Foundation Ontology and Semantic Language for Distributed Agents

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*THE REAL SCIENCE

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SingularityNET
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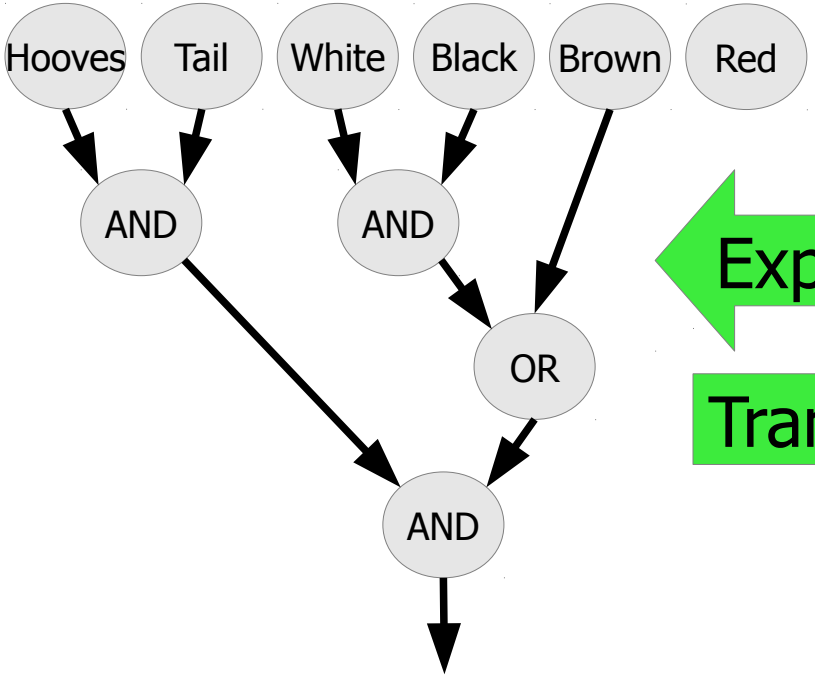
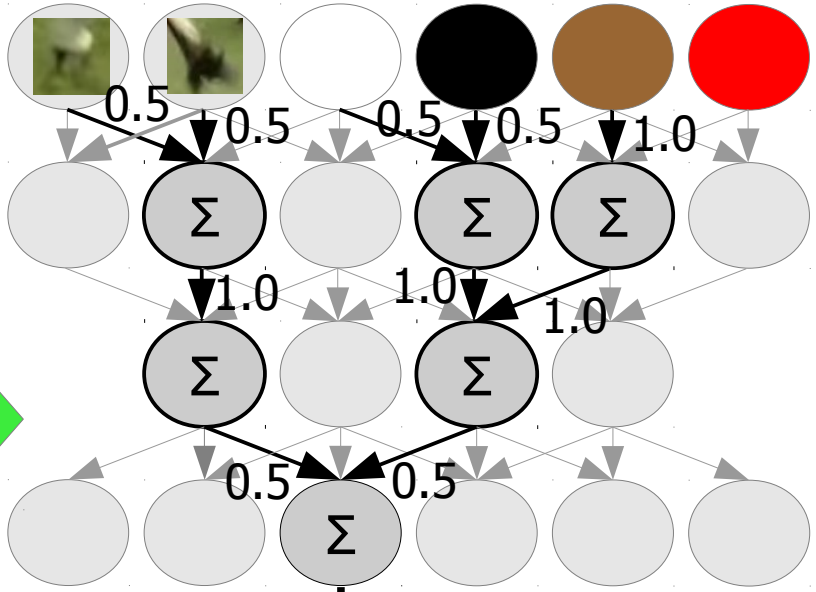
Bridging the Symbolic-Subsymbolic gap for "explainable AI" and "transfer learning"



Explain

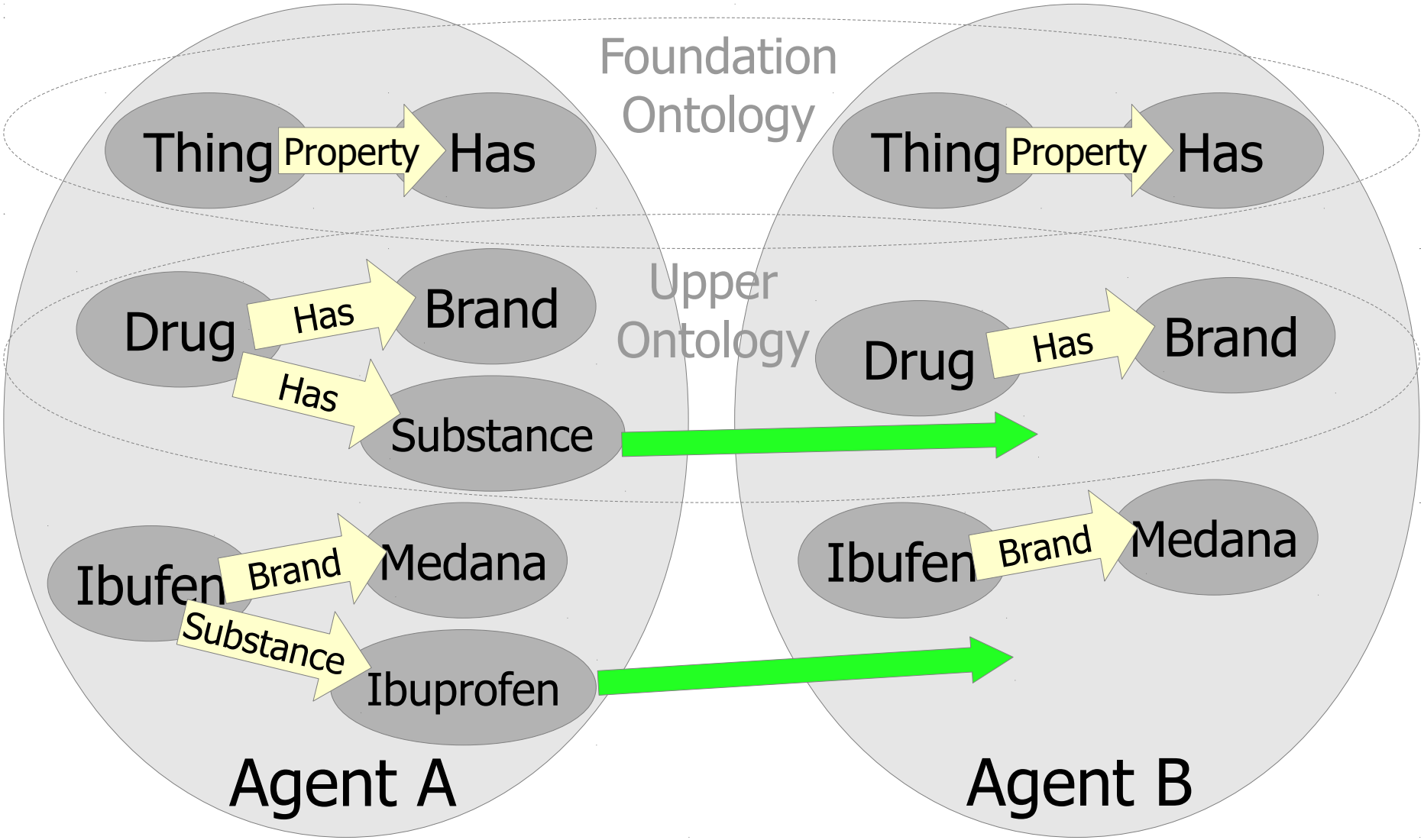
Transfer



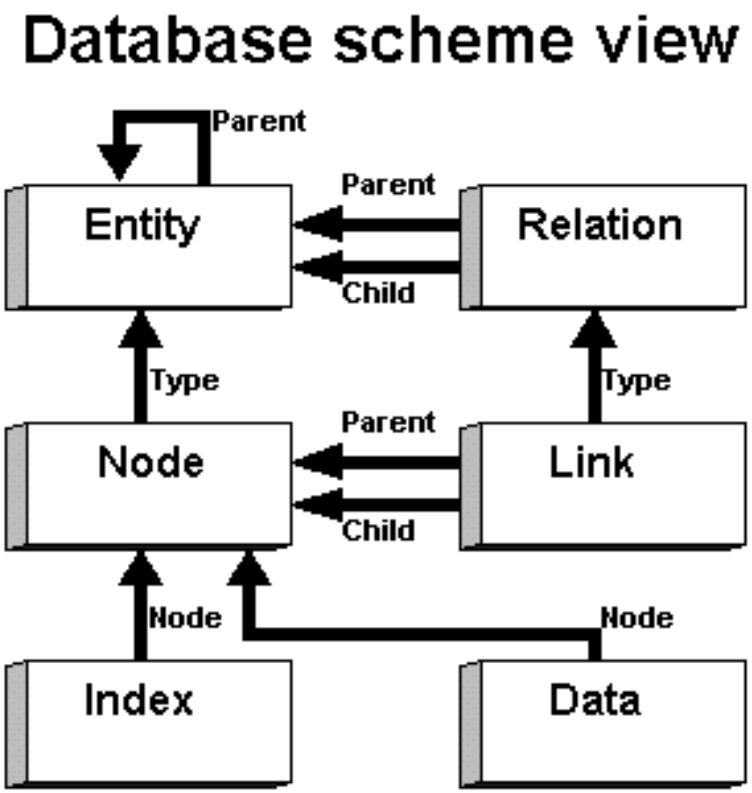
(Hooves AND Tail) AND
((White and Black) OR Brown)

=> Horse

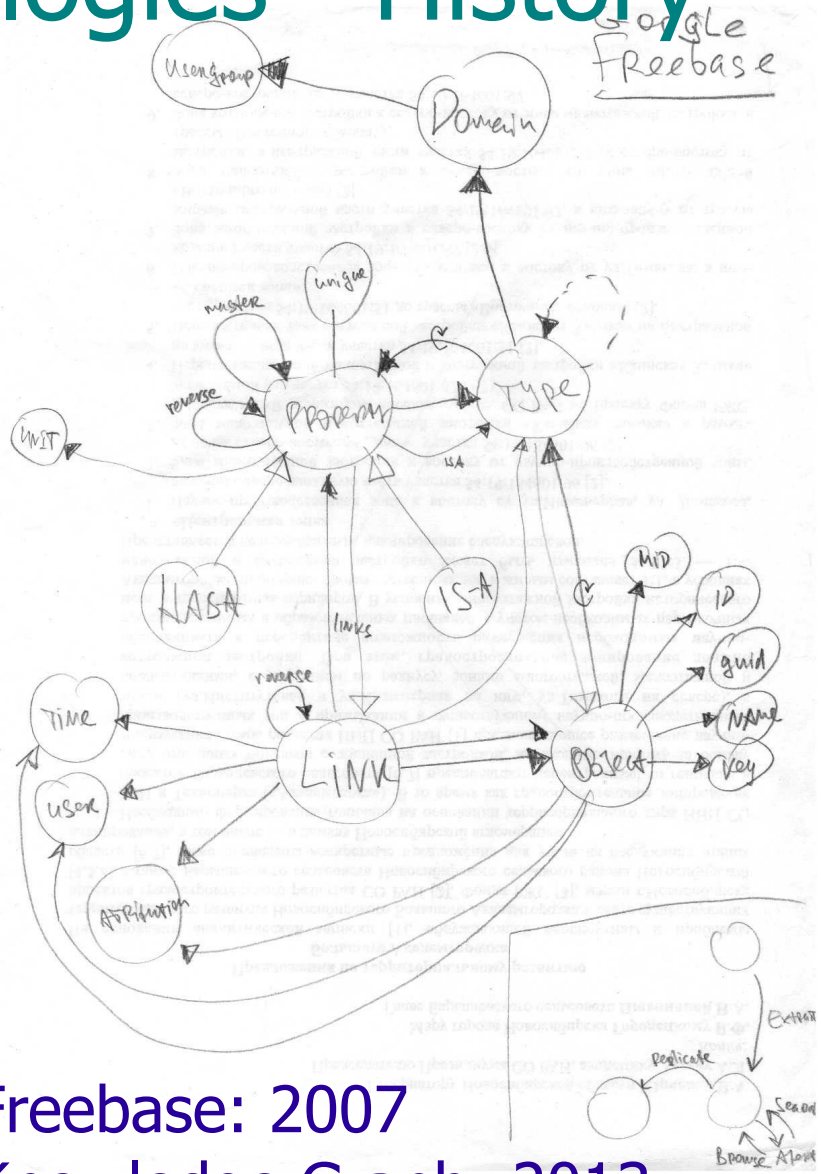
Foundation Ontologies for Distributed (Multi-Agent) Systems



