

Second International Workshop on Parts and Attributes
ECCV 2012, Firenze, Italy
October, 2012

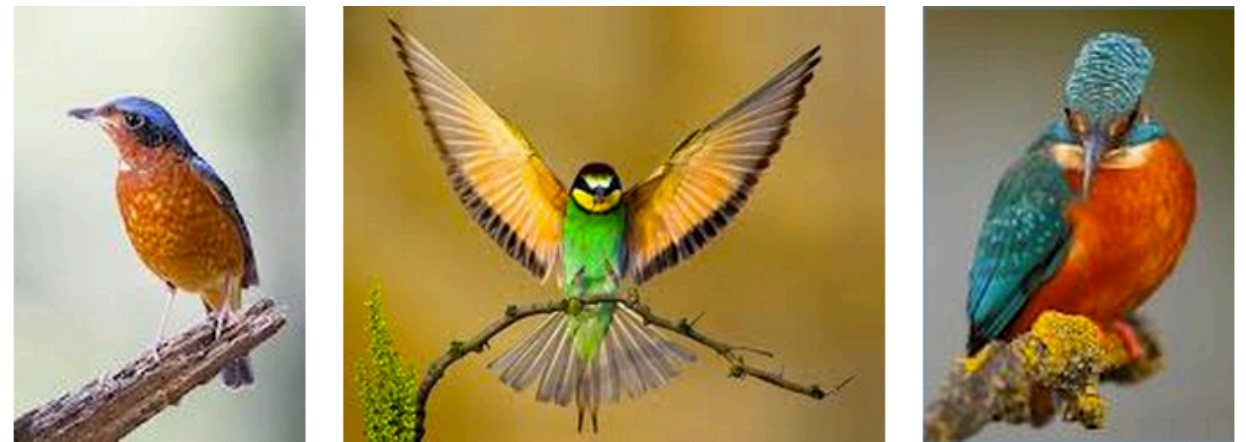
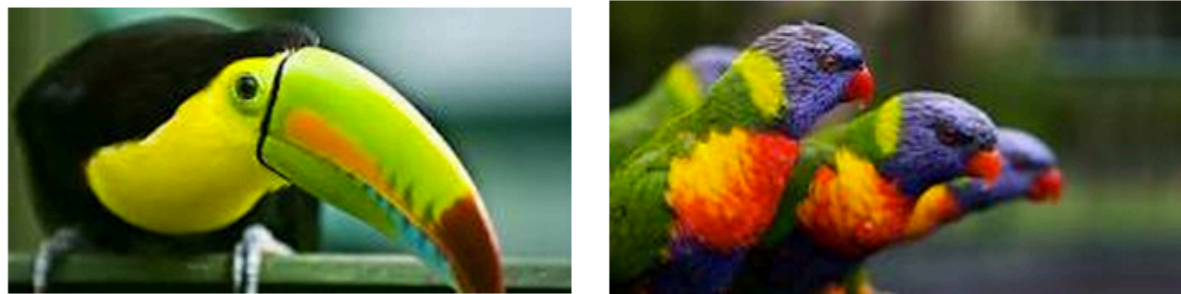
Discovering a Lexicon of Parts and Attributes

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Toyota Technological Institute at Chicago

Motivation

- Detailed object recognition
- Communication requires a lexicon

Diverse Visual Categories

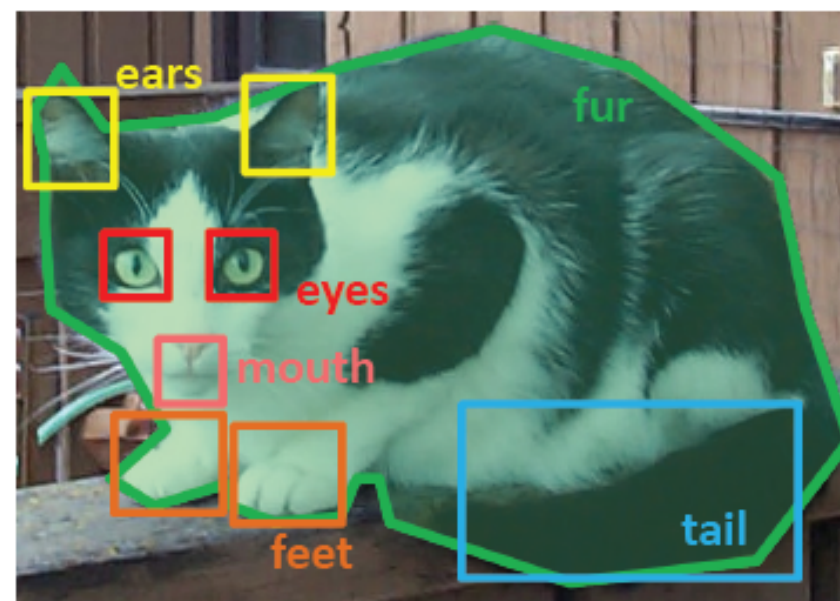


CUB 200 dataset, Visipedia project



High-heel Blue Shoe

Berg et al., 10



Object Categories:
animal, land animal,
domestic, mammal,
carnivore, cat

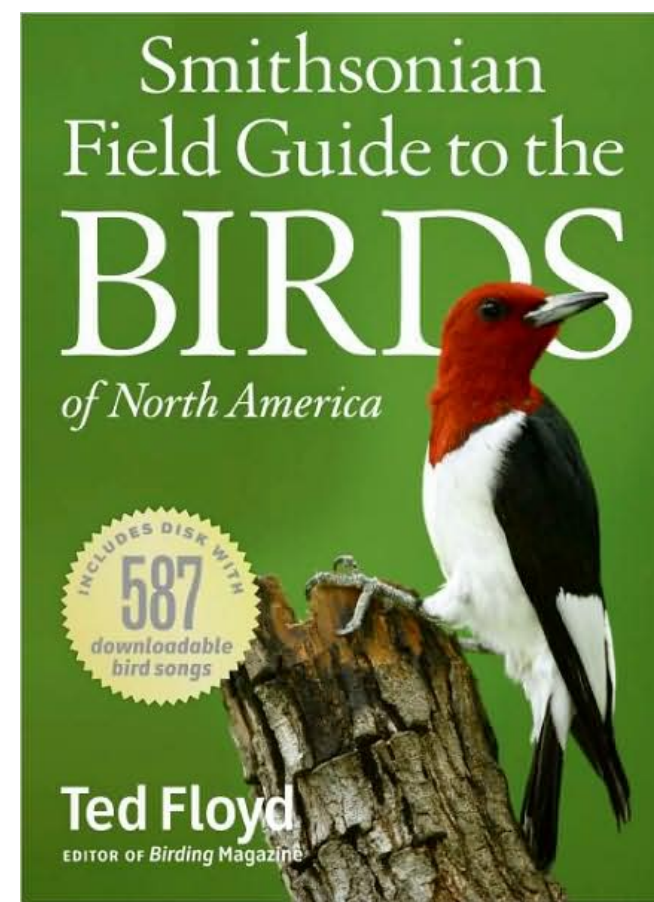
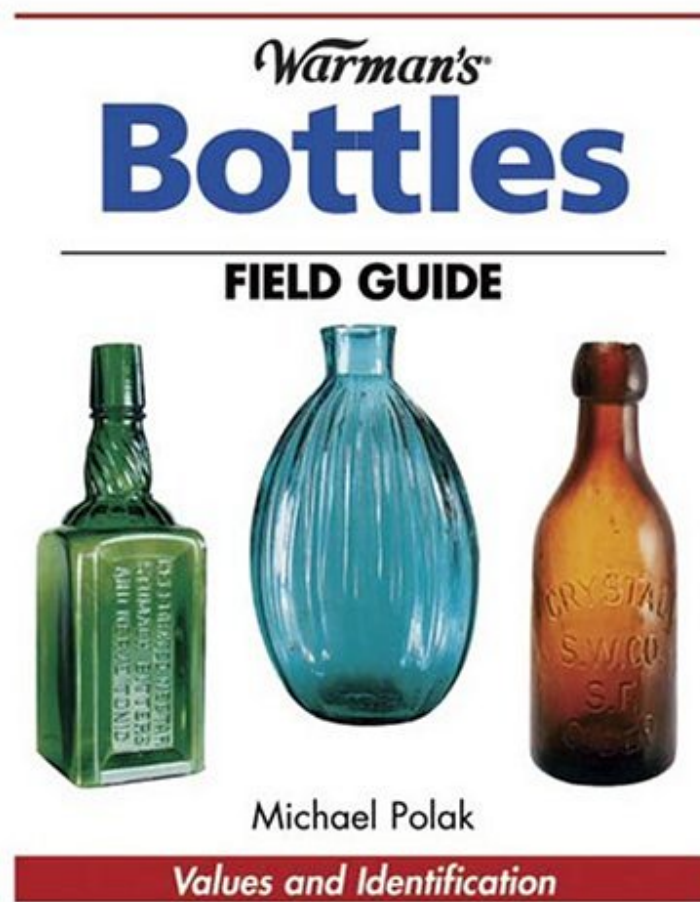
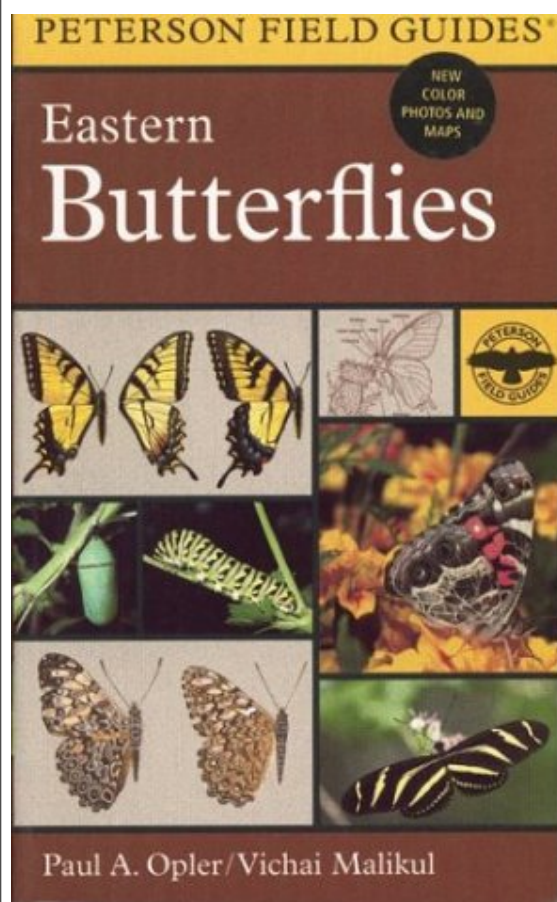
Viewpoint/pose: lying
down, left side, facing
camera

Other likely parts: four
legs

Farhadi et al, 09

Source of part and attribute lexicons

- Field guides provide exhaustive lists when available
- Expert vs. Layman
- Task specific vs. not



Source of part and attribute lexicons

- Captioned images



Dazzle after dark with Judith Leiber's decadent oversized crystal-embellished silver-tone clutch. Carry this fabulous extra to add high-octane glamour to an LBD and teetering heels. Shown here with an Emilio Pucci dress and Givenchy shoes.



