	0.261	0.258	0.244	6.3	48.4	80.3	89.4

Table 4: Performance of the proposed CVSE++(Res152) with respect to the ladder number L . (On MS-COCO dataset)

Conclusion & Future Work

- Continuous Relevance Degree
- New Ladder Loss Function for Coherent Embedding
- Coherent Score as performance metric
- Our method → Coherent Visual-Semantic Emb Space
- Future work: Extend to other metric learning apps.

Thanks!

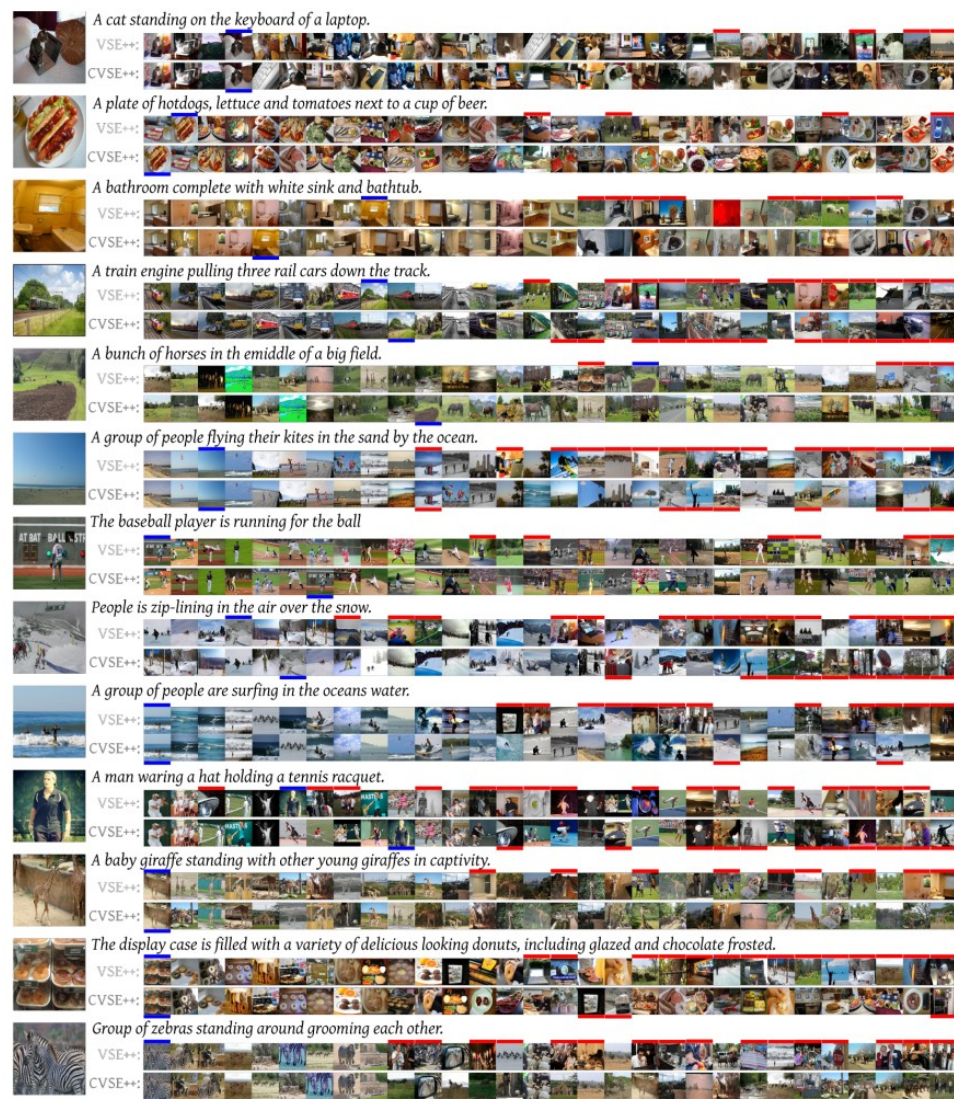


Figure 2. Comparison of the sentence-to-image top-30 retrieval results between VSE++ (baseline, 1st row) and CVSE++ (Ours, 2nd row). For each query sentence, the ground-truth image is shown on the left, the totally-relevant and totally-irrelevant retrieval results are marked by blue and red overlines/underlines, respectively. Figure best viewed in color.