Foundation Ontologies - History

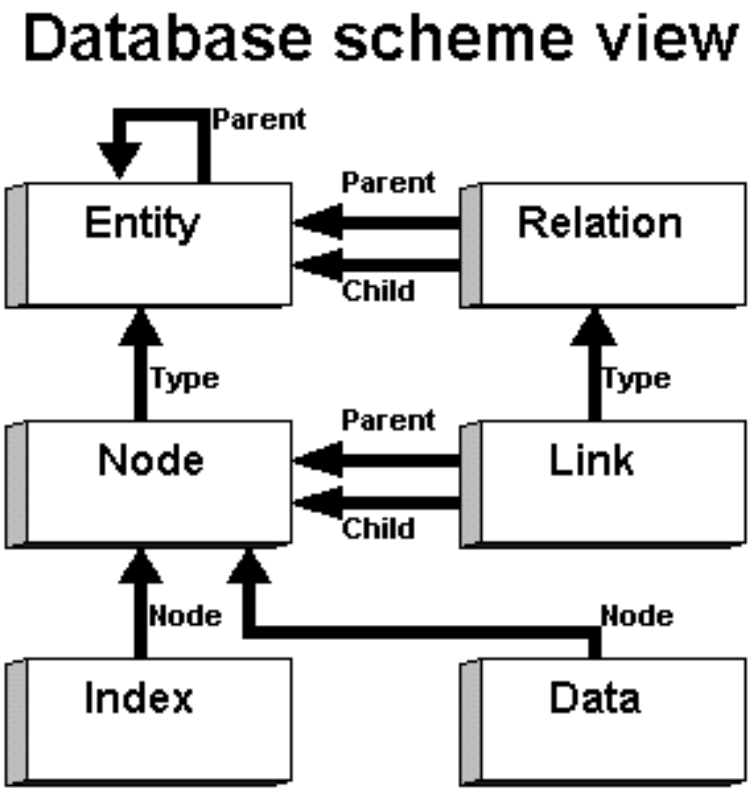


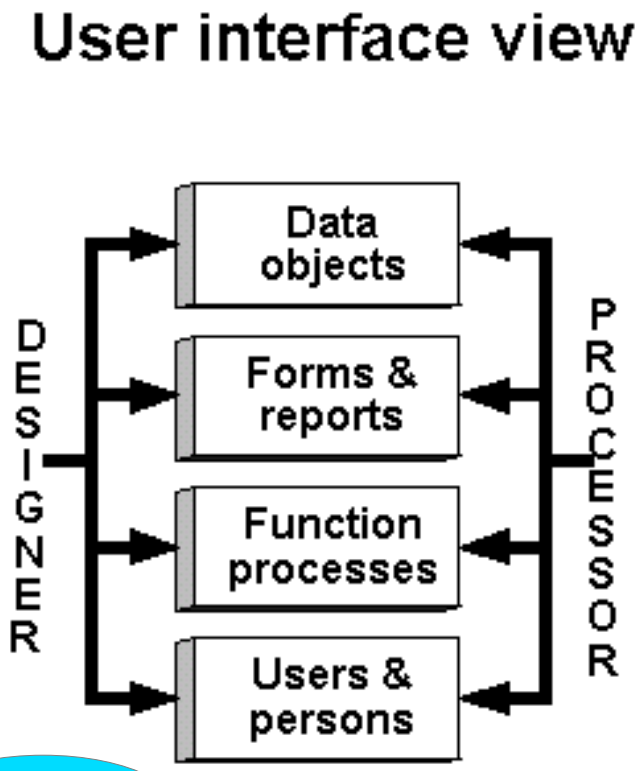
Data4: 1995



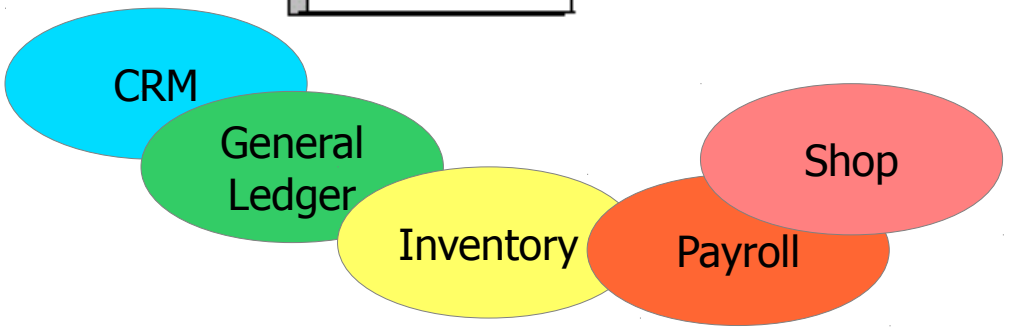
Freebase: 2007
Knowledge Graph: 2013

Foundation Ontologies - Applications



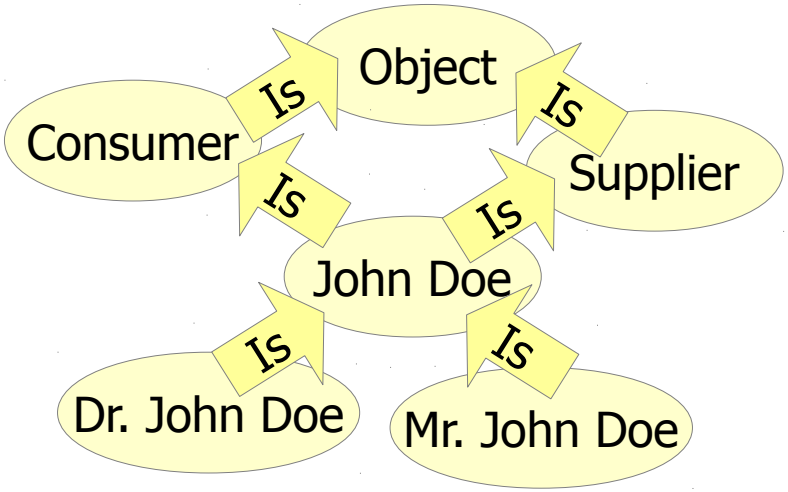


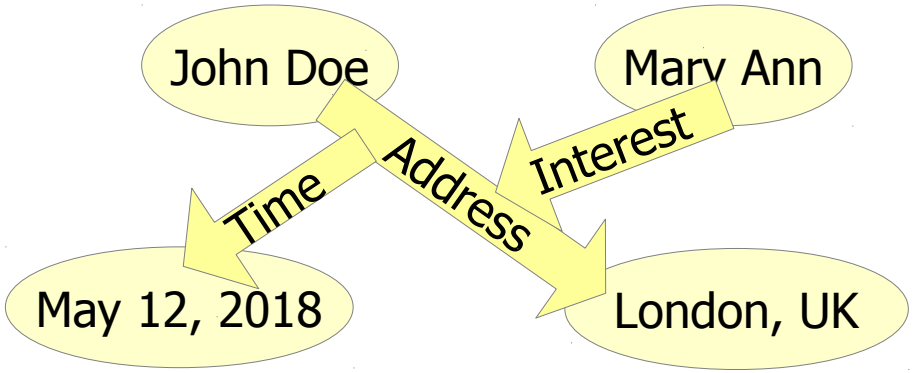
Data4: 1995



Lessons Learned:

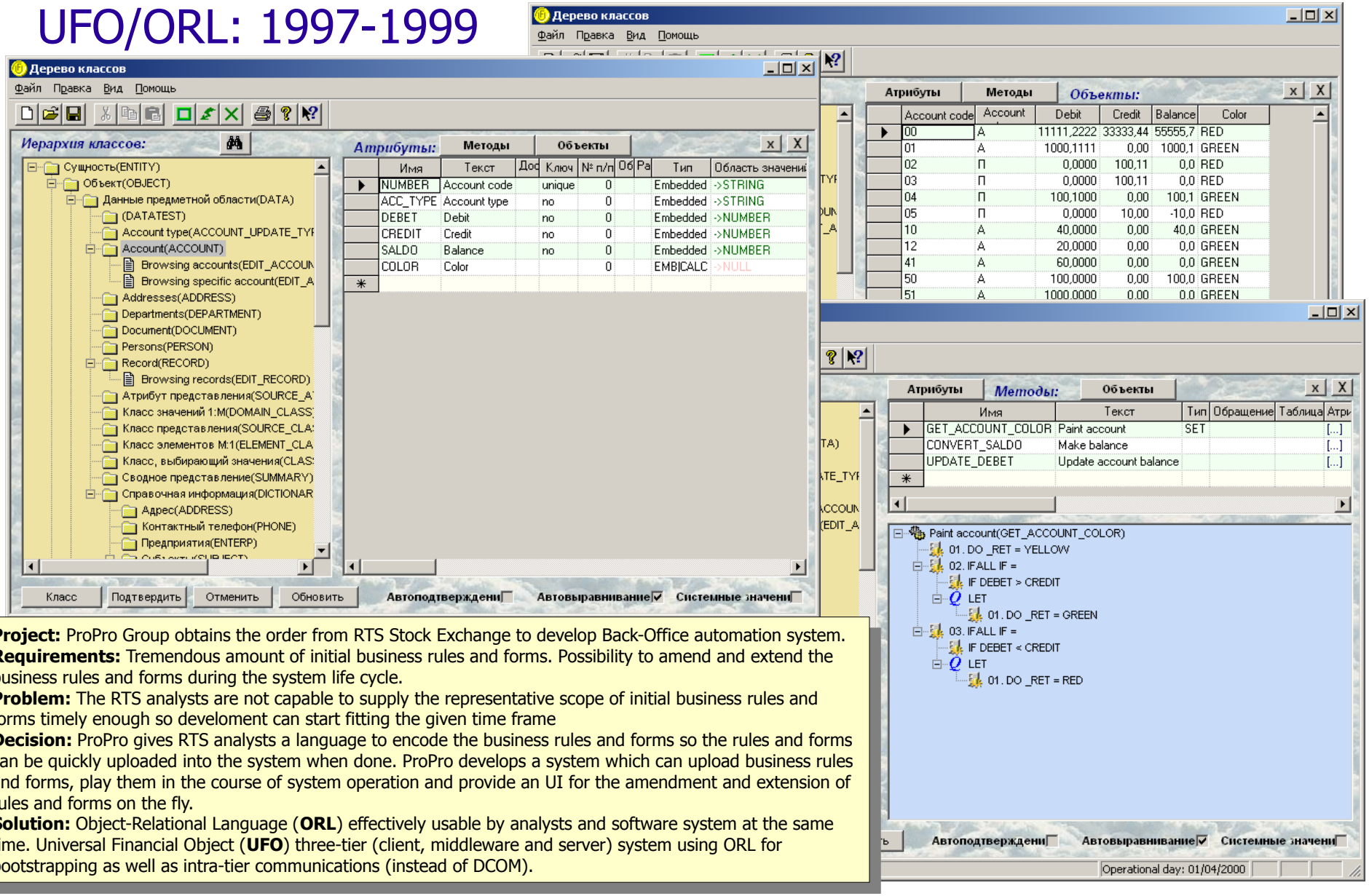
1. Class is an Object
2. Object may be a Class
3. Link can be a Node





