connecting the dots: motivation

"who is the leader of USA?"

facts … [X is prime-minister of C] … [X is president of C]

no such fact [X is leader of USA] … now what?

X is president of C => X is leader of C – *rules* (*knowledge*)

✓ Obama is president of USA => Obama is leader of USA

example of *reasoning* ..

reasoning can be tricky:

Manmohan Singh is prime-minister of India

Pranab Mukherjee is president of India

"who is the leader of India"

… *much* more *knowledge* is needed

reasoning and web-intelligence

"book me an American flight to NY ASAP"

"this New Yorker who fought at the battle of Gettysburg was once considered the inventor of baseball"

Alexander Cartwright or Abner Doubleday – *Watson got it right*

"who is the Dhoni of USA?"

- *analogical reasoning* - X is to USA what Cricket is to India (?)
- \+ *abductive reasoning* – there *is no* US baseball team … so ?

  find *best possible answer^*
- \+ *reasoning under uncertainty* … who is the "most" popular ?

Semantic Web:

- web of linked *data*, *inference* rules and engines, query
  - pre-requisite: extracting *facts* from text, as well as *rules*

logic: propositions

A, B – 'propositions' (either True or False)

A and B is True: A=True and B=True ($A \wedge B$)

A or B is True: either A=True or B=True ($A \vee B$)

if A then B (same as if A=True then B=True)

is the same as saying A=False or B=True

also written as:

A=> B is equivalent to **~A $\vee$ B**

check: A=T, ~A=F, so (~A $\vee$ B) =T only when B=T

Important:

if A=F, ~A=T, so (~A $\vee$ B) is true regardless of B being T or F

logic: predicates

Obama is president of USA:

isPresidentOf (Obama, USA) - *predicates, variables*

X is president of C => X is leader of C

R: isPresidentOf (X, C) => isLeaderOf (X, C)

plus – the above is stating a rule for *all* X,C - *quantification*

"Obama is president of USA": *fact*

F: isPresidentOf (Obama, USA)

using rule R and fact F,

isLeaderOf (Obama, USA) is *entailed*

(*unification*: X *bound* to Obama; C *bound* to USA)