Conserve that I dig out from a ditch house in place.
A place of hot dig and other food.
A place of hot dig, hence a measure of heat to a cup of hot
A hot dig raps a ditch house and pappers with a side of
The hot dig sitting on top of a roadway with a beer near.
So even he dig a hot dig out his hand.
This would be a house and three of its of pits from a

VSE++:

A person riding down a slope while a train is at the top in the l
 A few young people on a old slope having a traffic.
 People are riding on a slope in a snowy field.
 A group of people standing on the snow.
 A lot of people on a highway to go for this skier.
 People in a place in the air over the snow.
 many people on a beach with many like a flying in the sky

A person riding down a slope said it was in the lift in the lift.
A few young people on a ski slope having a laugh.
People are riding on a ski down a snowy hill.
A group of people standing in the snow.
A lot of people on a snowy slope to go for a ski.
People in a snowy landscape are out the snow.
Many people on a hill with many people flying in the sky.

VSE++:
The display case is filled with the variety of delicious looking
A box that has several different models of it.
5 different models of diagonals on a table top.
Variety of diagonals in the ready for consumption.
There is a box of diagonals on the floor next to the display.
The items are in the class case for display.
A couple of diagonals are shown how they are used.
The items are in the class case for display.

- A box that has several buttons inside of it is made of *dialogs* or an *abusing* box.
- Variety of *dialogs* (color, ready for consumption).
- There is a box of various *dialogs* with no overlapping.
- The items are in the class *ca* for *display*.
- A couple of *dialogs* are used here to find if it is in the.
- Two *dialogs* will work with an *answers* and *new*.



Garment: *herding* is *unfashioned* with *no place*.
 A *place* *is* *first* *do* *go* *and* *other* *food*.
 A *herding* *is* *upped* *with* *meats* *and* *peppers* *with* *a* *side* *of*.
 A *place* *is* *first* *do* *go*, *lettuce* *is* *and* *meats* *is* *in* *in* *a* *cup* *five*.
 Someone *is* *building* *a* *herding* *in* *their* *land*.
 The *last* *day* *is* *three* *cup* *of* *arod* *tray* *with* *a* *beer* *one*.
 This *is* *and* *is* *in* *the* *and* *three* *days* *of* *pin* *bread*.

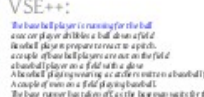
CVSE++:

- A person sliding down a slope while others ride the lift to the top.
- A lot of noise and a long way to go for this slide.
- People are sitting on the slide as a snowball!
- A group of people standing in the queue.
- People are playing in the air over the queue.
- A few young people on a side slope having a bit of fun.
- A skier is sliding sideways and jumping into the air.
- Many people are sitting at the top looking down at the other slides.

A person **climb** *up* a steep hill or **climb** the light in the air.
 A lot of **effort** and a long way to go for this **climb**.
 People are **climbing** *up* a steep hill.
 A group of people **standing** in the **crowd**.
 People **is** *climbing* in the **air** over the **crowd**.
 A few young people are **climbing** *up* a steep hill.
 A **climb** is **climbing** *up* a steep hill or **climbing** *up* the air.
 A **climb** is **climbing** *up* a steep hill or **climbing** *up* the air.

[illegible]

The display can be fitted with a variety of accessories including:
 - Standardised dimensions to suit hanging
 - Variety of dimensions to meet display requirements
 - A base that has several dimensions to choose from
 - The choice of a variety of dimensions to suit different applications
 - Front dimensions to suit the display's overall dimensions
 - The choice of a variety of dimensions to suit different applications
 - The choice of a variety of dimensions to suit different applications
 - The choice of a variety of dimensions to suit different applications

[illegible]

VSE++:
 people surfing and getting a adrenaline surf in the water
 A group of people are surfing in the ocean water.
 A surfer on a wave as it breaks
 A person in a surfboard riding on a wave
 A person riding a surfboard on the ocean.
 A person on a surf and riding a wave.
 A father and son ride waves while using a body board in

people surfing and getting a tube surf in the water.
A group of people are surfing in the ocean water.
A surfer on a pipe surf as it breaks.
A person on a surfboard riding on a wave.
A person riding a surfboard in the ocean.
A person on a surfboard riding a wave.
A father and son ride waves while using a body board in

VSE++:
A couple of giraffes being fed by people at the zoo.
Two giraffes standing in a small fenced-in enclosure.
A mother and her baby watch a group of giraffes in a zoo.
A giraffe standing in a pool of water.
Three giraffes standing in a field.
A giraffe standing in a field.

A couple of giraffes being fed by people at the zoo.
Two giraffes stand next to a small object in an enclosure.
A mother and her baby watch a group of giraffes in a zoo.
A giraffe standing close to a fence while people stand around.
Three large giraffes are in a small enclosure.
A giraffe sticking its head over a fence.

24. A group of seven people have paid a membership fee. Each has a different number of children. The difference of the ages between the oldest and the youngest is a child.



The baseball player is running for the ball.
The base runner has made it off, as the batter means for the
baseball player on a field with a glove.
A couple of men on a field playing baseball.
A soccer player dribbles a ball down a field.
A baseball player with the catcher's mitt watches during a game.
A close-up view of a baseball player, out-of-focus.