Semantic Modeling of Business Processes

UFO/ORL: 1997-1999

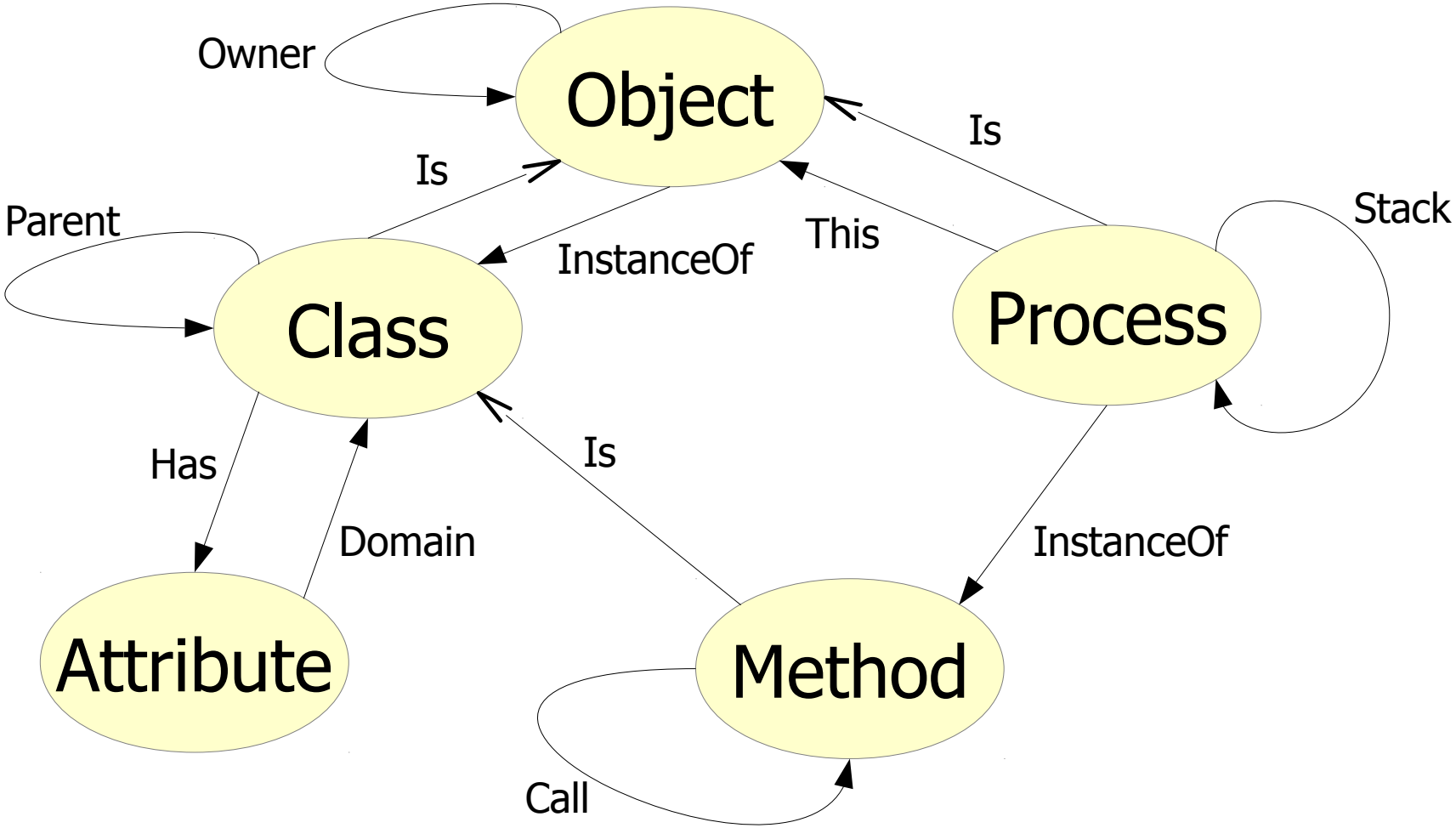


Project: ProPro Group obtains the order from RTS Stock Exchange to develop Back-Office automation system.
Requirements: Tremendous amount of initial business rules and forms. Possibility to amend and extend the business rules and forms during the system life cycle.
Problem: The RTS analysts are not capable to supply the representative scope of initial business rules and forms timely enough so develoment can start fitting the given time frame
Decision: ProPro gives RTS analysts a language to encode the business rules and forms so the rules and forms can be quickly uploaded into the system when done. ProPro develops a system which can upload business rules and forms, play them in the course of system operation and provide an UI for the amendment and extension of rules and forms on the fly.
Solution: Object-Relational Language (**ORL**) effectively usable by analysts and software system at the same time. Universal Financial Object (**UFO**) three-tier (client, middleware and server) system using ORL for bootstrapping as well as intra-tier communications (instead of DCOM).

Semantic Modeling of Business Processes

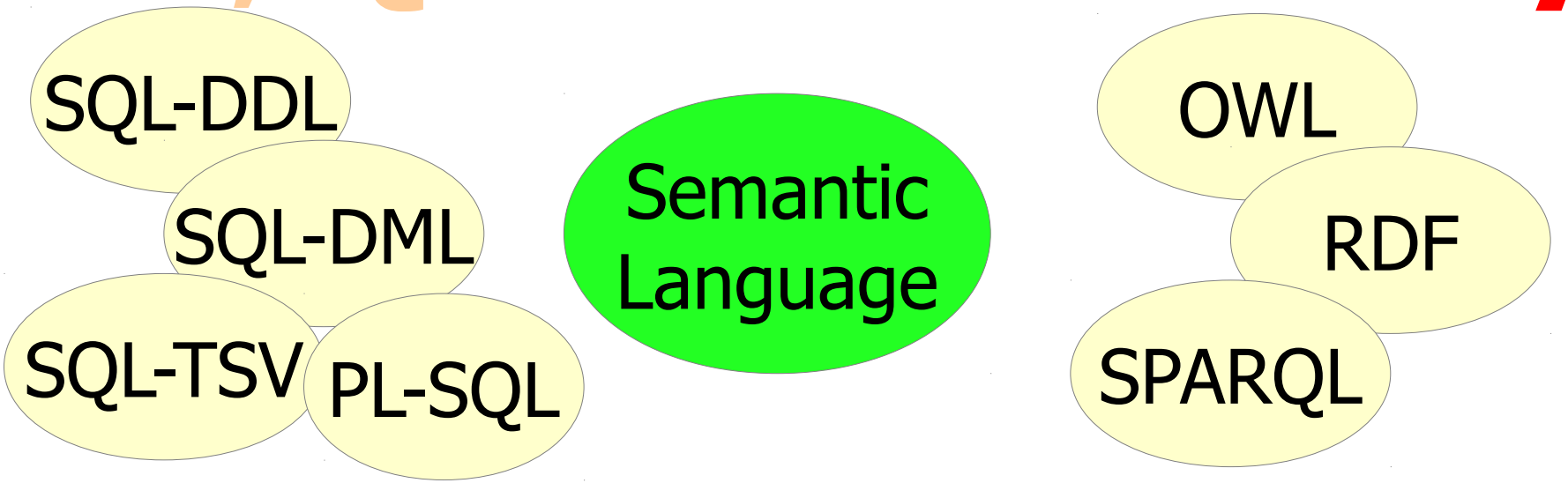
UFO/ORL: 1997-1999

Foundation Ontology



Lesson Learned:

Can have **only one**, language for **DDL, DML, PL, QL** instead of **many**.

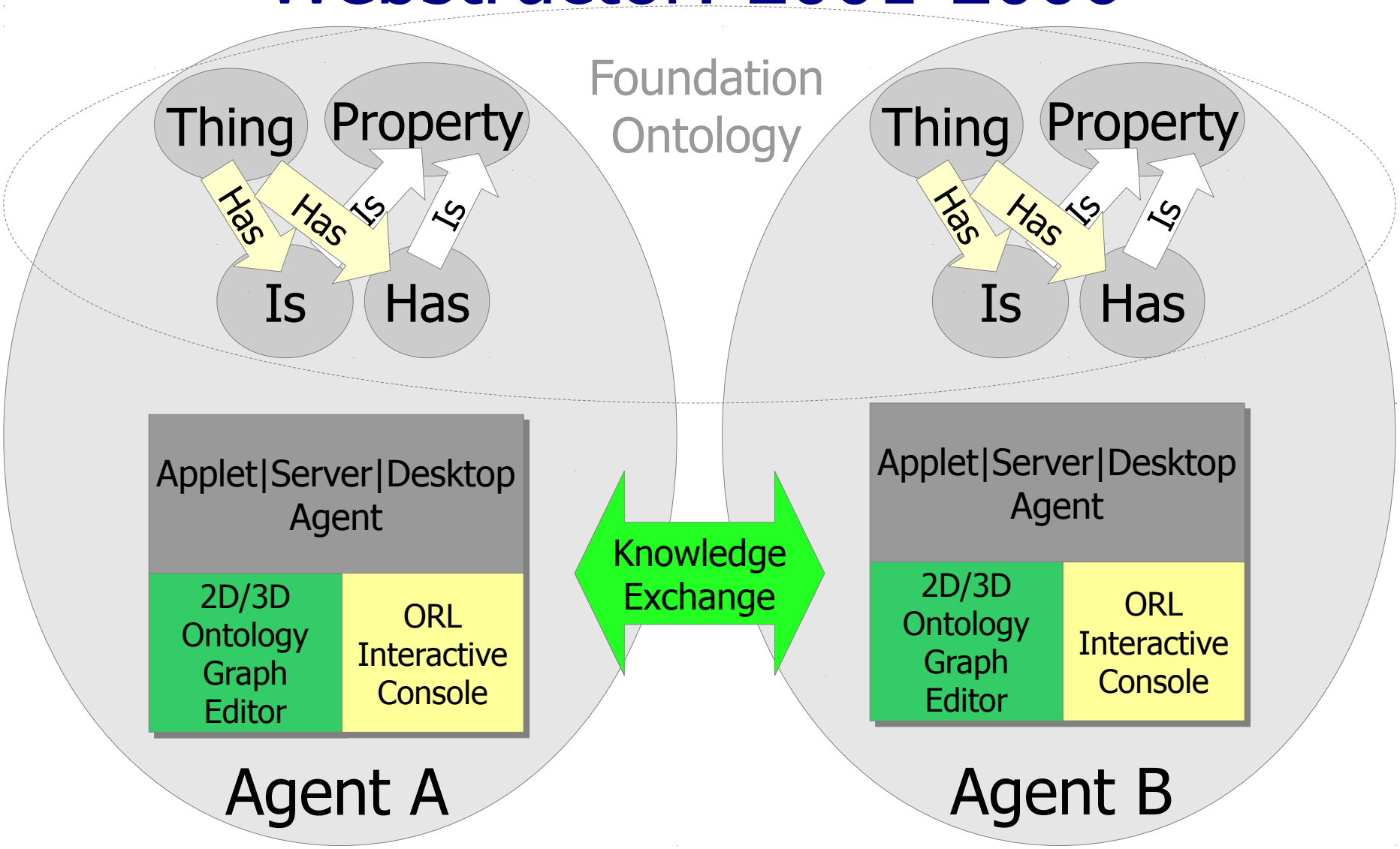


Semantic Modeling of Business Processes

Object Relational Language (ORL)