The 12K pink and green gold leaves gently cascade down on these delicate beaded 10K gold earrings.

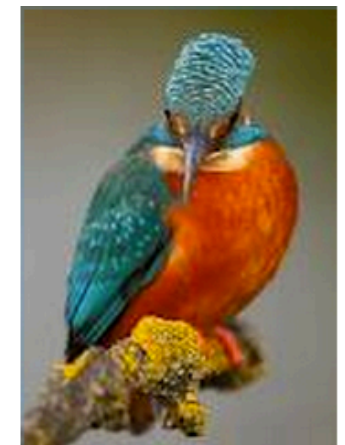
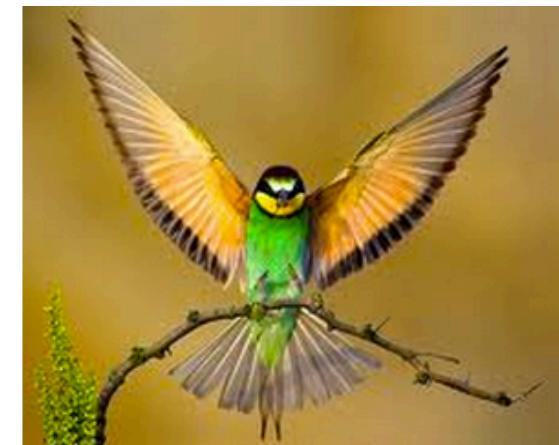
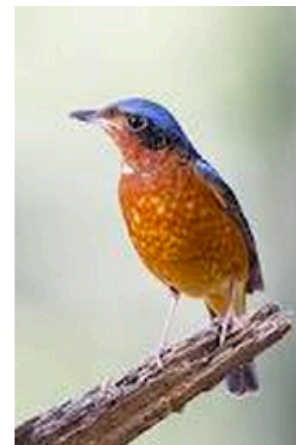
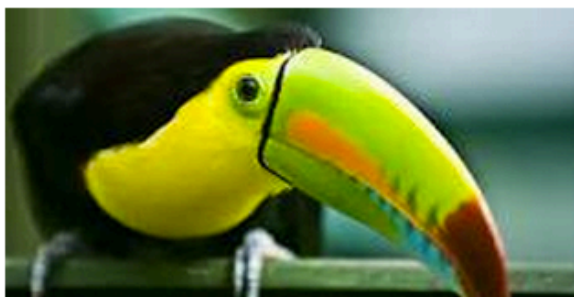


Rock and roll in these sexy, strappy heels from Report Signature. The smoldering Rockwell features a grey patent leather upper with pleated satin crossing at the open-toe atop a 1 inch platform, patent straps closing around the ankle with a gold buckled, and finally a 5 inch patent cone heel. Sizzle in these fierce mile-high shoes.

Limited by sources of such text
Descriptions are often not visual

What are good attribute lexicons?

- Properties
 - It should be easy to *communicate*
 - It should be easy to *differentiate* instances from one another



Discriminative description task



Describe the (visual) differences between the two

Discriminative description task

Discriminative description task

Description



list properties

- plane
- has engine
- red color
- has rudder

Discriminative description task

Description



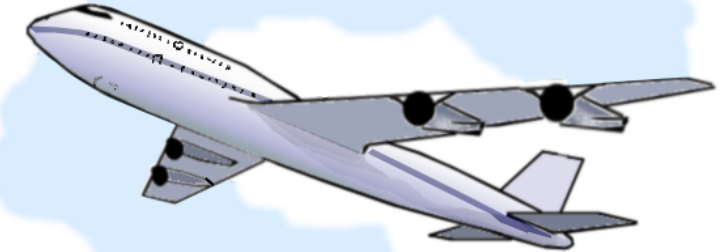
list properties

- plane
- has engine
- red color
- has rudder

Discriminative Description



VS.



list differences

propeller plane vs. passenger plane
one engine vs. four engines
red color vs. white color
round rudder vs. pointy rudder

Helps elicit a lexicon that enables fine grained discrimination

Is task specific by design

Discriminative description task

Description



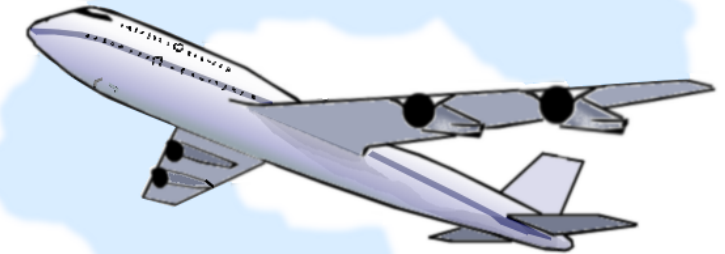
list properties

- plane
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Discriminative Description



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- propeller plane vs. passenger plane
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Helps elicit a lexicon that enables fine grained discrimination

Is task specific by design

Non-accidental properties, Biederman 87

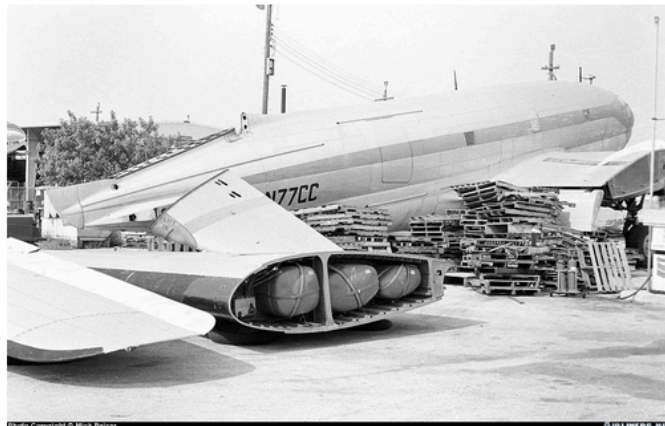
Pragmatics of Language, Levinson 83

Collecting descriptions on MTurk

Interface on AMT

Find differences between the two aeroplanes

[Click here](#) to see example answers.



List 5 differences between the two aeroplanes

1.
2.
3.
4.
5.

Submit Answer

free form text
(separated by 'vs')

Example annotations



- yellow and red rudder vs blue rudder
- two wings vs one wing
- yellow body vs blue body
- facing right vs facing left



- left facing vs right facing
- red rudder vs white rudder
- passenger plane vs propeller plane
- wings near bottom vs wings on top
- two side engines vs one side engine

Minimizes instruction bias
Keeps the interface simple

Example annotations: airplanes

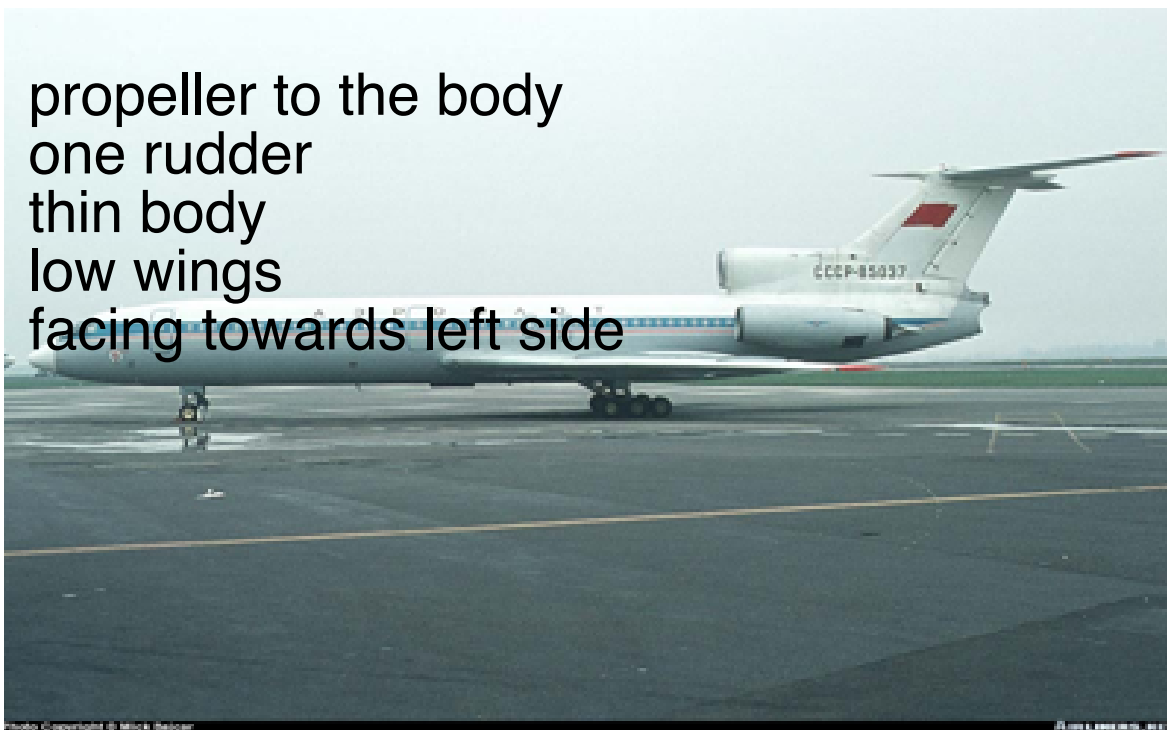
facing left
turbofan powered plane
longer tail
green rudder
passenger door open



