Commonsense in Parts: Mining Part-Whole Relations from the Web and Image Tags

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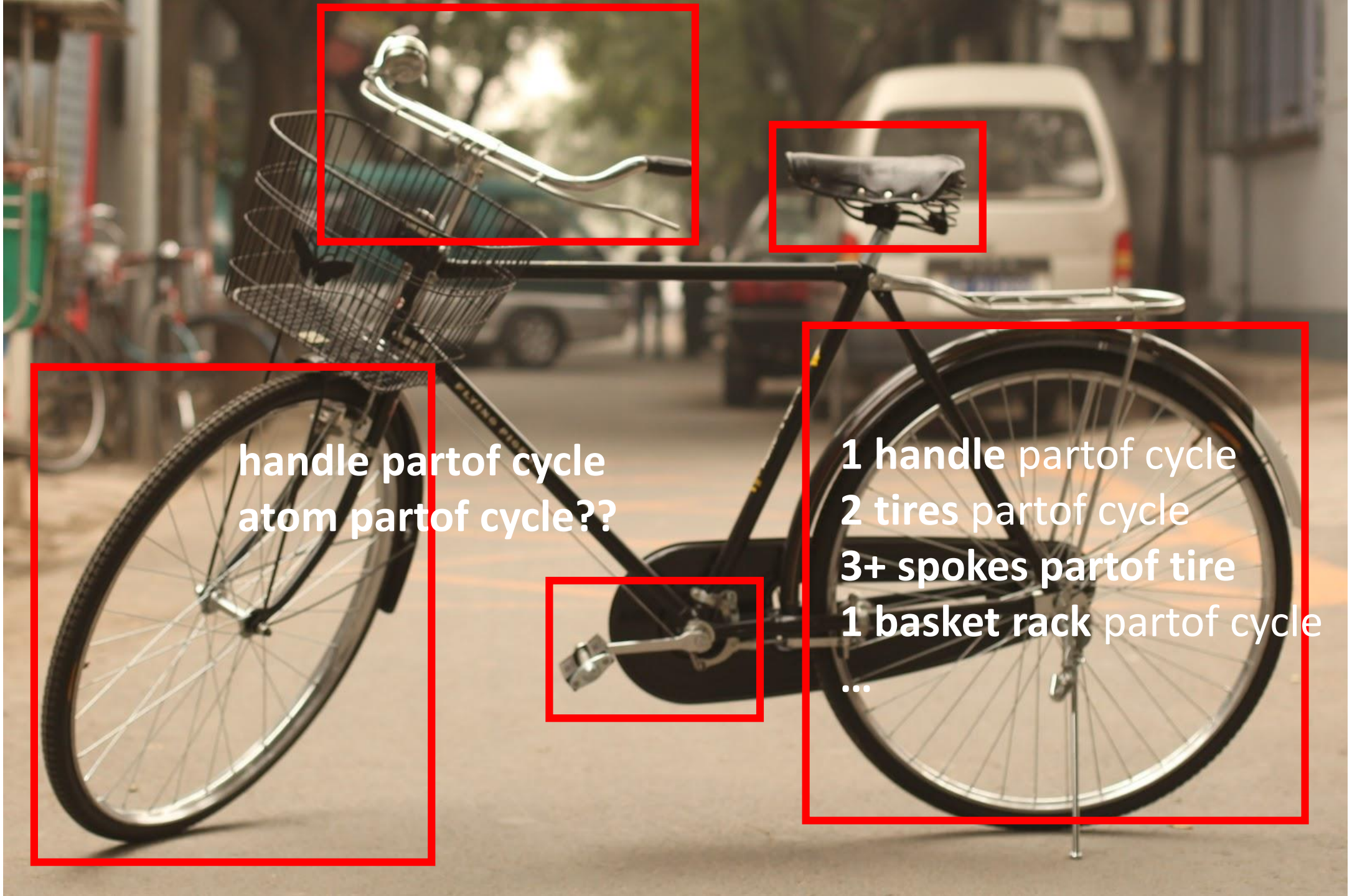
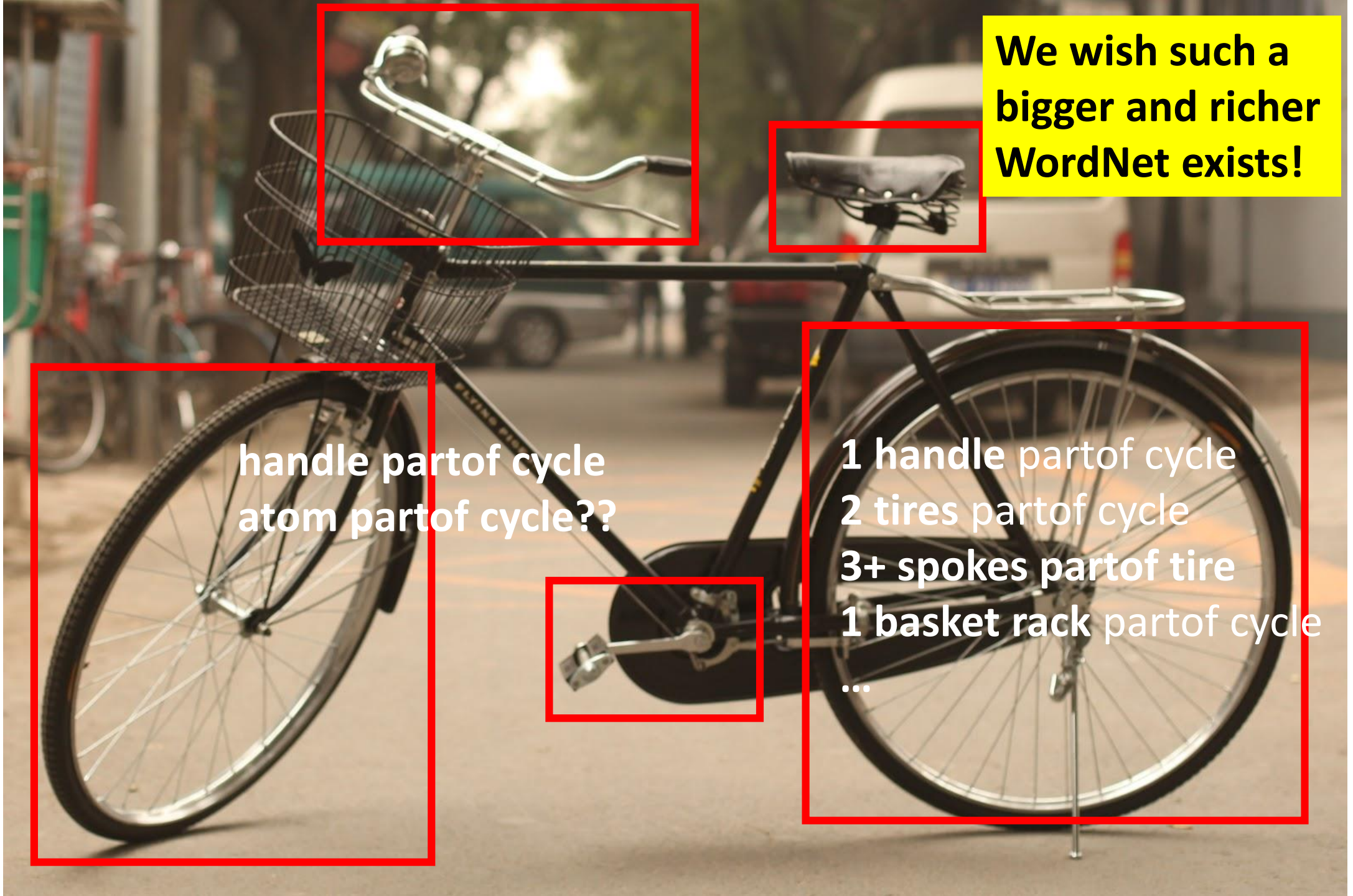
FLYING PIGEON