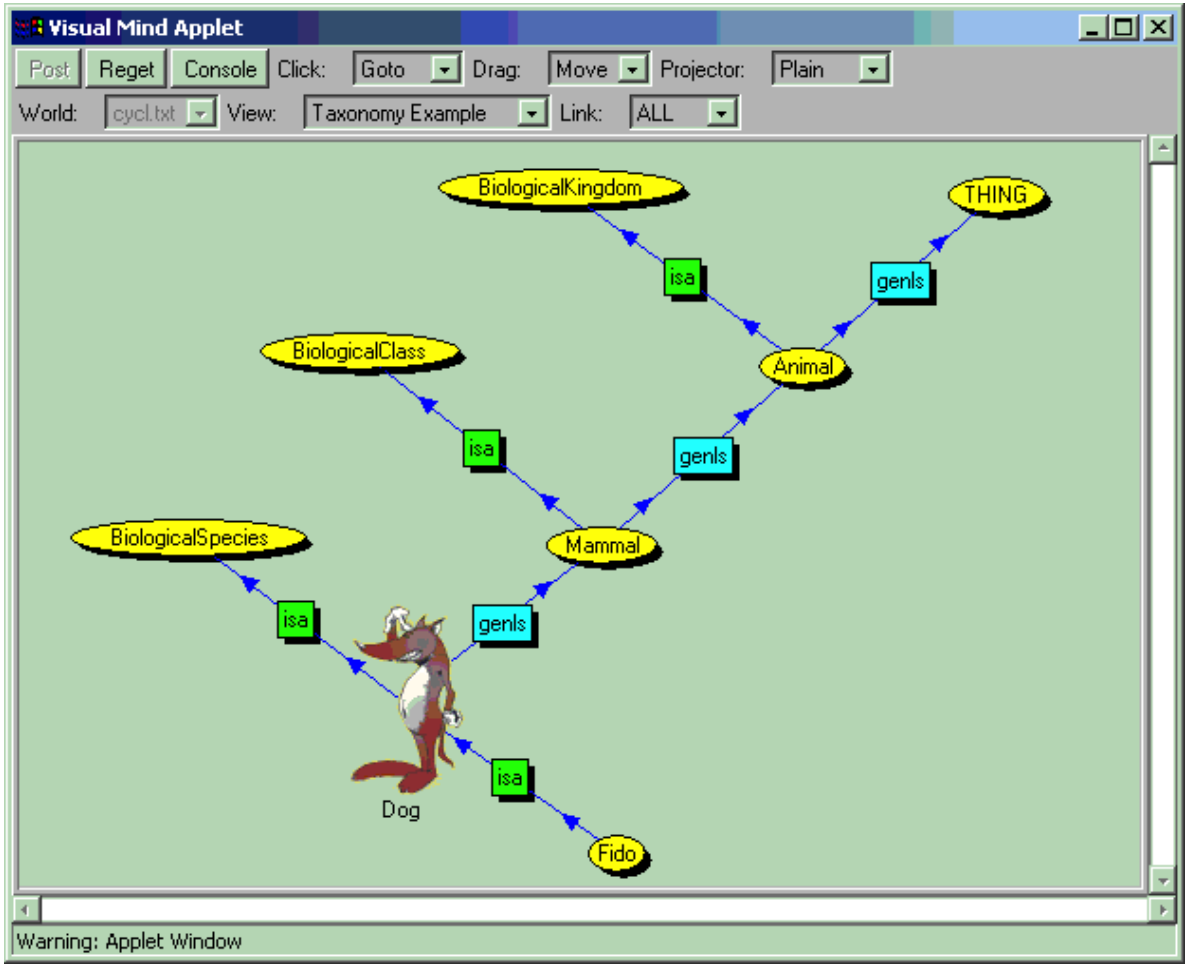
English	ORL
Here are the items A, B and C where A has properties X and Y while B and C are in relationship Z.	ITEM A,B,C;; A HAS (X), (Y);; B Z(C);;
In order to reach goal 1 one needs condition 2 and 3 to be held true while 2 can be true only if condition 4 happens.	CONDITION C2,C3,C4;; GOAL G1 REQUIRES (C2),(C3);; CONDITION(C2) REQUIRES (C4);;
Each morning need to perform this and that in order, having such and such done at once next.	PROCESS TIME “8:00”; REPEAT (DAILY); ORDER DO THIS, DO THAT;, FORK DO SUCH, DO SUCH;;;
What is that my stuff you mentioned yesterday or the day before?	STUFF(OWNER (ME), UPDATE (AUTHOR (YOU), {TIME “2013-03-22”, TIME “2013-03-21”}).TELL;
What were the relationships between P and Q last year?	PROPERTY(OWNER (P), THING (Q), TIME “2012”).TELL;
Let me know once they roll out next version of the product.	DO EMAIL TO “me@at.org”;; WHEN PRODUCT(VENDOR (THEY)).VERSION CHANGE;;

Distributed Knowledge Editor
Webstructor: 2001-2006



Webstructor: Distributed Knowledge Editor

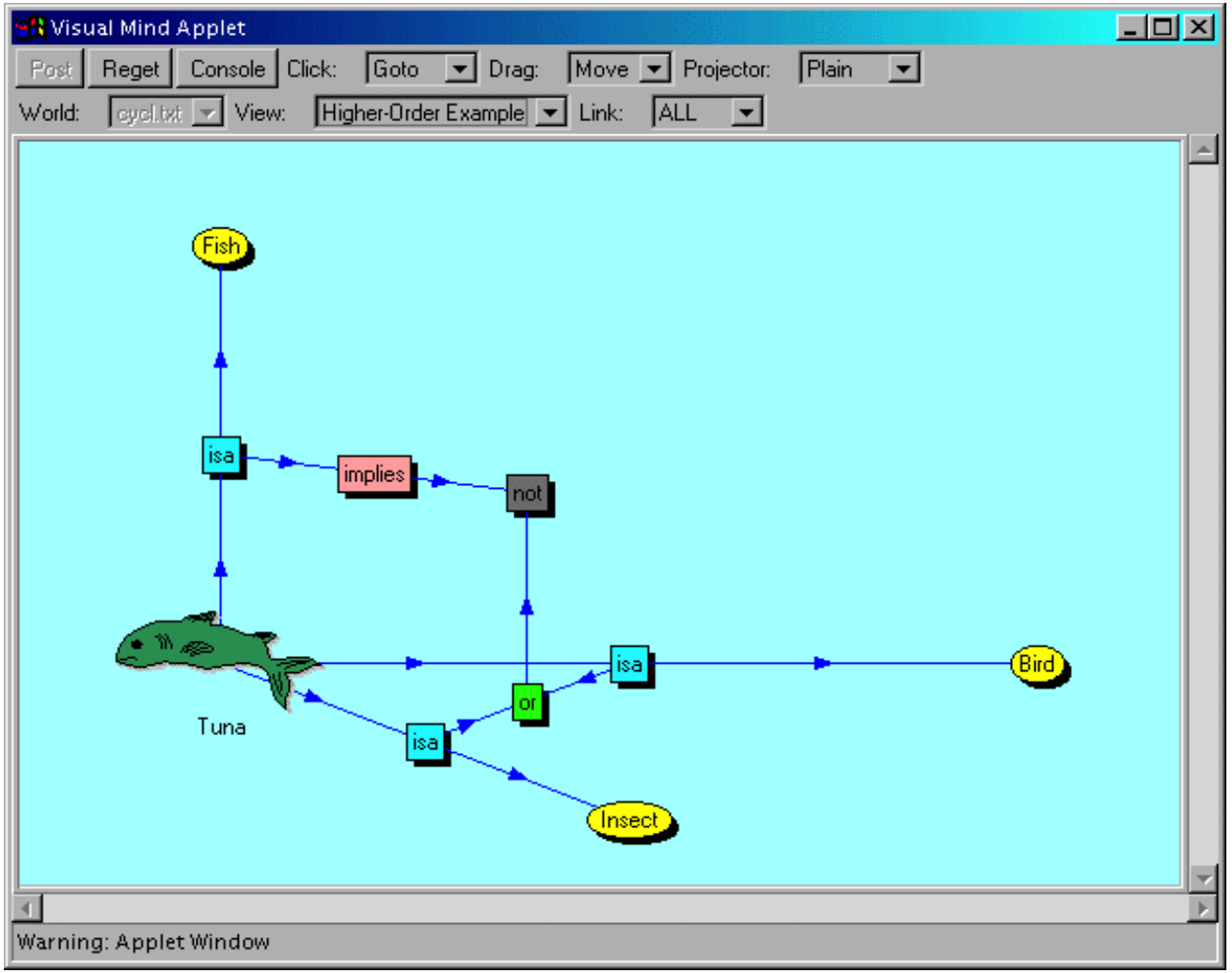
Visual ontology editor - representing Cyc «micro-theory»



Fragment of «biological kingdom» of Cyc «upper ontology»

Webstructor: Distributed Knowledge Editor

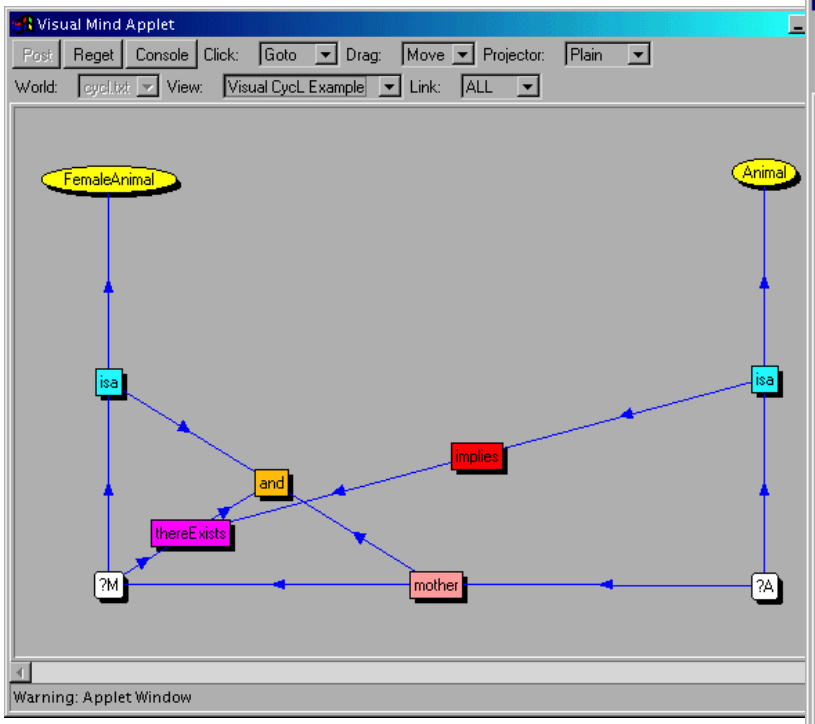
Visual ontology and predicate logic formula editor

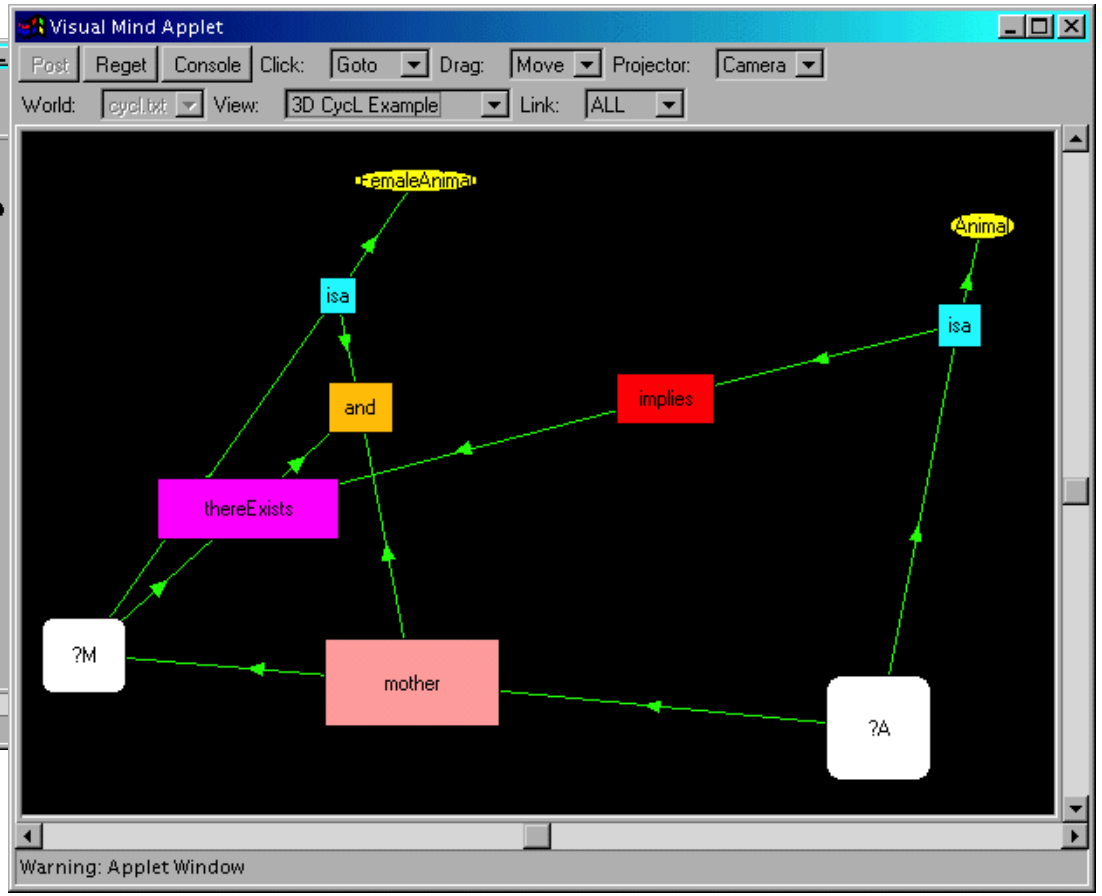


Expression: «If tuna is a fish, that implies it is not an insect or a bird.»