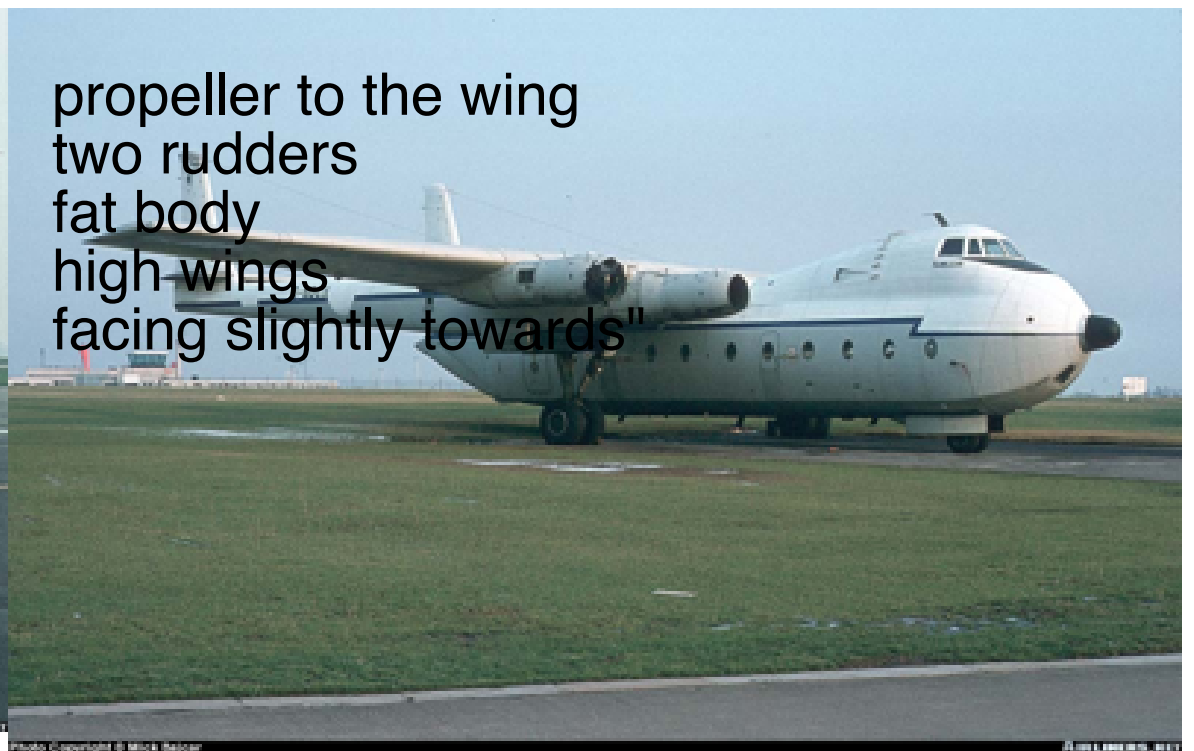
facing right
propeller powered plane
shorter tail
white rudder
baggage hold door open"



propeller to the body
one rudder
thin body
low wings
facing towards left side



propeller to the wing
two rudders
fat body
high-wings
facing slightly towards"



Example annotations: birds



black and white wings
white body
large eyes
small tail
v shaped beak



spotted wings
spotted body
small eyes
long tail
pointed beak"



yellow black body
pointy beak
short tail
black spot over head
short leg



orange brown body
shape beak
long tail
brown stripe over head
long leg"

Analyzing the text: instance specific properties



bird family
fur color
beak shape
tail size
beak color



beak size
tail size
wing color
head color
leg color



beak color
sitting vs. flying
feather color
tail size
leg color

Different properties are revealed for different instances

Analyzing the text: instance specific properties



5: blue wings
4: black beak
4: long tail
3: blue head
3: short beak
2: blue white body
2: blue white fur
2: sharp beak
2: short tail
1: big body
1: black legs
1: black legs
1: black wings
1: blue body
1: blue color head
1: gray body
1: long bird
1: orange white body
1: short wings
1: slim body
1: white and blue fur

Frequency of usage is a measure of its discriminability

Analyzing the text: instance specific properties



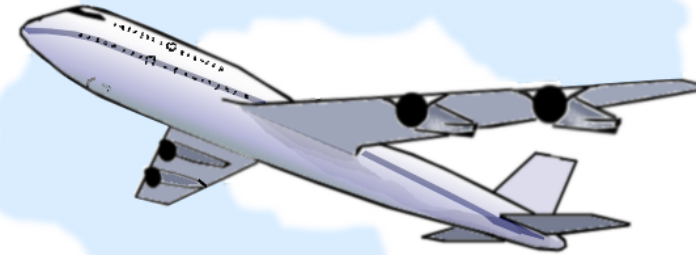
4: yellow head
3: short beak
2: fat body
2: long tail
2: short tail
2: small tail
1: big body
1: black sharp beaks
1: black wings
1: broad body
1: brown wing
1: grey yellow body
1: having tail
1: mixed yellow body
1: multi colour
1: orange white body
1: point beak
1: small beak
1: small size
1: small wings
1: thick fur
1: very fat body
1: wings
1: yellow and brown color
1: yellow black wings
1: yellow color head
1: yellow color wing
1: yellow feather
1: yellow fur
1: yellow neck

Frequency of usage is a measure of its discriminability

Analyzing the text : discovering a lexicon



VS.



list differences

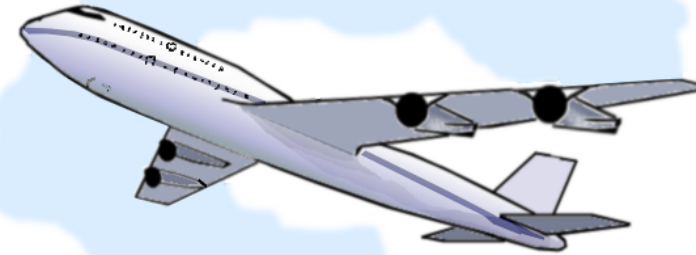
red rudder vs. white rudder
pointy nose vs. round nose

sentence pairs

Analyzing the text : discovering a lexicon



VS.



list differences

red rudder vs. white rudder
pointy nose vs. round nose



rudder

nose

parts

{red, white}

{pointy, round}

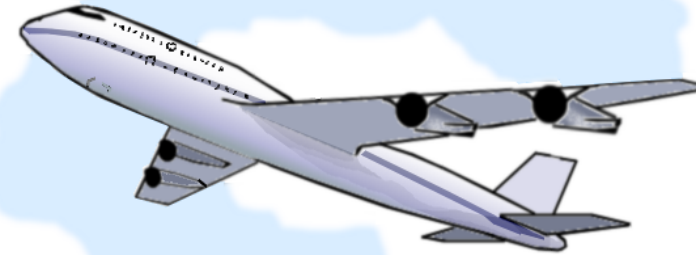
modifiers

sentence pairs

Analyzing the text : discovering a lexicon



VS.



list differences

red rudder vs. white rudder
pointy nose vs. round nose



rudder

nose

parts

{red, white}

{pointy, round}

modifiers

sentence pairs

Key idea

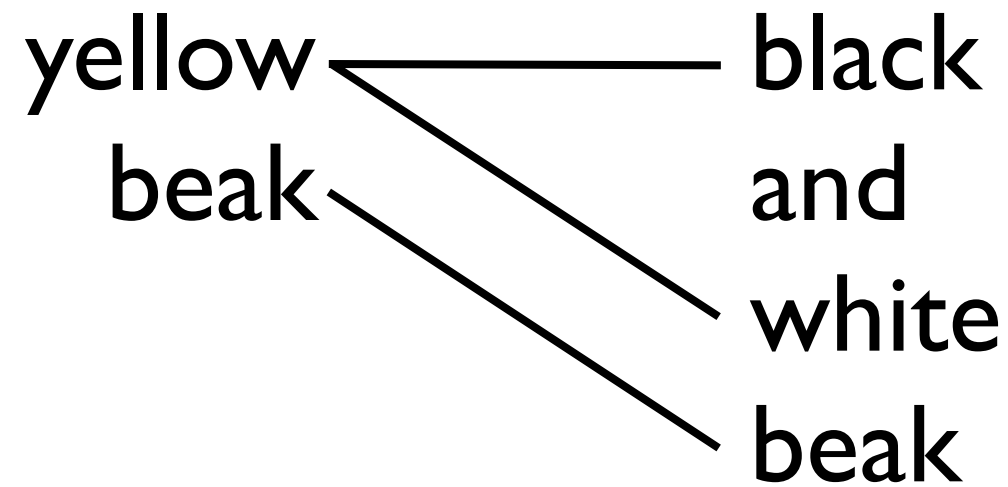
nouns : words that repeat

modifiers : words that are different

Each sentence has only one noun and modifier

Analyzing the text : discovering a lexicon

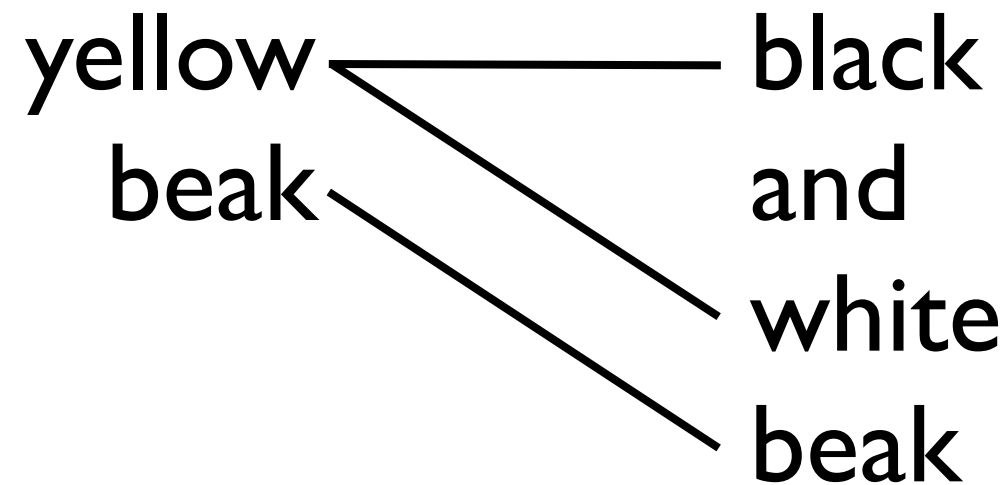
Sentence alignment



Used in NLP to initialize translation tables (IBM models)

Analyzing the text : discovering a lexicon

Sentence alignment



Used in NLP to initialize translation tables (IBM models)