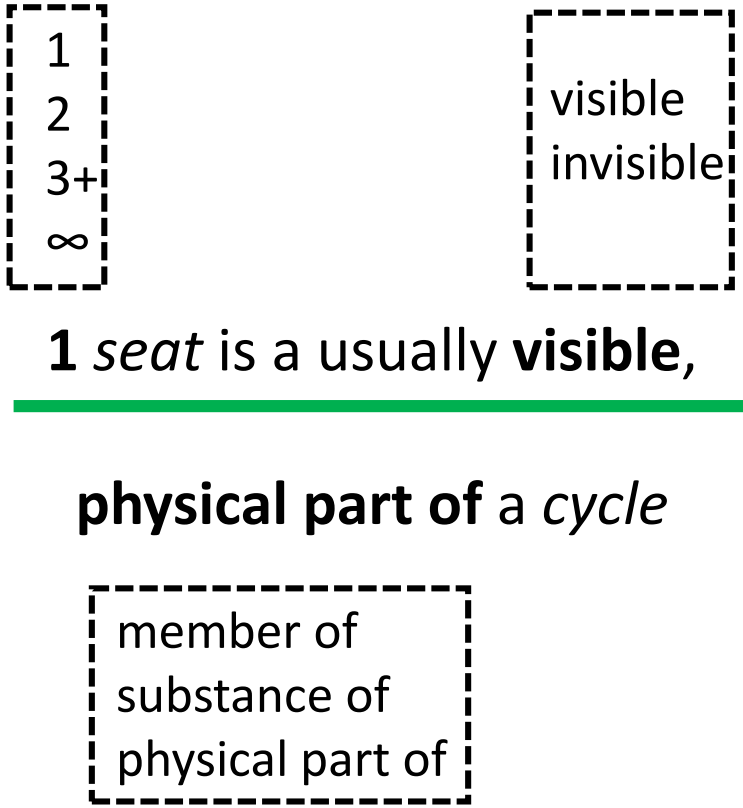
handle partof cycle
atom partof cycle


handle partof cycle
atom partof cycle??
1 handle partof cycle
2 tires partof cycle
3+ spokes partof tire
1 basket rack partof cycle
…


We wish such a bigger and richer WordNet exists!
handle partof cycle
atom partof cycle??
1 handle partof cycle
2 tires partof cycle
3+ spokes partof tire
1 basket rack partof cycle
…

1 *seat* is a usually **visible**,

physical part of a *cycle*



seat (reservation)
seat (support to sit)
seat (center of authority)

cycle (rhythm, oscillation)
cycle (bicycle)

1
2
3+
∞

visible
invisible

seat (reservation)
seat (support to sit)
seat (center of authority)

1 *seat* is a usually **visible**,

physical part of a *cycle*

cycle (rhythm, oscillation)
cycle (bicycle)

member of
substance of
physical part of

Unstructured and ambiguous
{cyclist, seat} *is part of* a {team, cycle}
1 seat, 2 brakes, 2 tires part of cycle!!
the seat is visible while the atom is not!!

seat (reservation)
seat (support to sit)
seat (center of authority)

1 *seat* is a usually **visible**,

physical part of a *cycle*

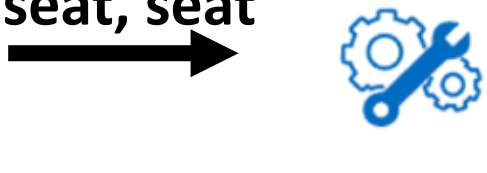
cycle (rhythm, oscillation)
cycle (bicycle)

	Curated: WordNet	Semi: ConceptNet	Auto: Text	Auto: Images	?
Size	↓17215	↓1493	↑1130000	↓68	↑
Accuracy	↑100	→68	↓20	↓15	↑
Fine-grained	↑1	↓0	↓0	↓0	↑
Refined args	↑1	↓0	↓0	↓0	↑
Visibility	↓0	↓0	↓0	↑1	↑
Cardinality	↓0	↓0	↓0	↓0	↑

How can we fill this gap?

WN
wheel, cycle

seat, cycle
seat, seat



seat, cycle
seat, sports cycle

visible

1 seat

Score

Reason

Enrich

WN
wheel, cycle

seat, cycle
seat, seat

seat, cycle
seat, sports cycle

visible

1 seat

wheel, physical part of, cycle
wheels ***are essential parts*** *of* a cycle
wheels ***on sale along with*** the cycle

* are essential parts of *
seats are essential parts of a **cycle**
dollars are an essential part of **life**
snake is an essential part of **machine**

Score

Reason

Enrich

* ***are essential parts*** *
* ***on sale along with*** *

PE are essential parts of PE
seat, cycle
dollars, ~~**life**~~
snake, **machine**