Webstructor: Distributed Knowledge Editor

Visual 2D/3D editor of logical assertions (e.g. CycL)





(implies (isa ?A Animal) (thereExists ?M (and (mother ?A ?M) (isa ?M FemaleAnimal))))

=

Mother of an animal is a female animal.

Lessons Learned:

1. 2D graphs are fun but not always practical
2. 3D graphs are even more fun but even more less practical
3. Distributed removal of knowledge (and its truth assessment) needs account for evidence and social reference

Aigents® Platform for Distributed Personal Agents

Monitoring content and social dynamics in online networks

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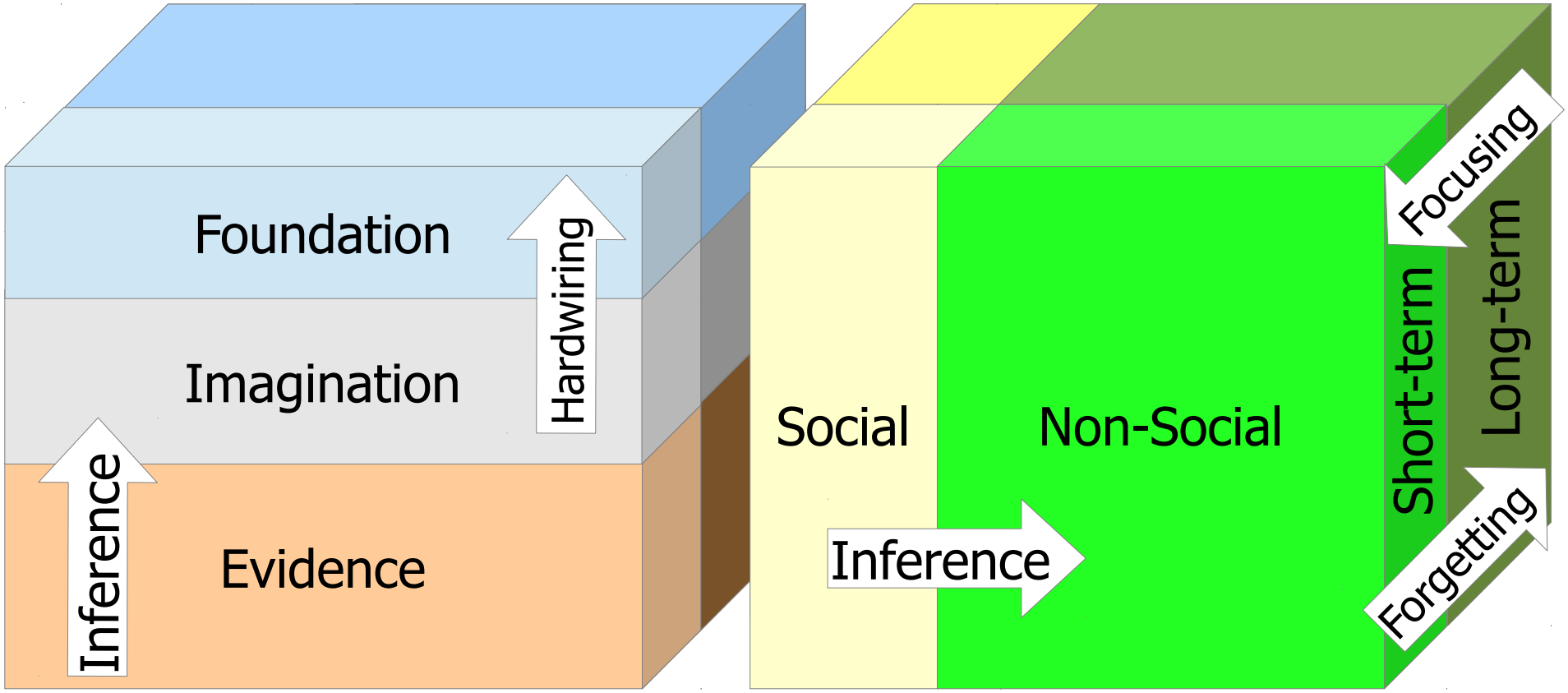
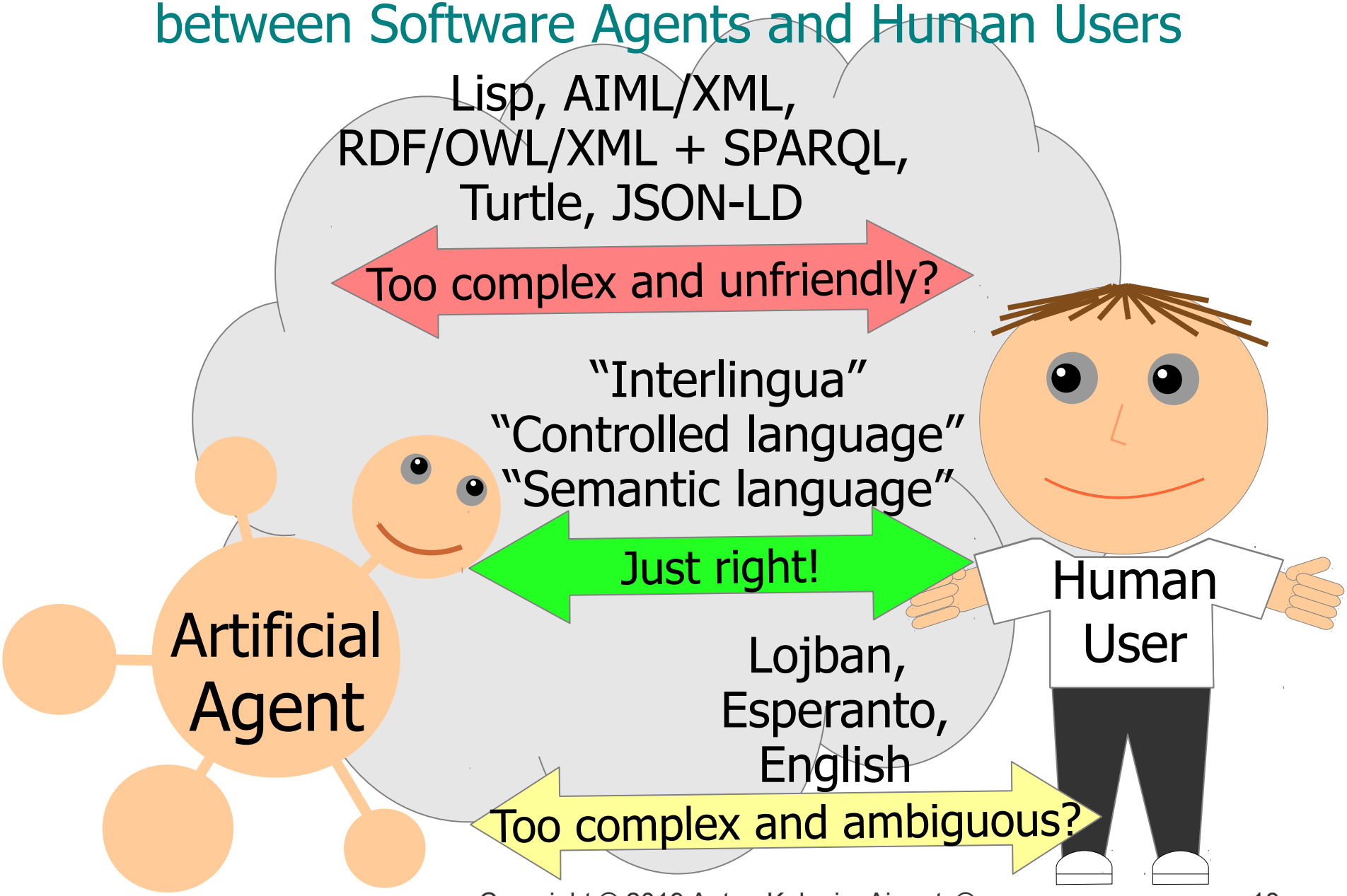
Social-Evidence based Knowledge Representation Model



Top layer - “foundation graph” of basic knowledge, which is necessary for social system to be shared by all of its members in order to communicate.
Middle layer - “imagination graph” keeping “inferred” knowledge.
Bottom layer - “evidence graph” containing everyday life-time experiences.

Using "Semantic Language" for Knowledge Transfer between Software Agents and Human Users



Agent Language (AL) for Home Automation and Internet-of-Things (IoT) – multilingual example

A: My is appliance, agent, thermostat, device.
A: My has shape, color, voltage.
A: My has location.
A: My shape rectangular, color white, voltage 220, location kitchen.
A: My has temperature, humidity, CO2, feeling.
A: Temperature, humidity, CO2 is number.
A: Feeling is good or bad.
H: What your feeling, temperature, humidity?
A: My feeling good, temperature 20, humidity 72.

A: Моя это прибор, агент, термостат, устройство.
A: Моя иметь форма, цвет, питание.
A: Моя иметь место.
A: Моя форма прямоугольный, цвет белый, питание 220, место кухня.
A: Моя иметь температура, влажность, CO2, самочувствие.
A: Температура, влажность, CO2 это число.
A: Самочувствие это хорошо или плохо.
H: Как твоя самочувствие, температура, влажность?
A: Моя самочувствие хорошо, температура 20, влажность 72.

Agent Language (AL) as a "Labeled Turtle"

Common domain-specific ontology for "controlled interlingua"

$thermostat_13 $property $humidity $isa $number

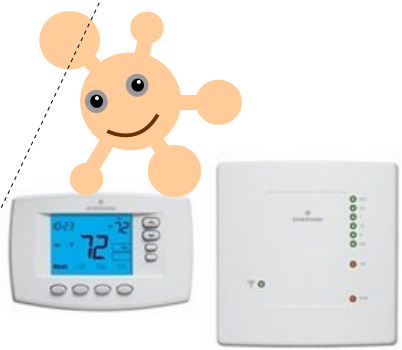
моя
иметь
влажность
это
число

Russian name space

$name

my
has
humidity
is
number

English name space

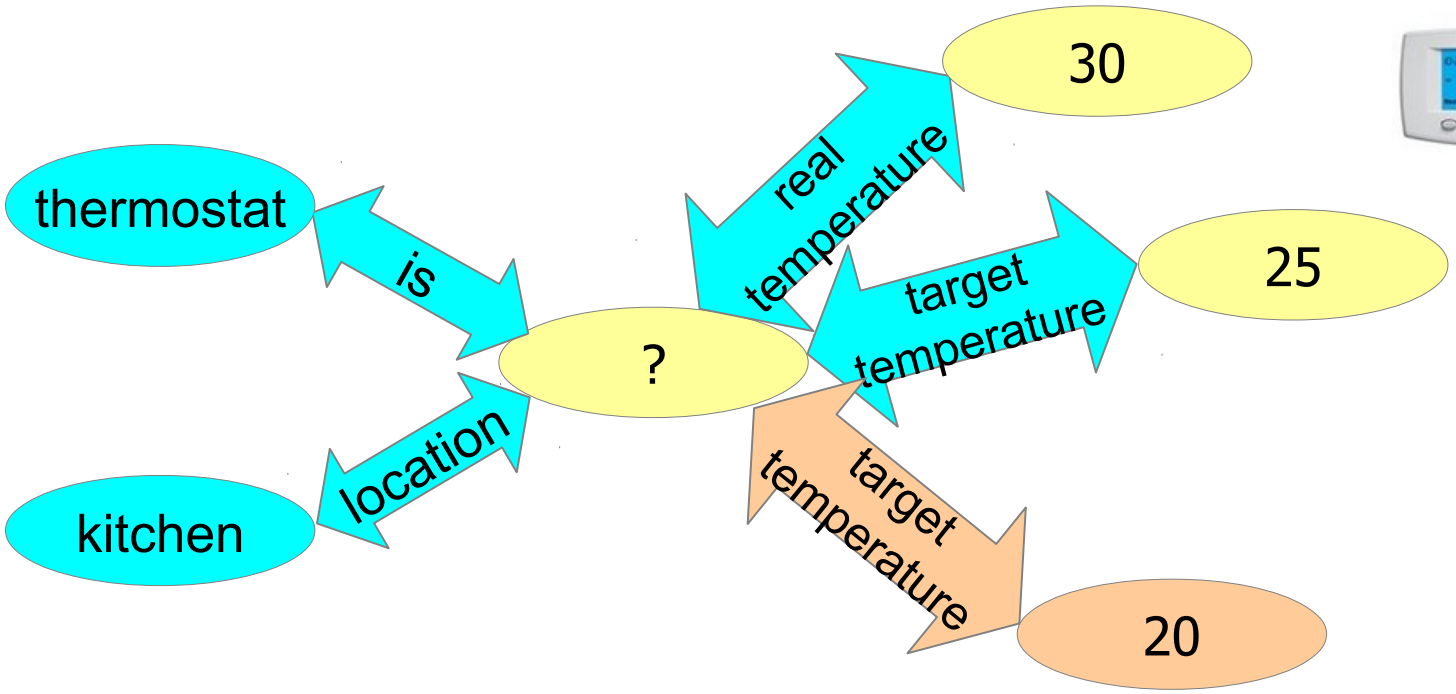


Agent Language (AL) as a Graph Manipulation

Interrogation:
What is thermostat, location kitchen real temperature, target temperature?