Goals

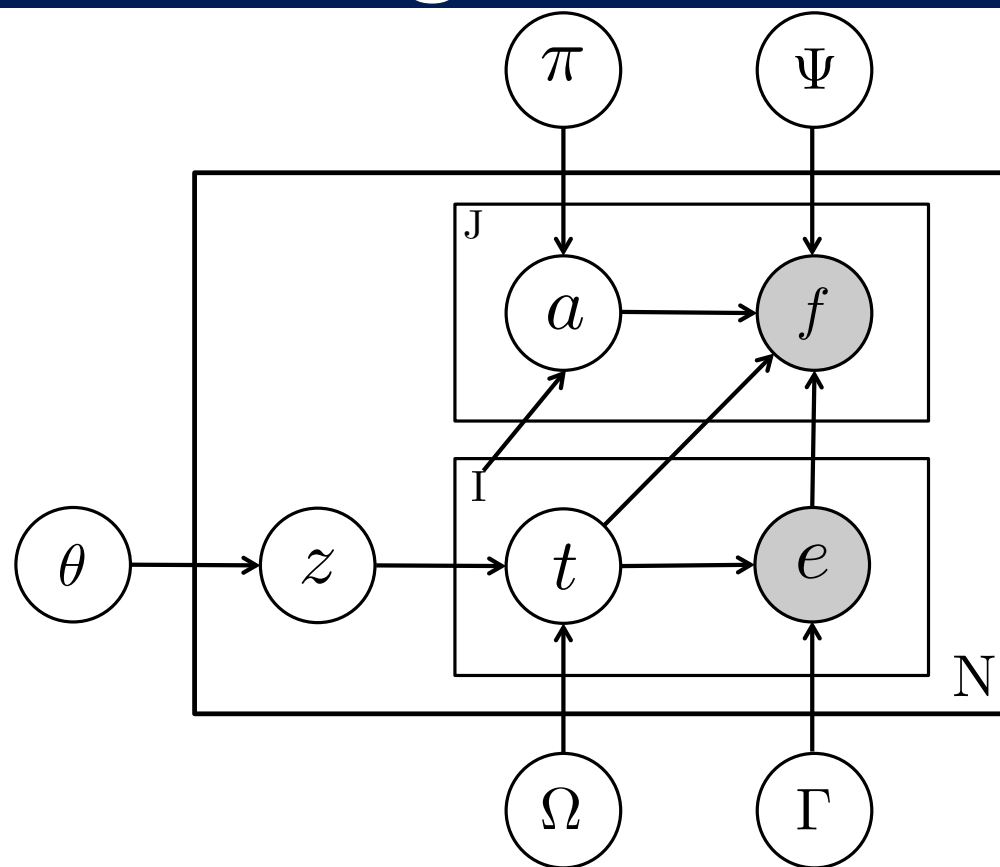
Discover a lexicon of parts, modifiers and part-modifier relations

Modifiers should be shared across attributes

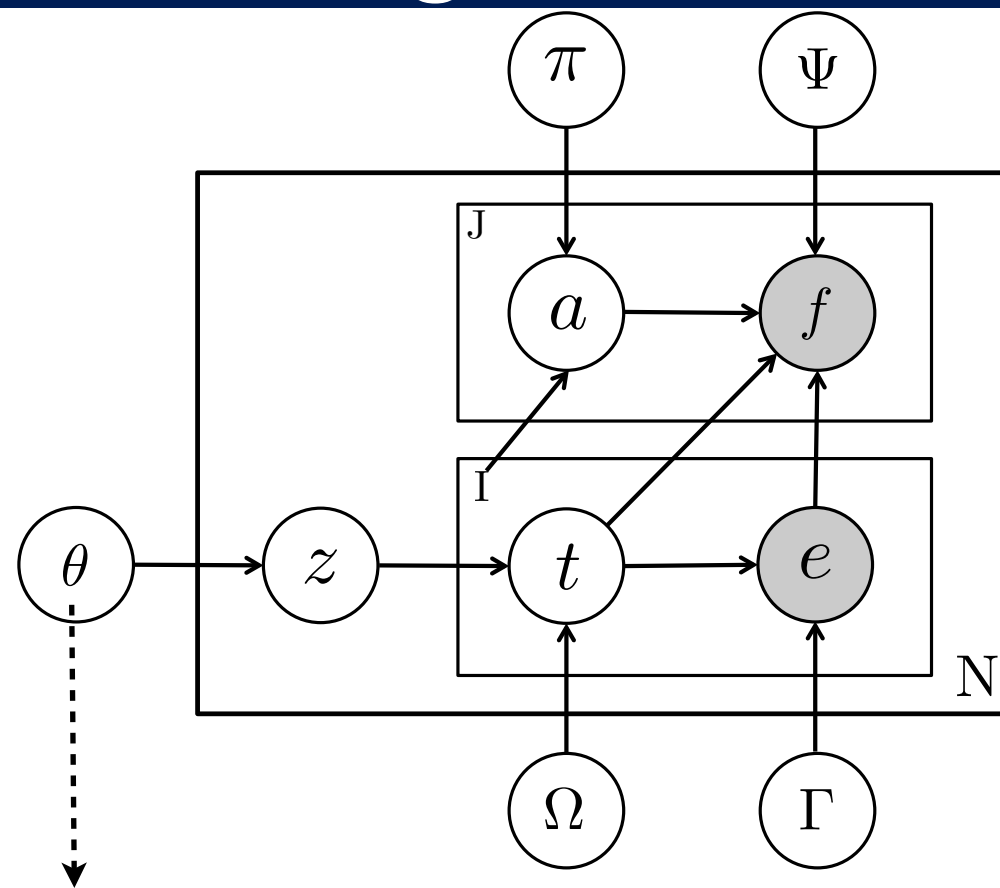
Estimate the frequency of each attribute

A generative model of sentence pairs

A generative model of sentence pairs



A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier

topic pairs

beak-size

beak-color

bird-size

wing-color

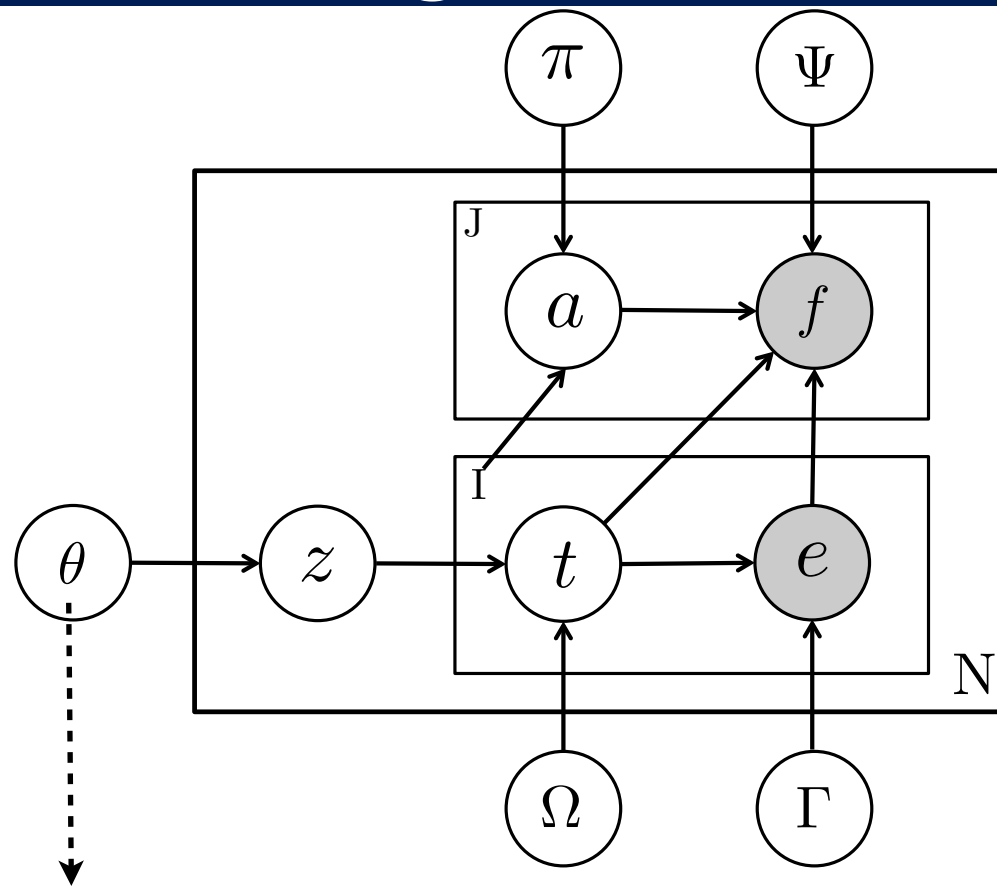
bird-kind

leg-color

head-color

...

A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

z

beak-size

beak-color

bird-size

wing-color

bird-kind

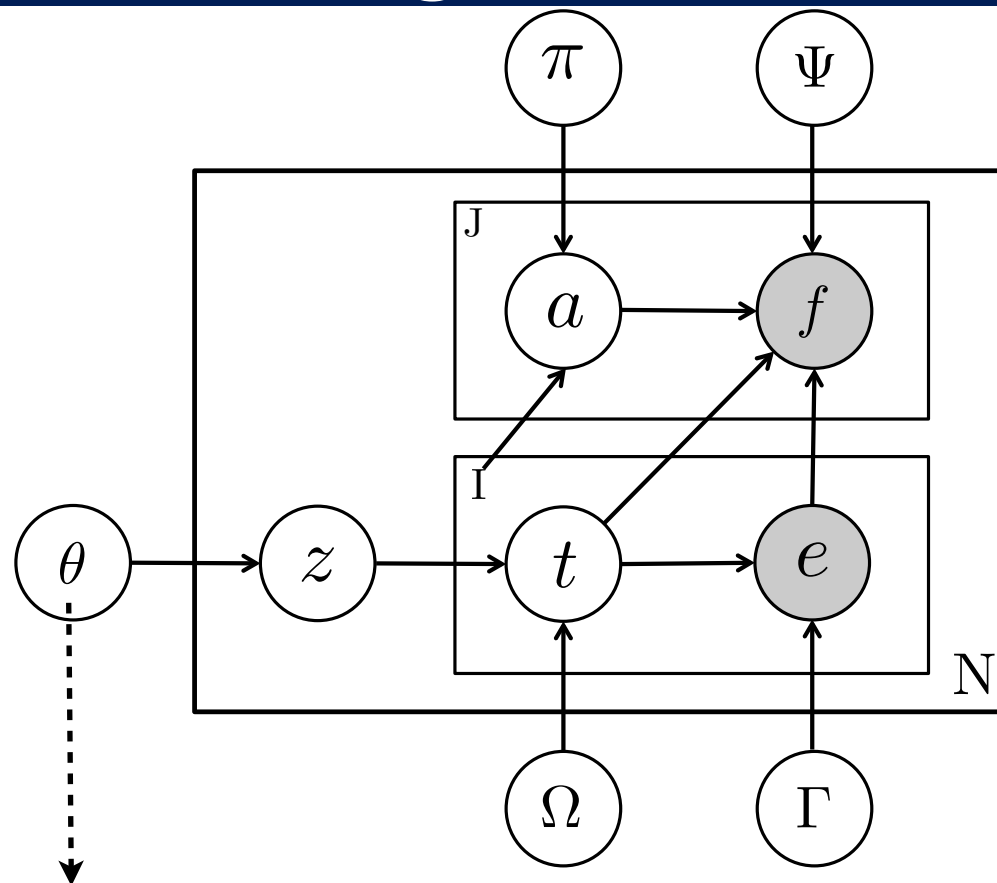
leg-color

head-color

...