Q: isLeaderOf (X, USA) – *query*

reasoning = answering queries or deriving new facts

using *unification* + *inference* = *resolution*

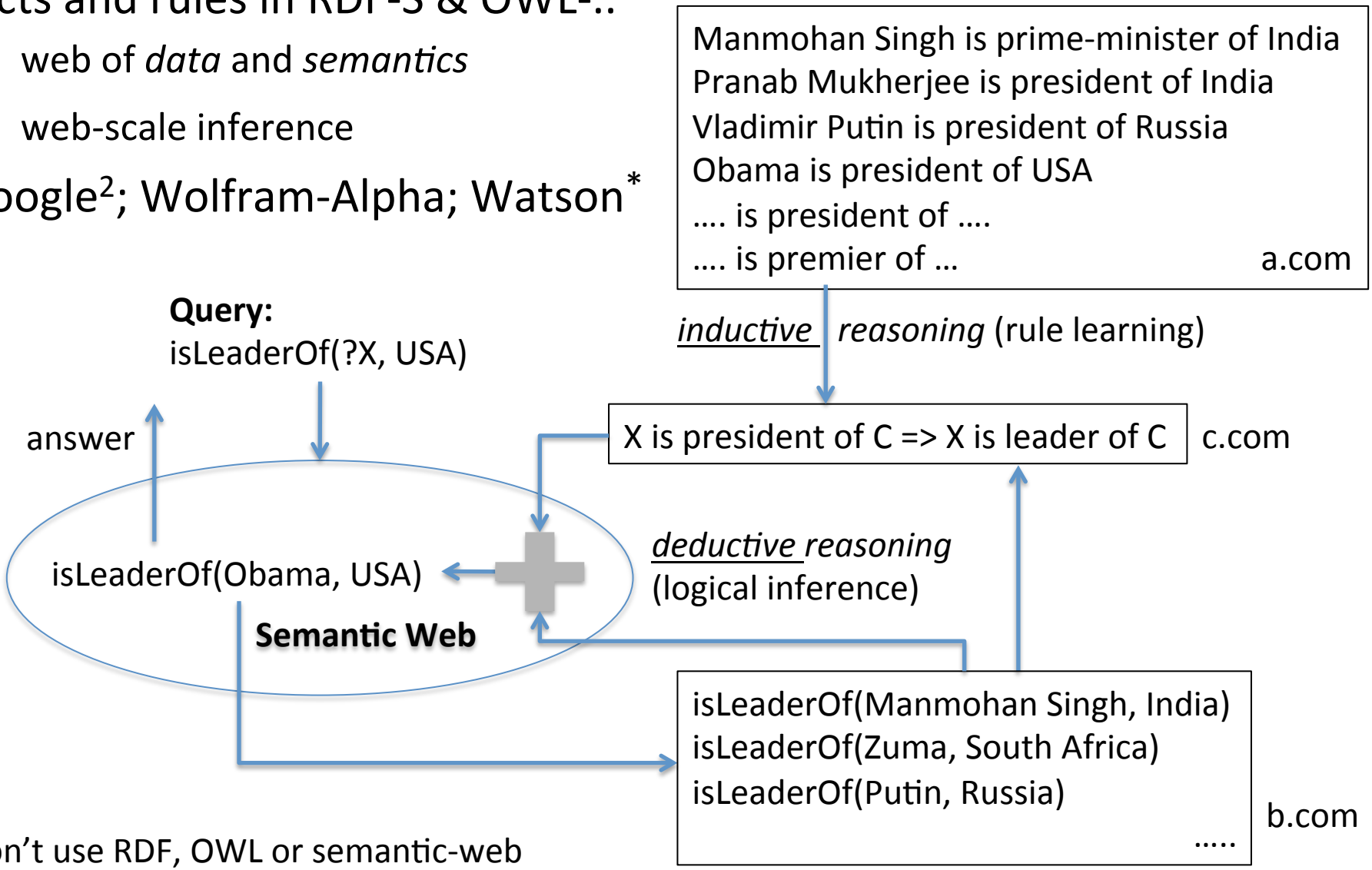
semantic web vision

facts and rules in RDF-S & OWL-..