Declaration:
Is thermostat, location kitchen real temperature 30, target temperature 25.

Direction:
Is thermostat, location kitchen target temperature 20!



Agent Language - EBNF

```
<message> := ( <statement> | <acknowledgement> )*
<acknowledgement> := ( 'ok' | ('true' | 'yes' | <number>) | ('no' | 'false' | 0) ) '.'
<statement> := <interrogation> | <confirmation> | <declaration> | <direction>
<interrogation> := 'what' ? <expression> '?'                    (* "open" incomplete graph *)
<confirmation> := 'if' ? <expression-set> '?'                   (* "closed" complete graph  *)
<declaration> := ( <expression-set> ) '.'                       (* "closed" complete graph *)
<direction> := 'do' ? <expression-set> '!'                      (* "closed" complete graph *)
<expression> := <term> (' ' <term>)*                            (* separated by spaces *)
<expression-set> := <all-set> | <any-set> | <seq-set>           (* different kinds of sets *)
<term> := <negation>? ( <anonymous>? | <self> | <peer> | <id> | <name> | <value> | <qualifier> )
<qualifier> := <expression> | <expression-set>
<any-set> := <or-list> | ( '{' <or-list> '}' )
<all-set> := <and-list> | ( '(' <and-list>  ')' )
<seq-set> := <next-list> | ( '[' <next-list> ']' )
<or-list> := <expression> ( (',' | 'or' ) <expression> )*
<and-list> := <expression> ( (',' | 'and' ) <expression> )*
<then-list> := <expression> ( (',' | 'next' ) <expression> )*
<negation> := 'not' | 'no' | '~'
<anonymous> := ('there' ('is'|'are')) | 'any' | 'anything' ?
<self> := 'my'|'i'|'we'|'our'
<peer> := 'your'|'you'
<value> := <number> | <date> | <time> | <string>
```

That is all!
There rest is done by means of domain-specific ontology and providing national-specific name space

Agent Language - comparisons

English
What is your feeling?
If your feeling is good?
Your feeling is good.
Have your feeling good!

Agent Language
Your feeling?
Your feeling good?
Your feeling good.
Your feeling good!

Russian (with tonal modulation)
Твое ощущение? (rising tone)
Твое ощущение хорошее? (rising tone)
Твое ощущение хорошее. (neutral tone)
Твое ощущение хорошее! (lowering tone)

Agent Language - written
I (can (eat, sleep), want (dance, sing)).
I {can (eat, sleep), want (dance, sing)}.
I (can {eat, sleep}, want {dance, sing}).
You [eat (rice, meat), drink {tea, beer}]!

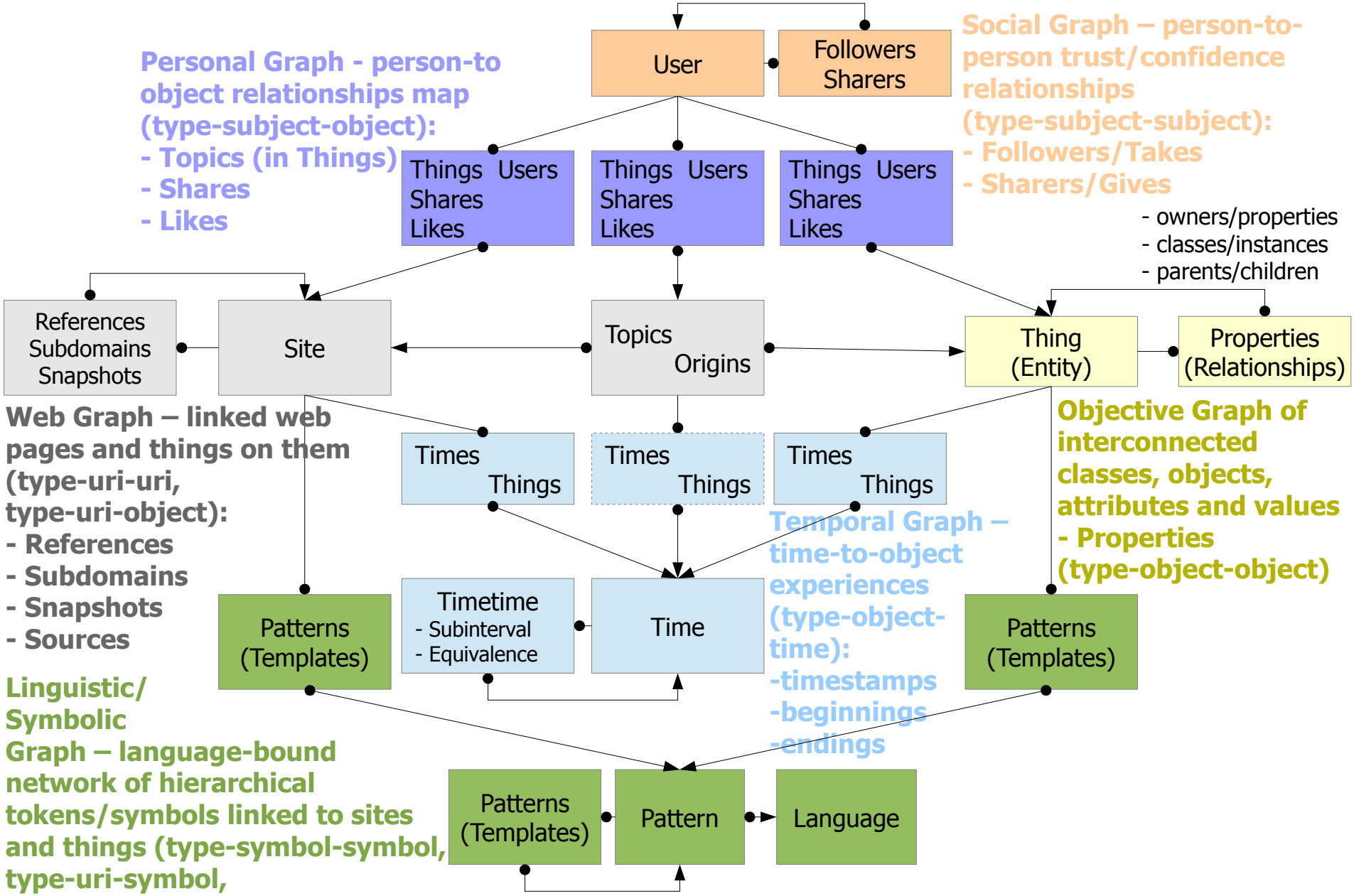
Agent Language - spoken
I can eat and sleep and want dance and sing.
I can eat and sleep or want dance and sing.
I can eat or sleep and want dance or sing.
You eat rice and meat next drink tea or beer!

Agent Language
A C (D,E).
A (C D, F G).
A (C (D,E), F (G,H)).
(A,B) C D.
(A,B) (C (D,E), F (G,H)).

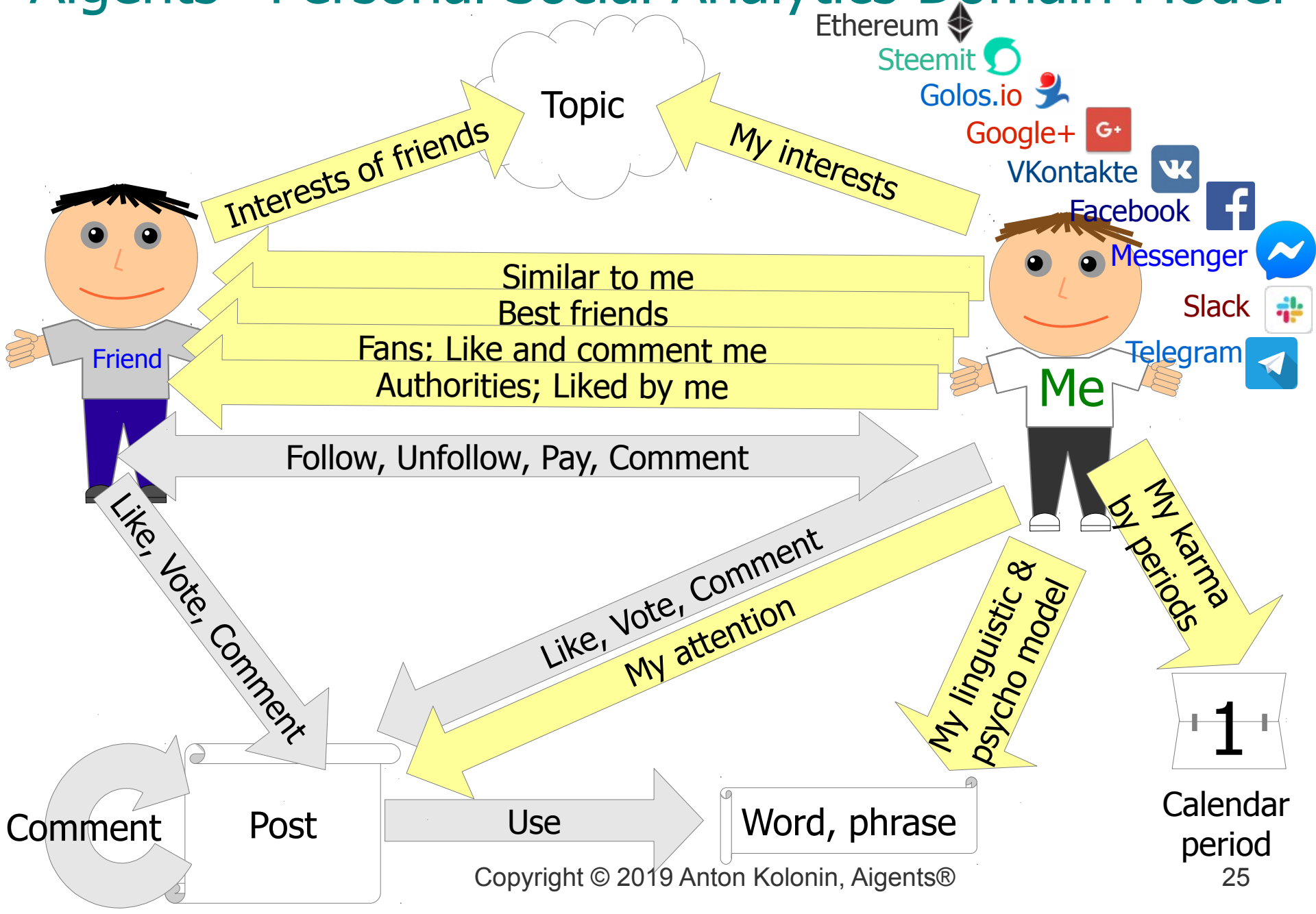
Term logic
A C D. A C E.
A C D. A F G.
A C D. A C E. A F G. A F H.
A C D. B C D.
A C D. A C E. B C D. B C E. A F G. A F H. B F G. B F H.

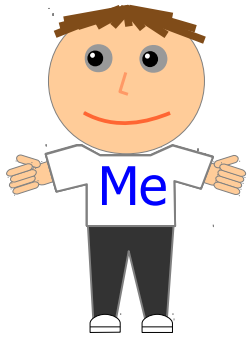
Turtle
A C D,E.
A C D; F G.
A C D,E; F G,H.