beak-color

A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

z

t

beak-size

beak-color

bird-size

wing-color

bird-kind

leg-color

head-color

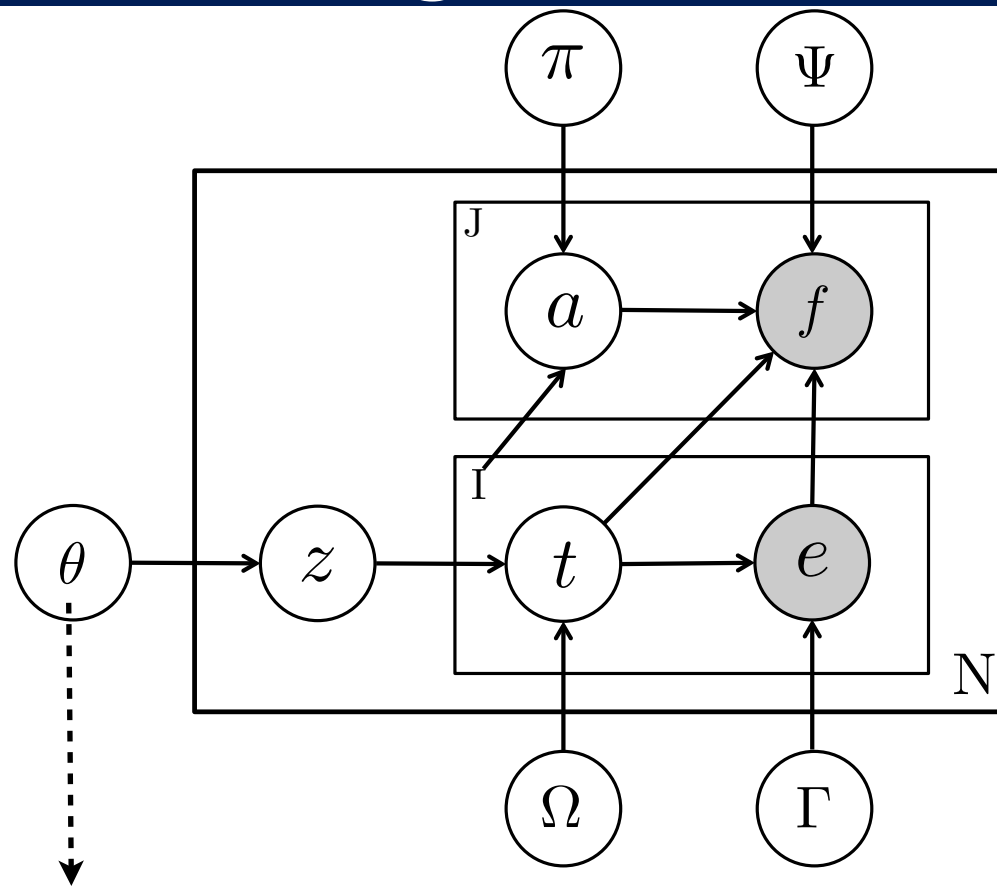
...

beak-color

topic:color

topic:beak

A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

z

t

e

beak-size

beak-color

bird-size

wing-color

bird-kind

leg-color

head-color

...

beak-color

topic:color

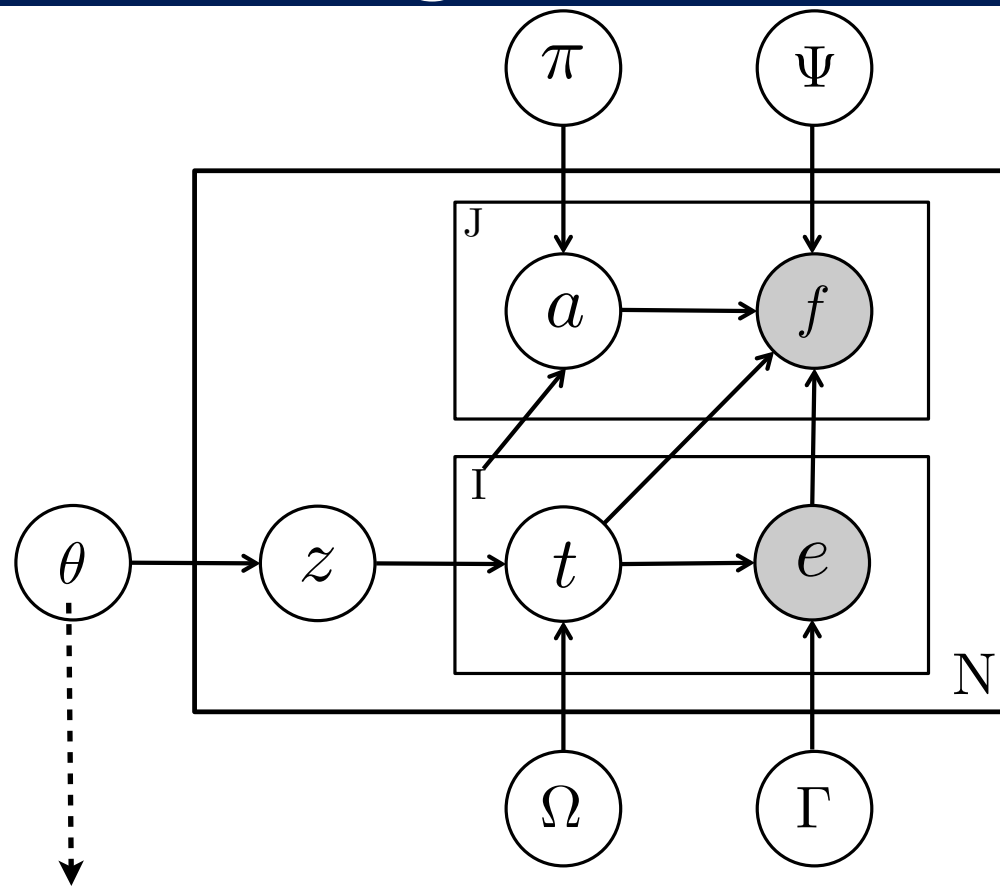
yellow

topic:beak

beak

NULL

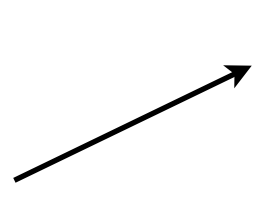
A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

- beak-size
- beak-color
- bird-size
- wing-color
- bird-kind
- leg-color
- head-color
- ...

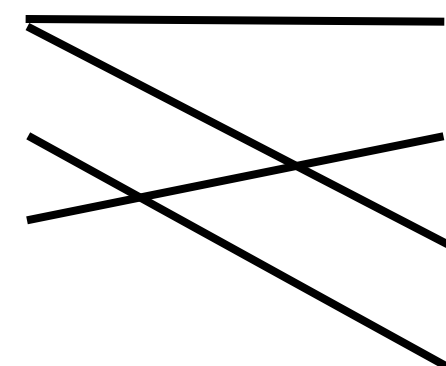


beak-color

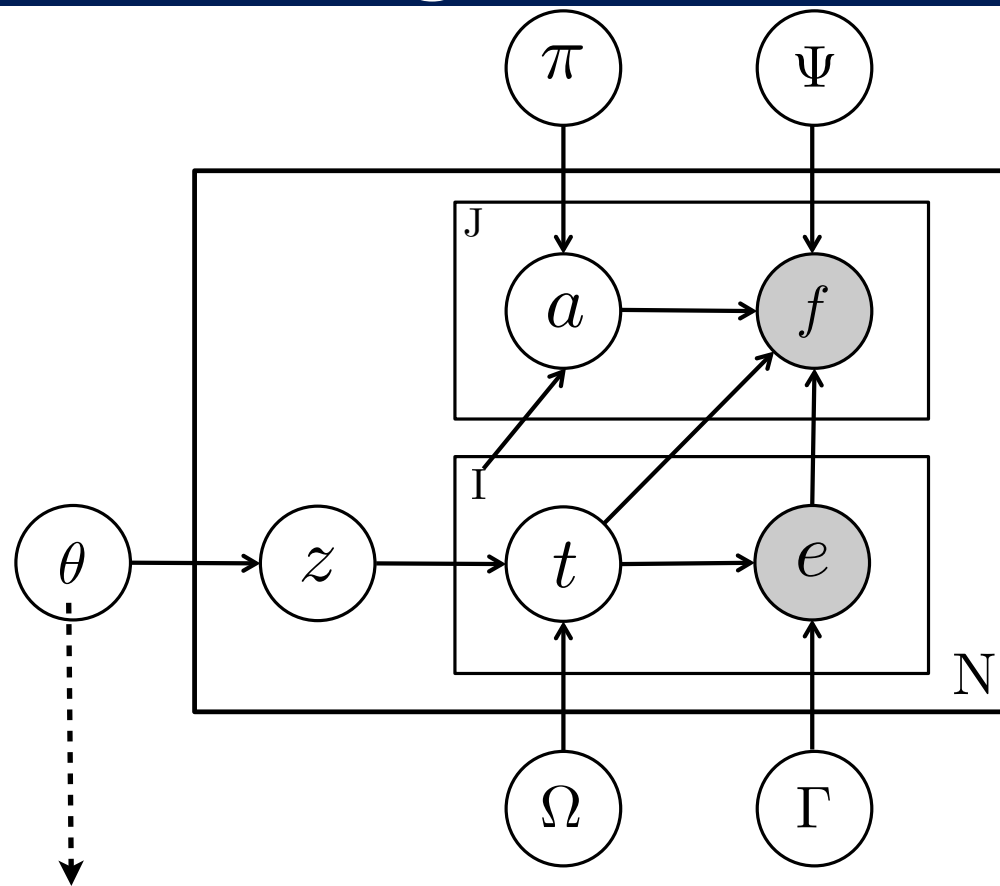
z t e a

topic:color
topic:beak

yellow
beak
NULL



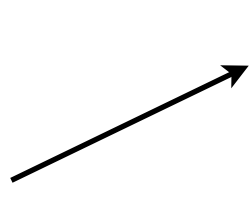
A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