CVSE++:

- A group of people are surfing in the sea and some people surfing and getting ready to surf in the water
- A surfer on top of wave as it breaks
- A person riding a surfboard in the ocean.
- A person on a surfboard in the water.
- A father and son ride waves while wearing a life board in the hole out in the ocean riding wave with a surfboard

a group of people are surfing on the sea and some
 people surfing and getting ready to surf in the water
 a surfer on top of wave as it breaks
 a person riding a surfboard in the ocean.
 a person is a surfer in the water
 a father and son ride waves while a boy and a girl are in the
 background in the ocean riding waves with a surfboard

CVSE++:

That giraffe transferred to a second fence in an enclosure.
 A couple of giraffes is being feed by people at the zoo.
 A mother and her baby watch a group of giraffes in a zoo enclosure.
 A giraffe standing close to a fence while people stand around.
 A giraffe standing in the background of a fence.
 The giraffe is in the enclosure on a sunny day.

CVSE++
 The graphs transform to a wordnet by use in an enclosure.
 A couple of graphs is being found by people at the zoo.
 A mother and her baby watch a group of graphs in a zoo enclosure.
 A graph standing close to a fence while people stand around.
 A graph is looking in the last one's absence.
 The graphs in an enclosure on a sunny day.

The two girls are standing together by the tree.



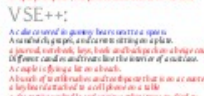
A man after hitting a tennis ball into the court
a tennis player stretching to save a ball
a soccer player dribbling a ball down a field
A tennis player preparing to start a tennis ball.
A person swinging a softball bat and hitting a softball.
A guy running a tennis ball up and preparing to serve.
A man with a bat standing at a ball diamond ready to hit.

VSE++:
*A die covered in gummy bears on a table.
 A snail in a gutter, and a car is sitting on a plate.
 A journal, notebook, legs, book and backpack on a bridge over
 18 feet of water and on the river or of a suitcase.
 A couple is flying a kite on a beach.
 A couple is in a kitchen and a couple is that is in a movie
 a boy has a truck to a cell phone on a table*

[illegible]

VSE++:
 a close up of true zebras in a field with trees
 Group of zebras standing in a field grazing each other
 A couple of zebras are walking through tall grass and trees.
 THREE ZEBRAS ARE STANDING TOGETHER IN THE OPEN PL.
 Two zebras face each other and graze on open field.
 A group of zebras are grazing in a field.
 Three zebras stand in a field and in the wide open plain.
 Three zebras walking through a field towards an open field.

Group of zebras standing and grazing each other
A couple of zebras are walking through an open field.
THREE ZEBRAS ARE STANDING TOGETHER IN THE OPEN.
Two zebra face each other and graze on an open field.
A group of zebras in a grassy field.
Three zebras stand and graze in the wide open plain.
Three zebras walking straight line through an open field.



A tennis player hitting a tennis ball on the court.
A tennis player stretching to hit a ball.
A person swinging a softball bat at hitting a softball.
A tennis player preparing to hit a ball.
A guy taking a tennis ball up and preparing to serve.
A man playing tennis on a tennis court and wearing a red shirt.
A child swinging a bat at a ball.

CVSE++:
*A cake covered in honey, best not to eat.
 On one could as well have the honey of a nutcase.
 A snail's, grapes, and nuts is sitting on a plate.
 A close up of three cakes sitting next to each.
 A slice of pizza with a bunch of vegetables in springs.
 A small plate of pizza and onion rings.
 A person is eating out and eating a cake.
 A small cake with some cream on a small plate.*

A *calceol* is a seedling nursery, but it must be a space.
 Different kinds of seedlings live the lives of a seedcase.
 A newbudd, guppy, and crane is sitting on a plate.
 A close up of three calceol sitting in a dish.
 A silk of a panna with a bunch of seedlings in a panna.
 A small plate of a panna and a cone tree.
 A person is working out and eating a calceol.
 A small plate of a panna and a cone tree.

CVSE++:
 A class of *zobas* standing side by side
 Group of *zobas* standing in a row and growing each other
 A close up of a mirror showing two *zobas*
 THREE *ZOBAS* ARE STANDING TOGETHER IN THE OPEN AIR
 A close up of a *zoba* in a desert
 A couple of *zobas* are walking through sand/grass
 Two *zobas* face each other and glare at one another
 A group of *zobas* are grazing for food

Group of zebras standing and grazing each other
A close-up of a mirror showing true zebras
THREE ZEBRAS ARE STANDING TOGETHER IN THE ORANGE AND
A close-up of a zebra's head in a desert
A couple of zebras are walking through sand and grass.
Two zebras face each other and graze on a sparse field.
A group of zebras in a grassy field

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