Aigents® Upper Ontology for Online Media Monitoring & Studies

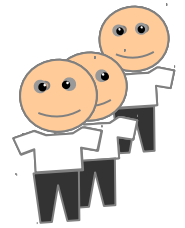


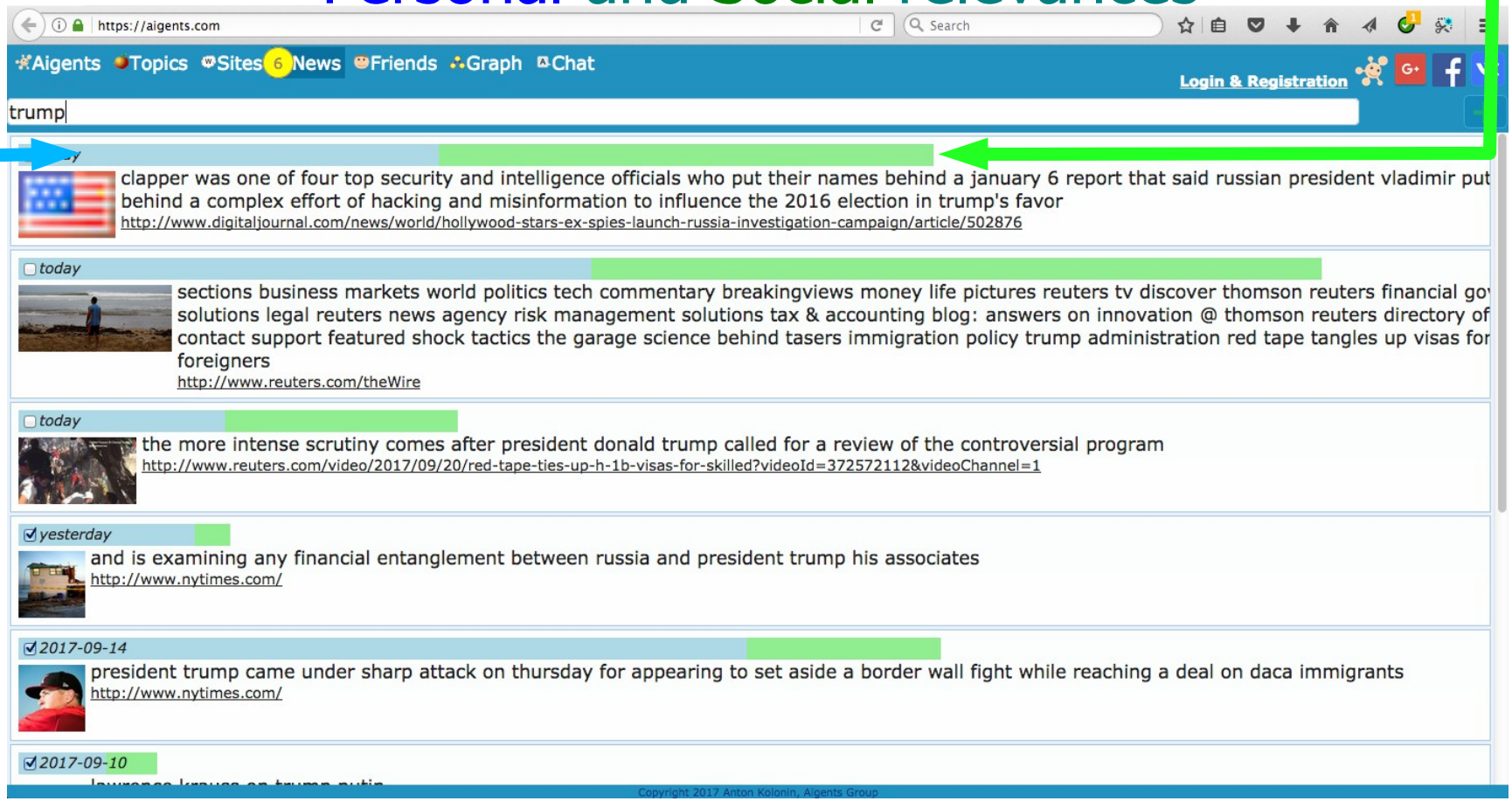
Aigents® Personal Social Analytics Domain Model



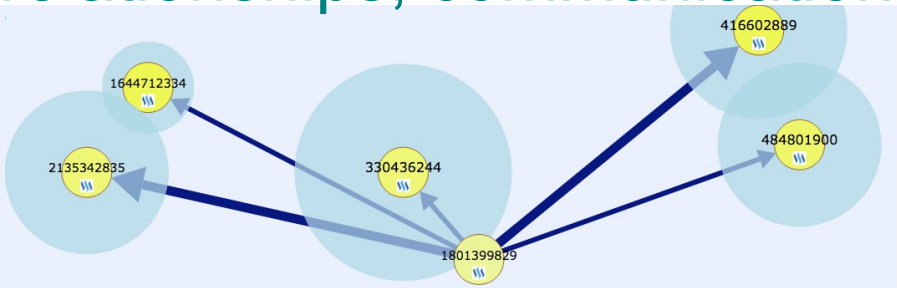


Case 1: Collaborative News Filtering: Monitoring web pages and extracting textual information with account to Personal and Social relevances

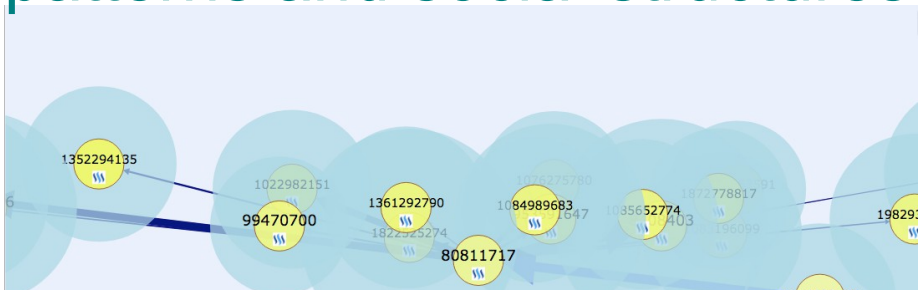




Case 2: Helping users to understand themselves better and perform more efficiently online – using their tracks in social networks and online resources, capture their interests, relationships, communication patterns and social structures.