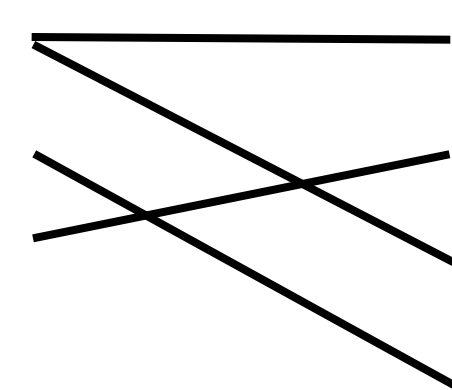
- beak-size
- beak-color
- bird-size
- wing-color
- bird-kind
- leg-color
- head-color
- ...



beak-color

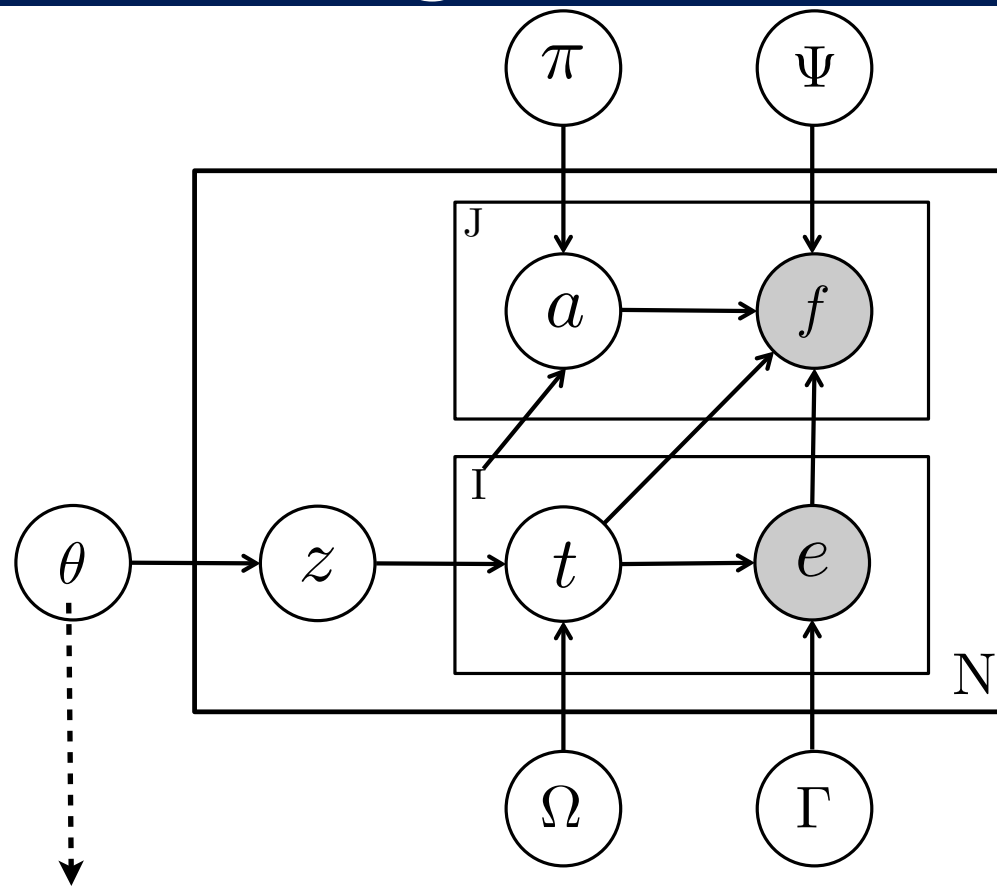
topic:color
topic:beak

yellow
beak
NULL



black
and
white
beak

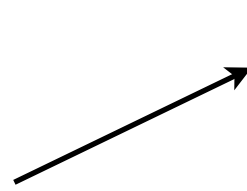
A generative model of sentence pairs



yellow beak
vs.
black and white beak

part-modifier
topic pairs

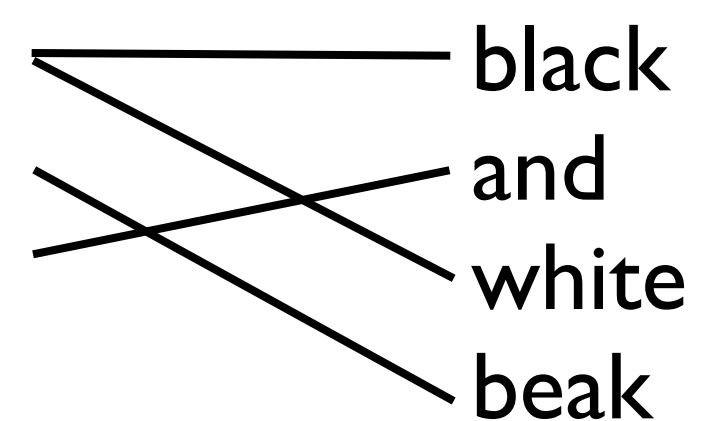
beak-size
beak-color
bird-size
wing-color
bird-kind
leg-color
head-color
...