Noun phrase aware wrapper over IMS: sports cycle -> cycle#6

Domain (r)	Relation: r	Range (r)
Physical Entity	**Physical part of (P)** wheel, cycle	Physical Entity
Physical + Abstract Entity	**Member of (M)** cyclist, team	Abstract Entity
Substance Entity	**Substance of (S)** rubber, wheel	Physical Entity

* ***are essential parts*** *
* ***on sale along with*** *

PE are essential parts of PE
seat, cycle
dollars, ~~**life**~~
snake, **machine**

Noun phrase aware wrapper over IMS: sports cycle -> cycle#6

$$\sigma(a_k) = \frac{e^{supp(a_k)}}{1 + e^{supp(a_k)}} \frac{e^{str(a_k)}}{1 + e^{str(a_k)}}$$

Score of a candidate a_k (either pattern or assertion)

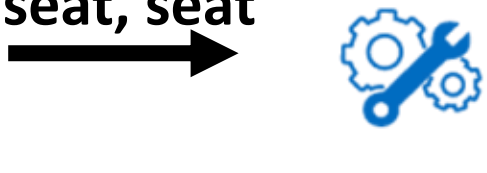
Seed Support: many distinct seed matches implies high score

Strength: Penalize semantic drift of candidates that match seeds of different relations (P,M,S)

Domain (r)	Relation: r	Range (r)
Physical Entity	**Physical part of (P)** wheel, cycle	Physical Entity
Physical + Abstract Entity	**Member of (M)** cyclist, team	Abstract Entity
Substance Entity	**Substance of (S)** rubber, wheel	Physical Entity

WN
wheel, cycle

seat, cycle
seat, seat



seat, cycle
seat, sports cycle

visible

1 seat

Score

seat is part of a seat

seat part of wheel
wheel part of seat

spoke part of wheel
wheel part of cycle
=> spoke part of cycle

sports cycle *isA* cycle
wheel part of sports cycle

Reason

Enrich

WN
wheel, cycle

seat, cycle
seat, seat

seat, cycle
seat, sports cycle

visible

1 seat

Score

Reason

cycle, fun, trip, go, **seat**, niket
seat is visible part of cycle

Are seats countable? [seat/seats]

en: seats are part of cycles
it: una sede è parte di un ciclo

Enrich

WN
wheel, cycle

seat, cycle
seat, seat

seat, cycle
seat, sports cycle

visible

1 seat

Score

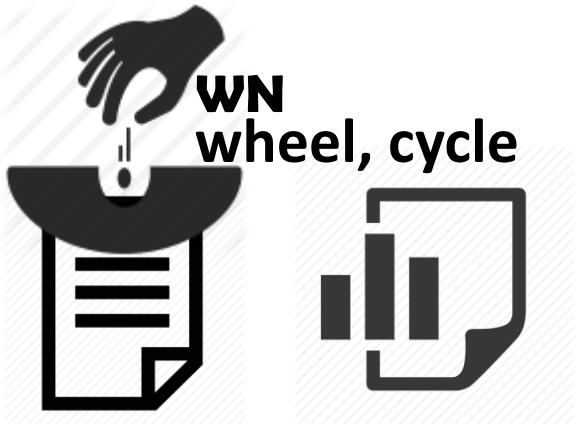
Reason

Enrich

PhysicalPart	Member	Substance	Visibility	Cardinality	Overall
89 %	96 %	71 %	98 %	80 %	**89 %**
6.65 M	0.04 M	0.06 M	0.74 M	6.69 M	**6.75 M**

Replacing WordNet by PWKB for image detection task, provides 10% relative increase in accuracy

$$\frac{\text{electron\#1} <_P^{\{3+,NV\}} \text{atom\#1}}{\frac{\text{musician\#2} <_M^{2} \text{duet\#2}}{\text{steel\#1} <_S \text{boiler\#1}}}$$



seat, cycle
seat, seat

seat, cycle
seat, sports cycle

visible

1 seat

1. from text to concepts (helps reasoning)
   wheel part of cycle ^ sports cycle *typeof* cycle => wheel part of sports cycle
2. from languages to languages (better cardinality estimates)
3. from image to text (additionally quasi visual verification)
4. from text to image (presented a use-case for better object detection)

http://**tinyurl.com/partwholekb**