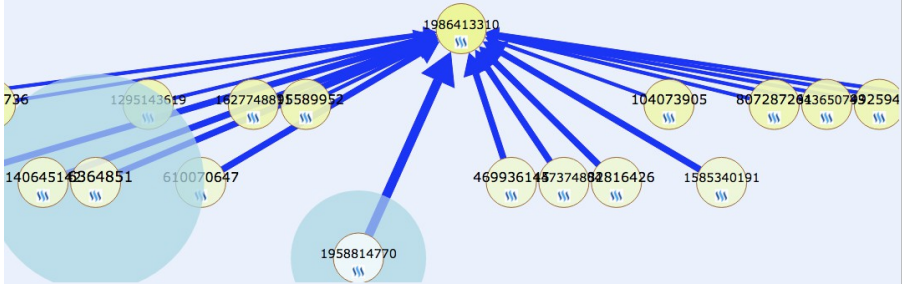


Social type: follower

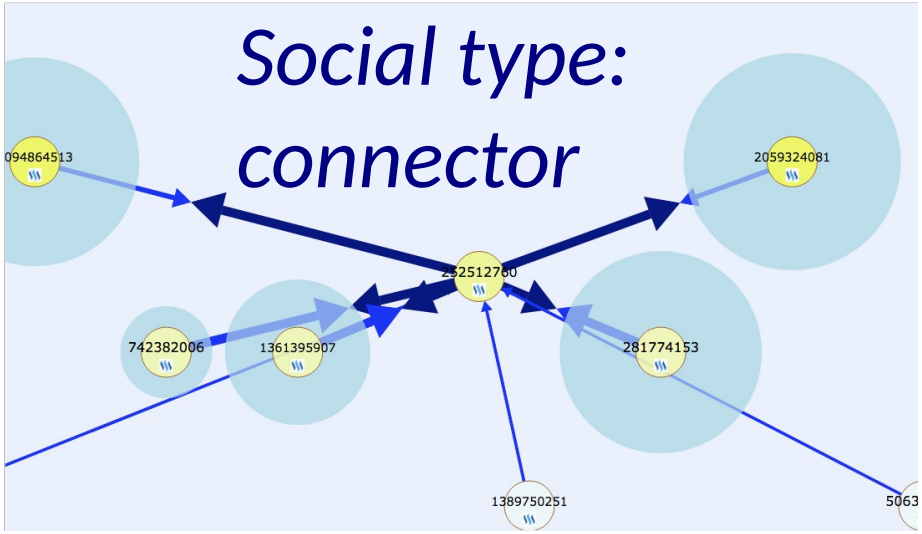


Social type: peer

Social type: opinion leader

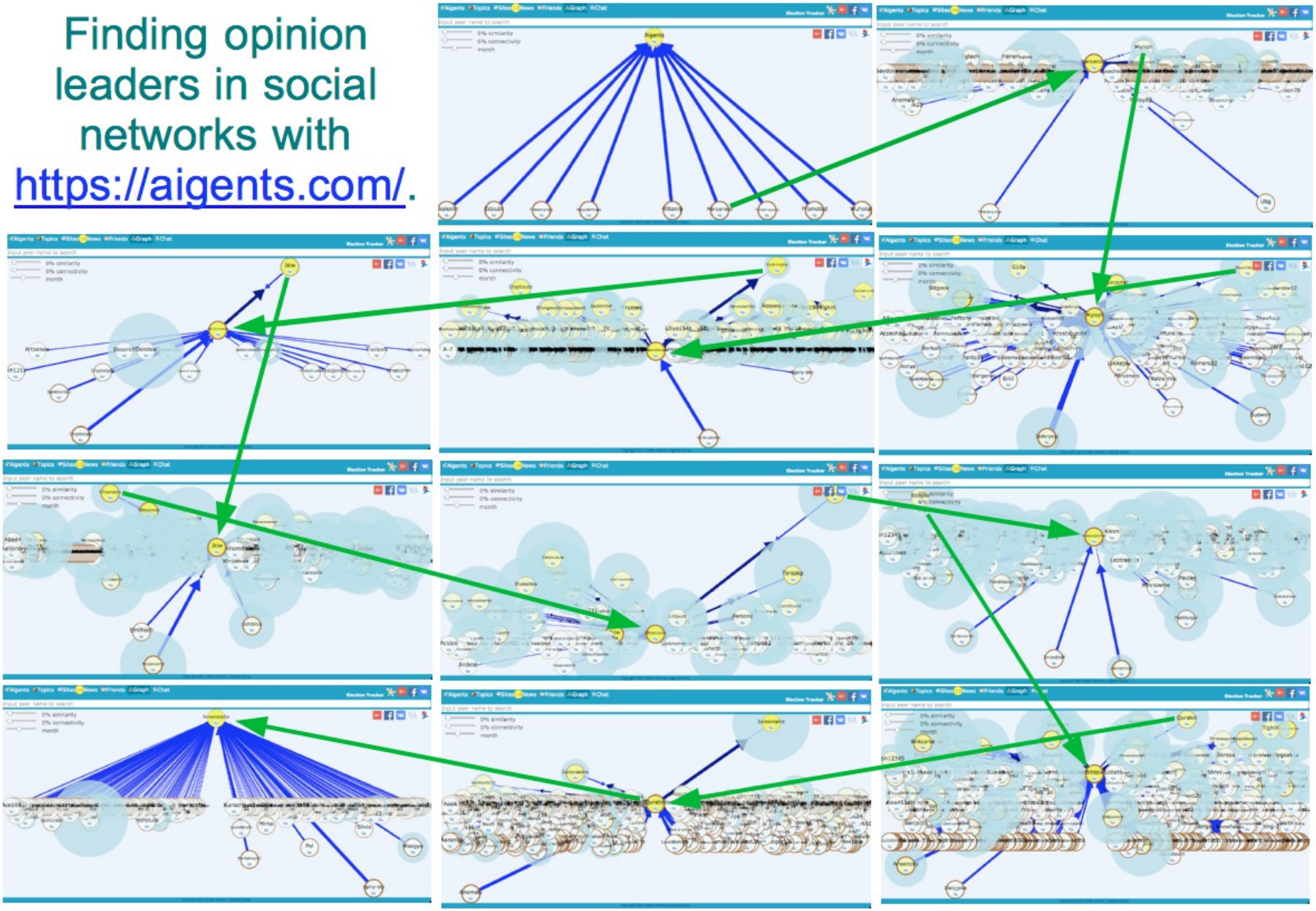


Social type: connector

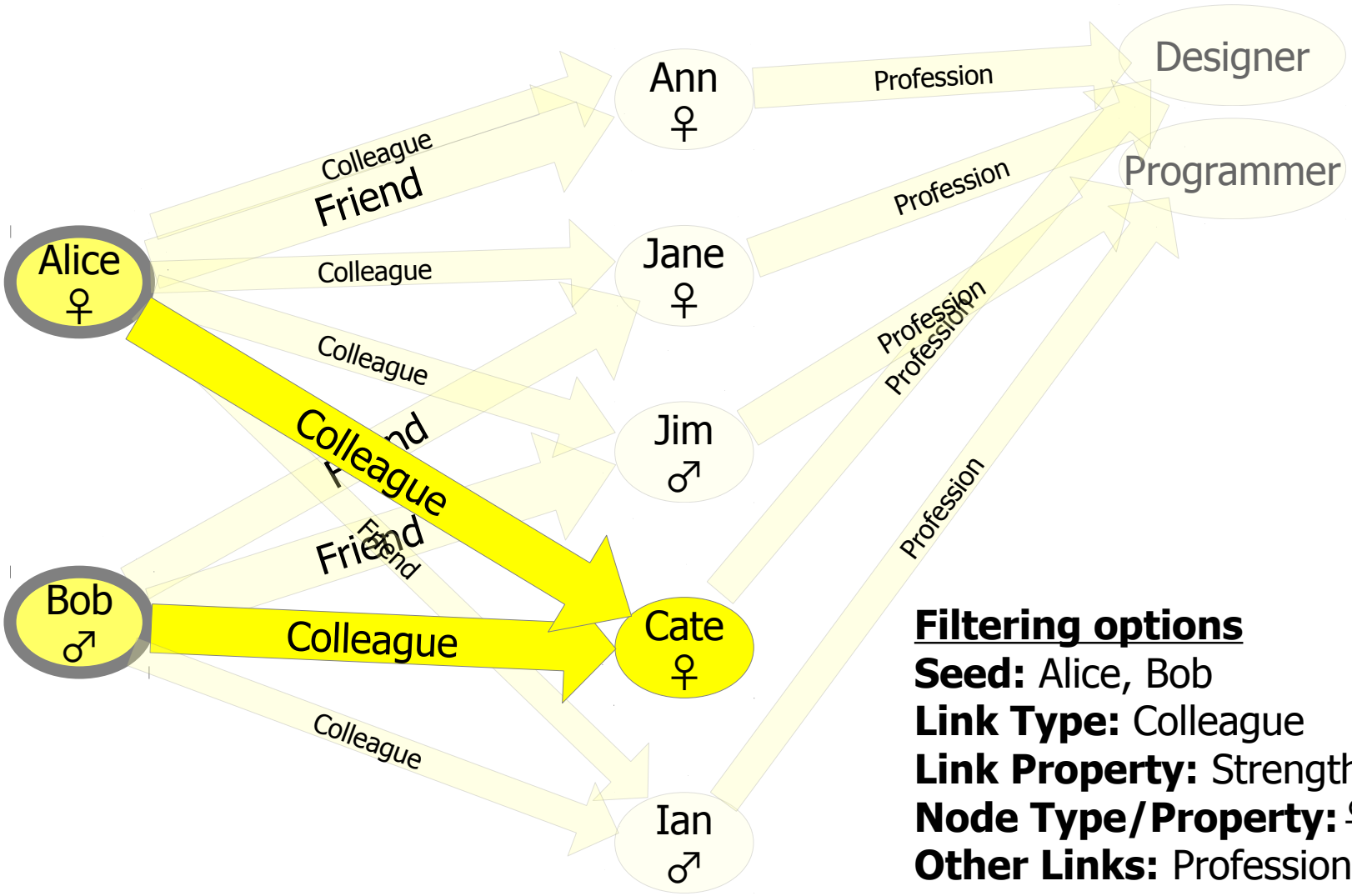


Case 3:

Finding opinion leaders in social networks with https://aigents.com/.

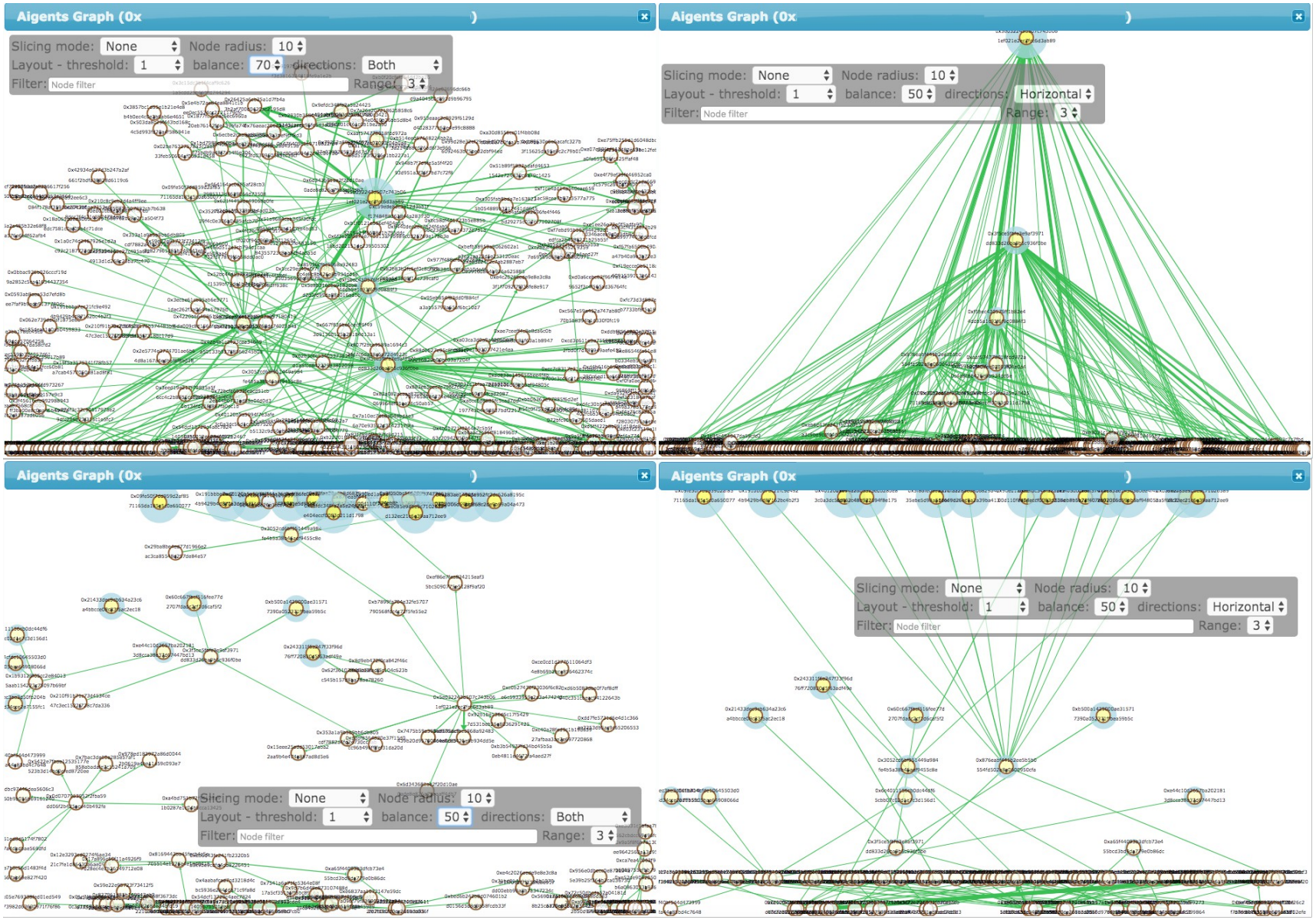


Aigents®: Graph Builder and Filter

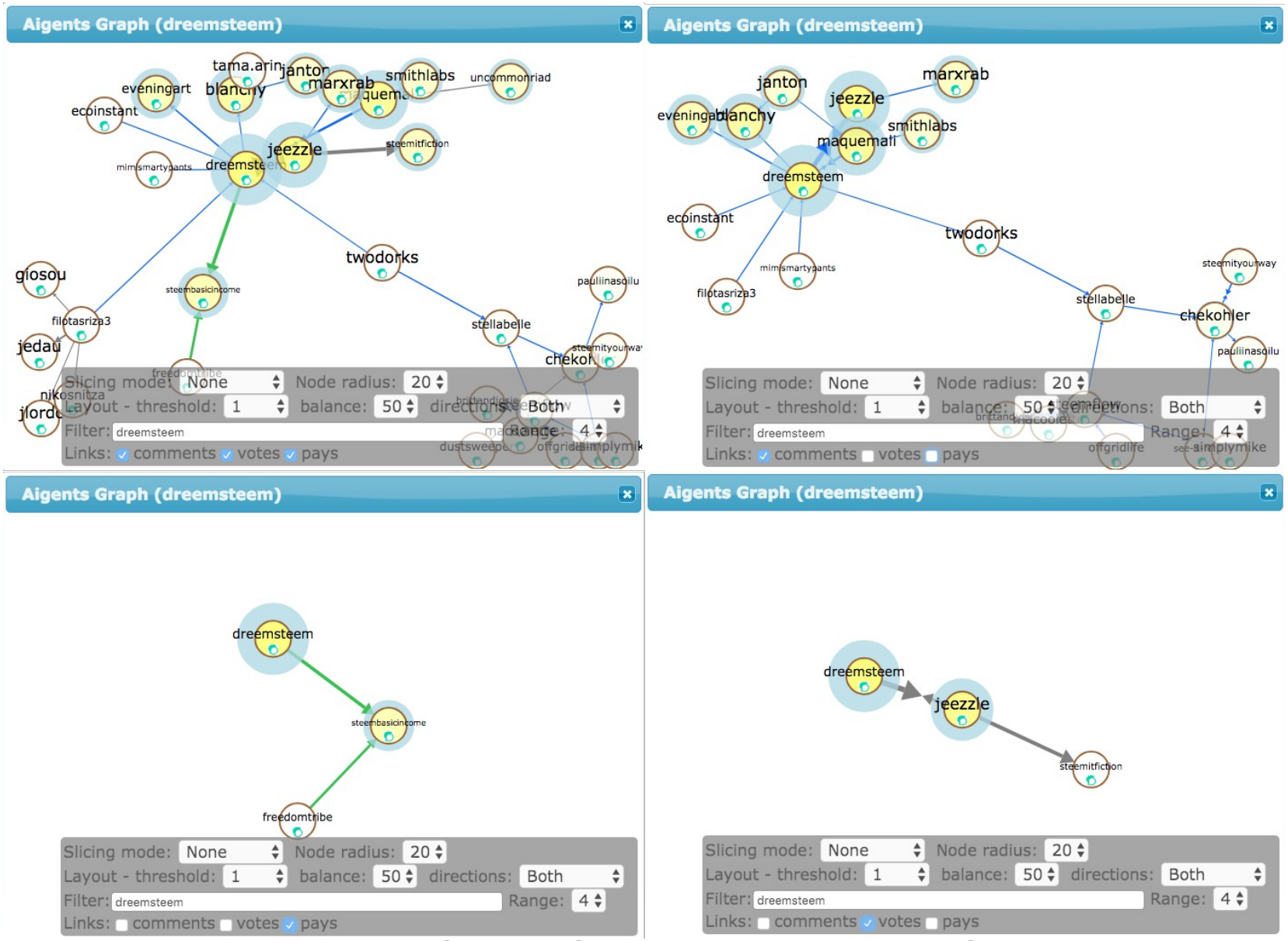


Filtering options
Seed: Alice, Bob
Link Type: Colleague
Link Property: Strength=High
Node Type/Property: ♀
Other Links: Profession=Designer
Link Range: 1

Aigents®: Ethereum cash flow graph study



Aigents®: Steemit social network graph study



Thank you for attention!
Questions?

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SingularityNET

Novosibirsk State University
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TravelChain

SKRIN

iHeart

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