beak-color

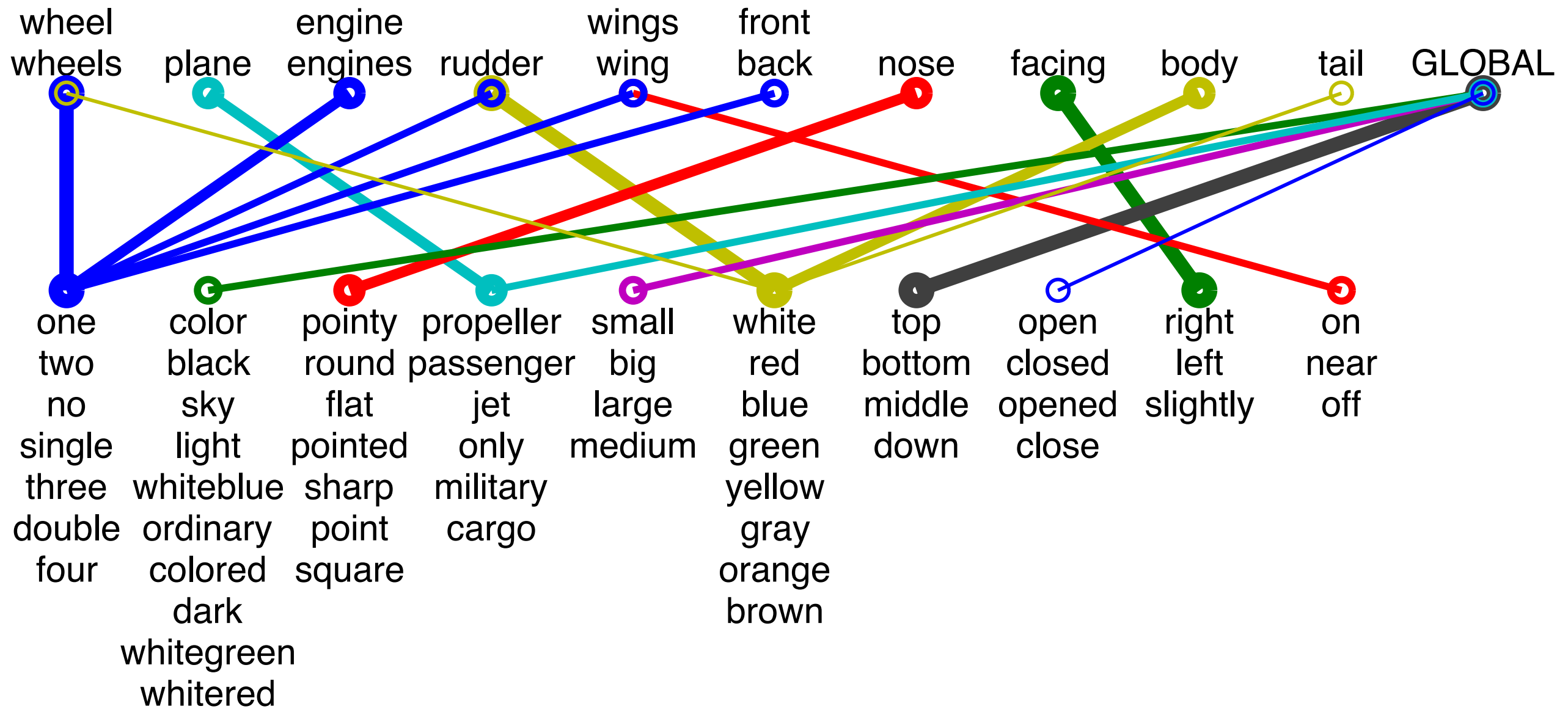
topic:color
topic:beak

yellow
beak
NULL



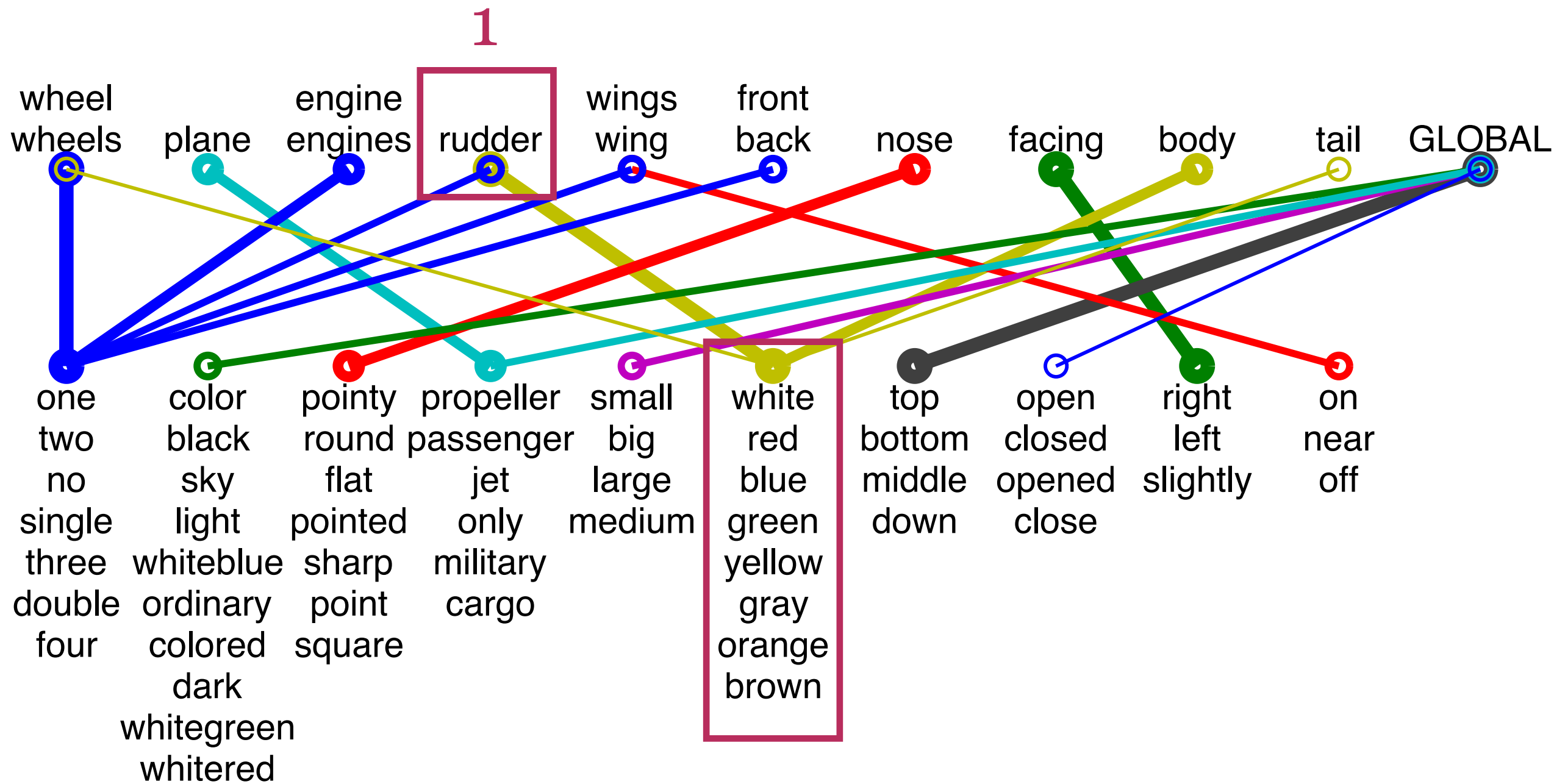
Initialize part and modifier topics using word alignments

Parts, modifiers and attributes of airplanes



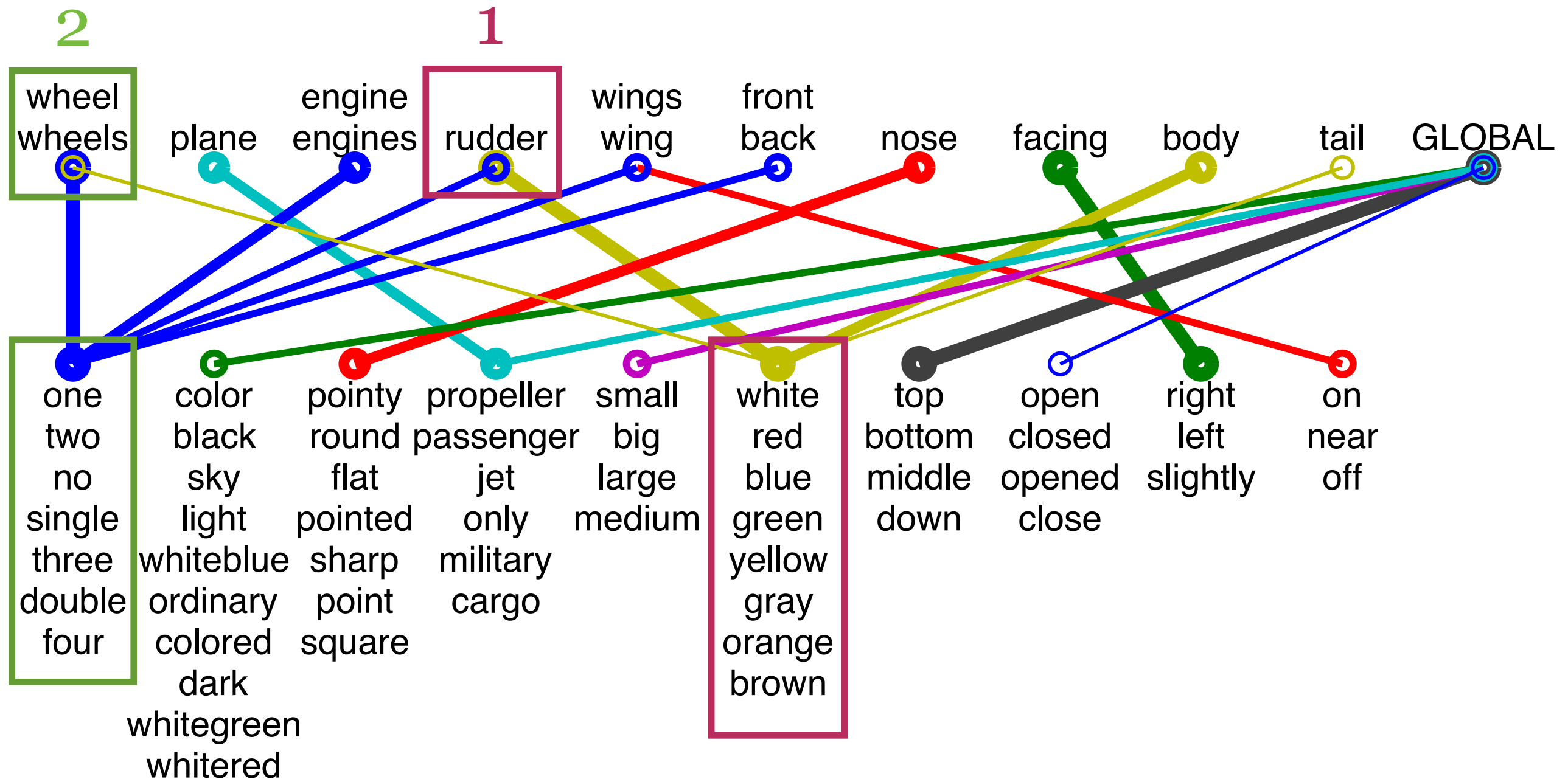
200 images, 1000 random pairs
Images from airliners.net

Parts, modifiers and attributes of airplanes



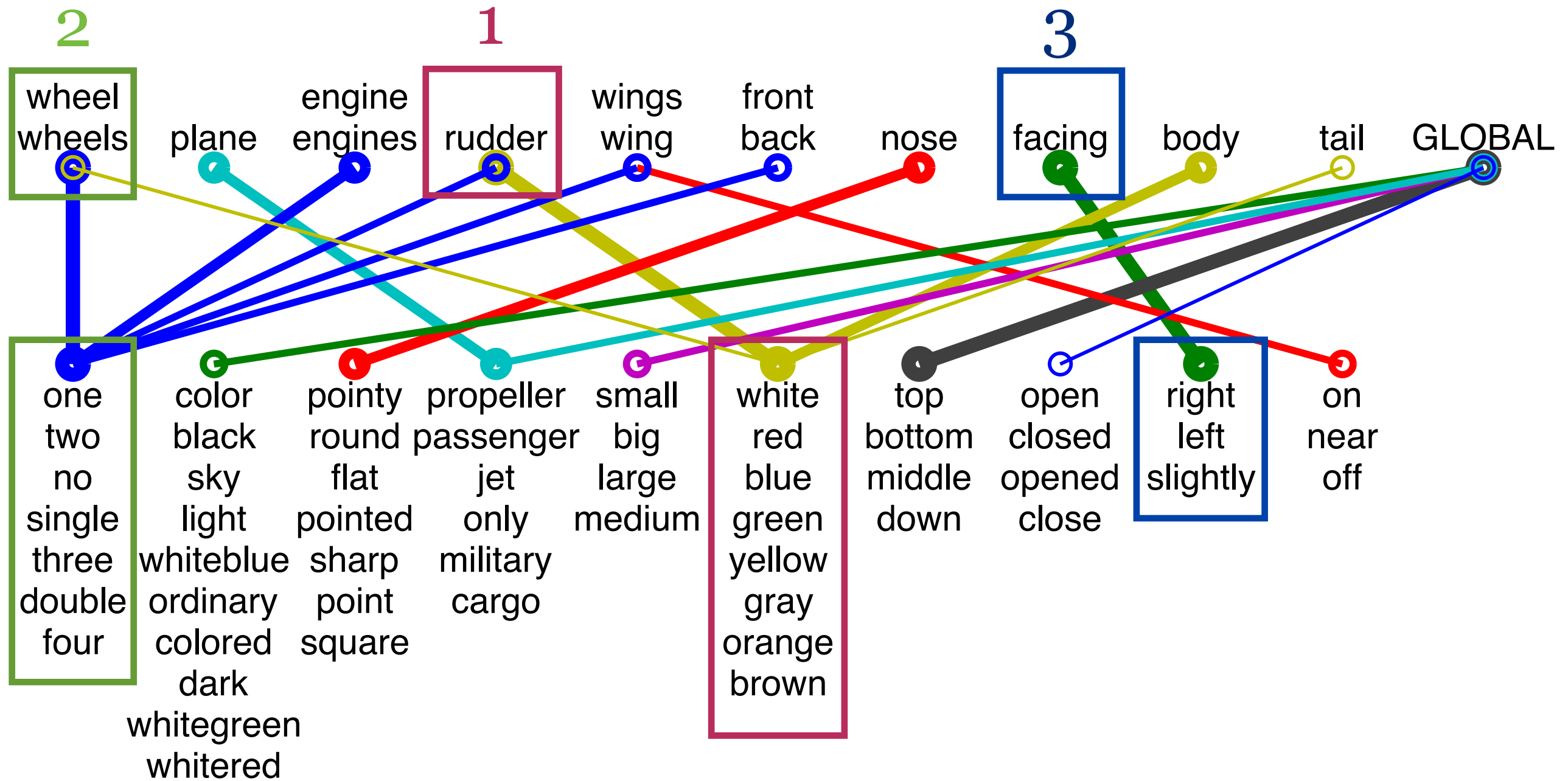
200 images, 1000 random pairs
 Images from airliners.net