web of *data* and *semantics*

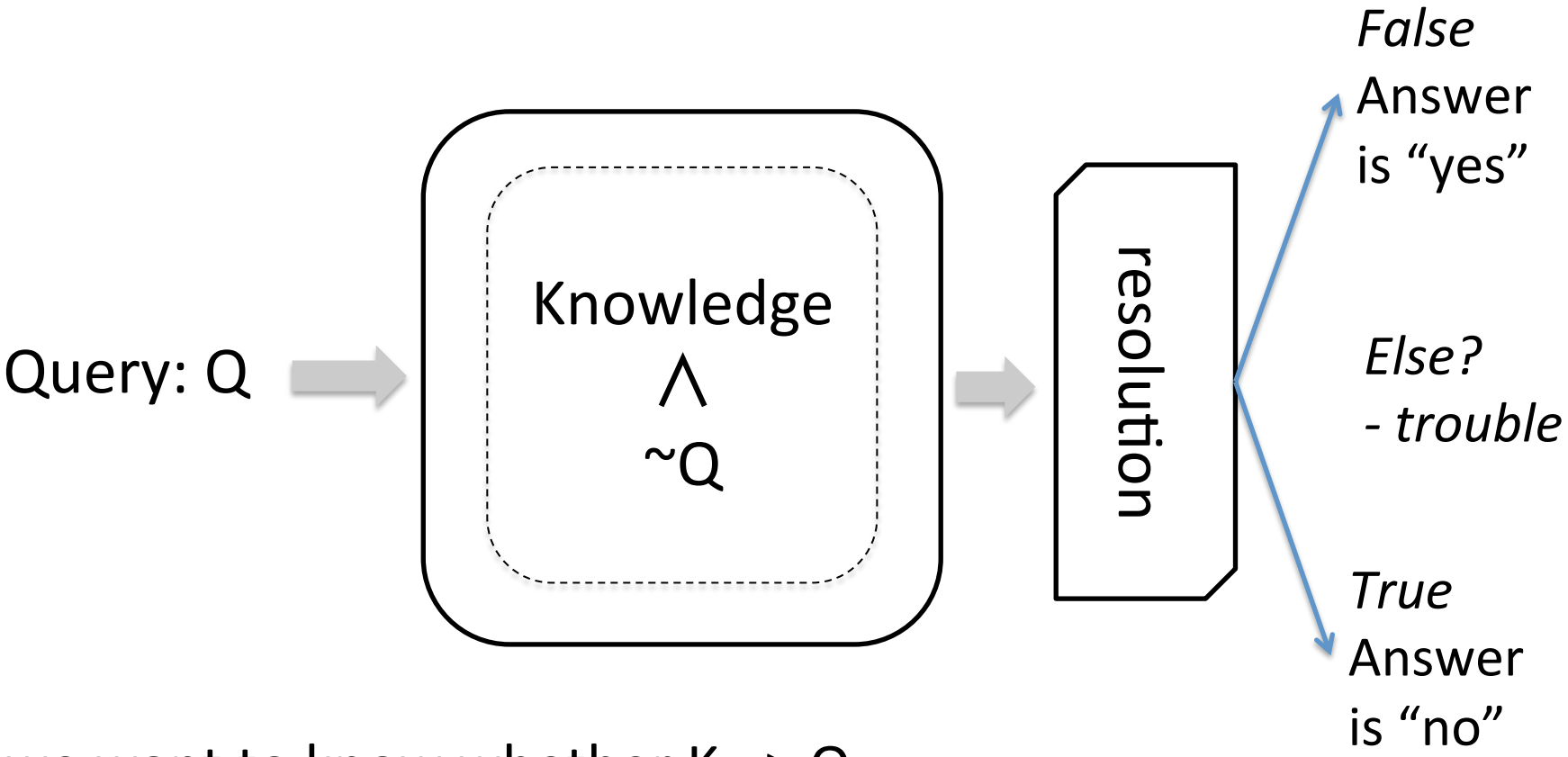
web-scale inference

Google[2]; Wolfram-Alpha; Watson*



*don't use RDF, OWL or semantic-web *technology* though they have similar intent, spirit …

logical inference: resolution



we want to know whether K => Q

i.e. ~K ∨ Q is True

i.e. K ∧ ~Q is False !

in other words K augmented with ~Q *entails* falsehood, for sure

logic and uncertainty

predicates *A, B, C*

1. For all *x, A(x) => B(x).*
2. For all *x, B(x) => C(x)*

1 and 2 *entail* For all *x, A(x) => C(x)* fundamental

however, consider the *uncertain* statements:

1': For **most** *x, A(x) => B(x). "most firemen are men"*

2'. For **most** *x, B(x) => C(x). "most men have safe jobs"*

it *does **not*** follow that "For **most** *x, A(x) => C(x)*" !

logic and causality

- if the sprinkler was on then the grass is wet

  $S \Rightarrow W$
- if the grass is wet then it had rained

  $W \Rightarrow R$

therefore it follows, i.e. $S \Rightarrow R$ is *entailed*

which states “the sprinkler is on, so it had rained”

- *problem is that causality was treated differently in each statement => absurdity*

causality and classification

if S then W (W is an observable *feature* of S)

$S \longrightarrow W$

if R then W (W is an observable *feature* of R)

$R \longrightarrow W$

if *W* is observed then *R* happened *(abduction)*

concluding which *class of event* observed S or R

abductive reasoning

= from effects to likely causes