Parts, modifiers and attributes of airplanes



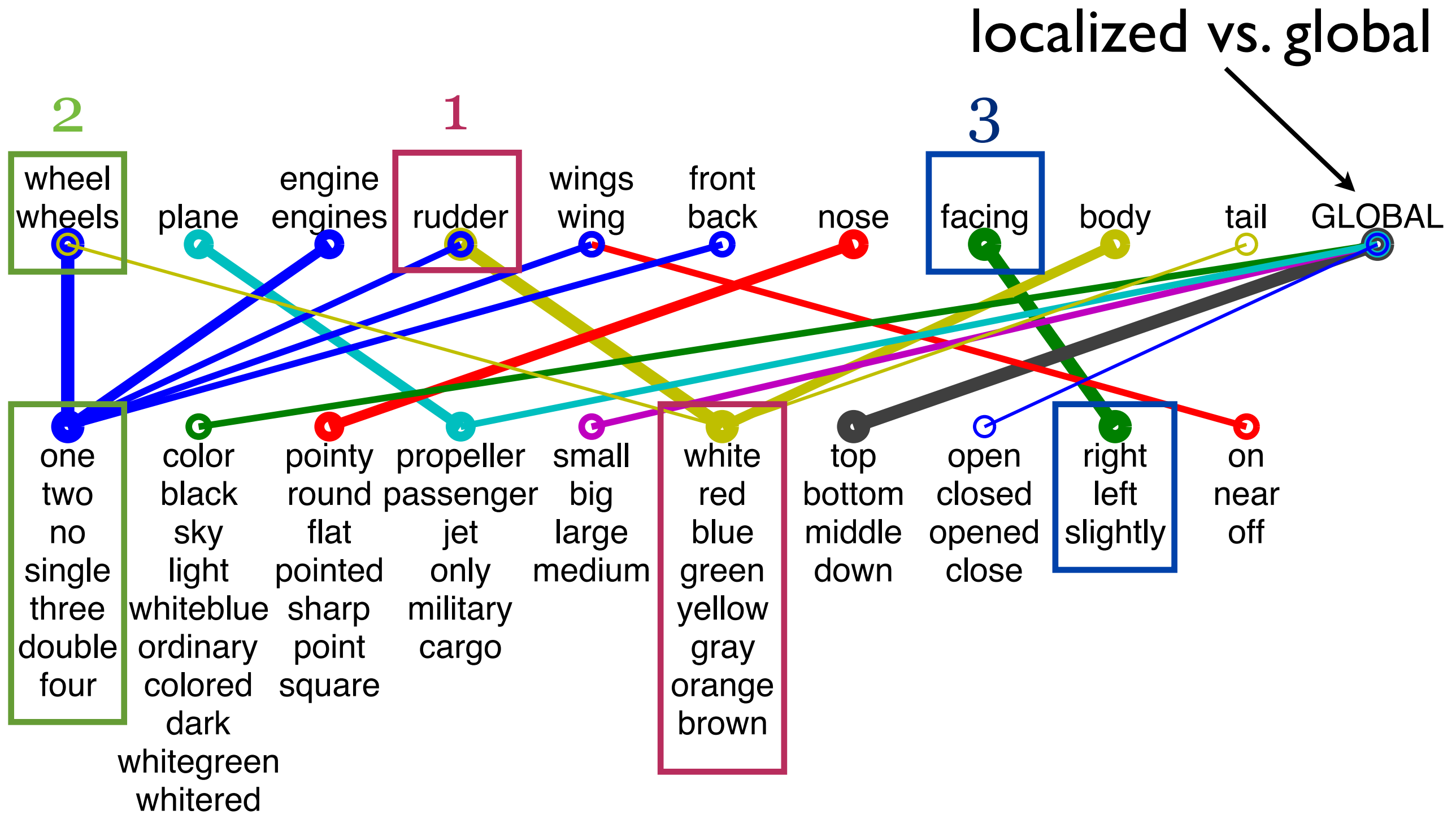
200 images, 1000 random pairs
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Parts, modifiers and attributes of airplanes



200 images, 1000 random pairs
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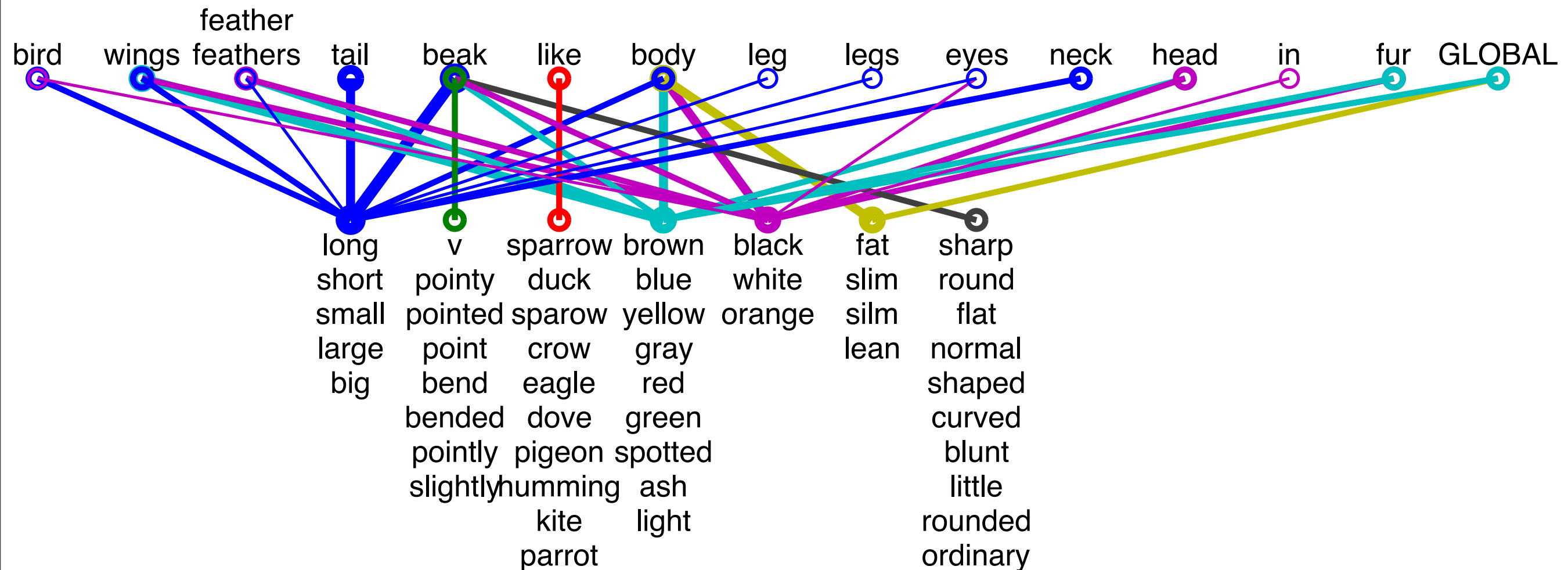
Parts, modifiers and attributes of airplanes



200 images, 1000 random pairs
 Images from airliners.net

Parts, modifiers and attributes of birds

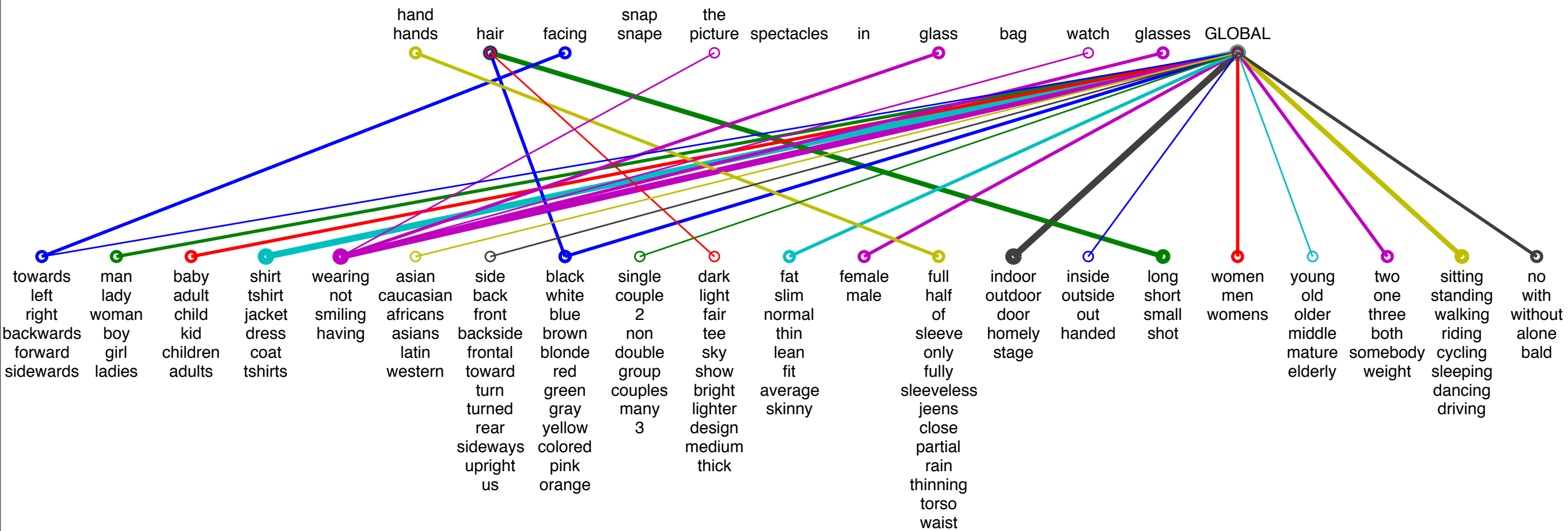
beak-size, wing-color, tail-size, body color, bird type



200 images, 1600 pairs
1 image per category
CUB 200 dataset

Parts, modifiers and attributes of people

location, shirt vs tshirt, hair length, gender



400 images, 1600 pairs
Random images from
PASCAL VOC II

Conclusions

- Discriminative description is an effective way to elicit a lexicon of attributes that are useful for fine-grained distinction
- Simple analysis of sentence pairs can help discover
 - a lexicon of parts
 - a lexicon of modifiers
 - relationships between parts and modifiers (attributes)
 - the relative frequency of these in a dataset
- A useful tool to bootstrap annotation collection process