The New Era of High Functionality Computing

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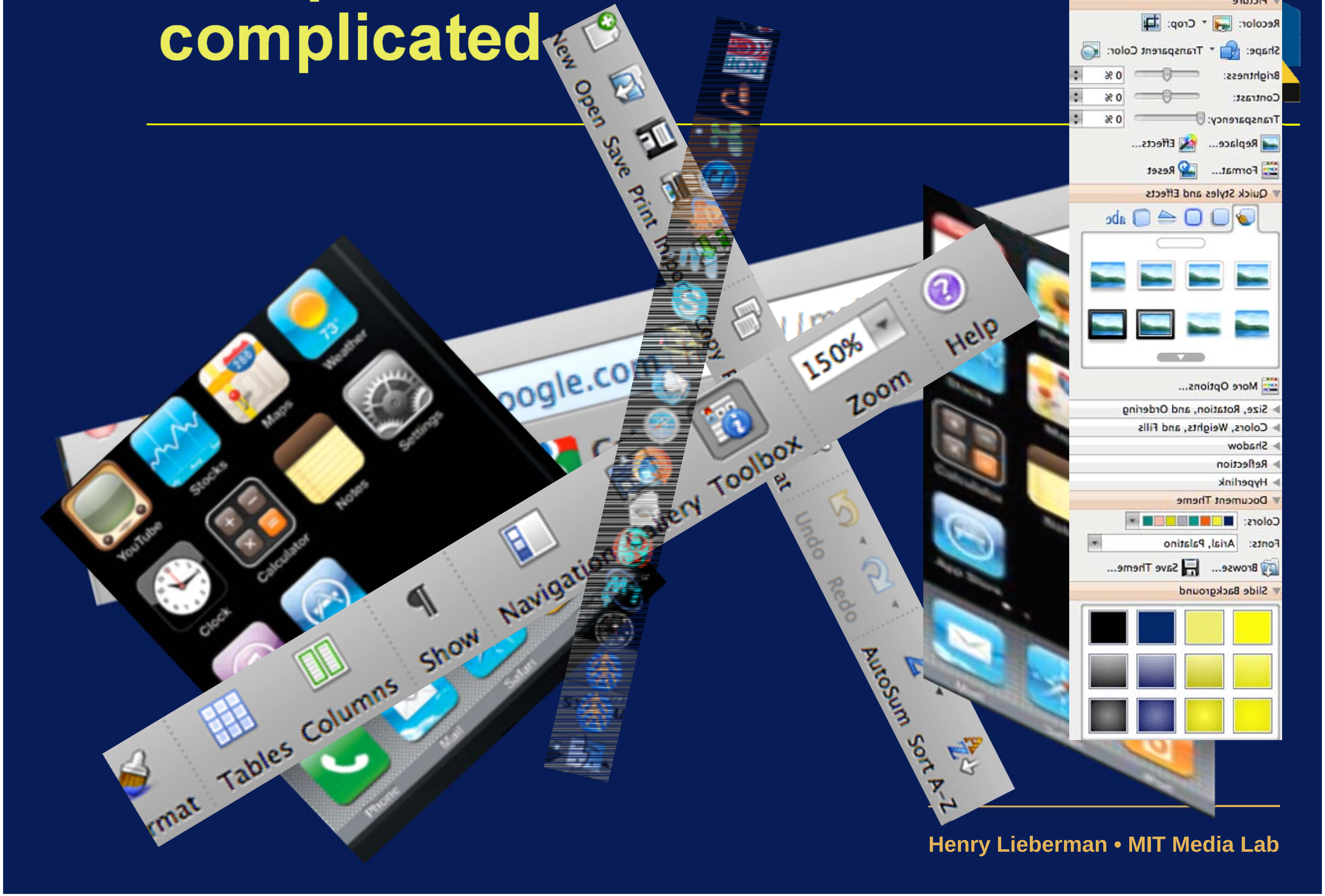
Computers are too damn complicated



Three big issues

Complexity

Can’t keep growing interfaces simply by adding new functions

Instructibility

How do we tell computers what we want them to do?

Risk

What happens if something goes wrong?

AI in user interfaces

Goal-oriented interfaces

End-user programming

End-user debugging

Intelligent defaults

Recommender systems

High Functionality (hi-fun) computing

Computer can perform a large number of independent operations

Each operation might be complex (perform non-trivial transformation, have many steps)

Operations may interact

Many data types

May have to learn abstract concepts

Much potential for human error

Low-functionality (lo-fun)

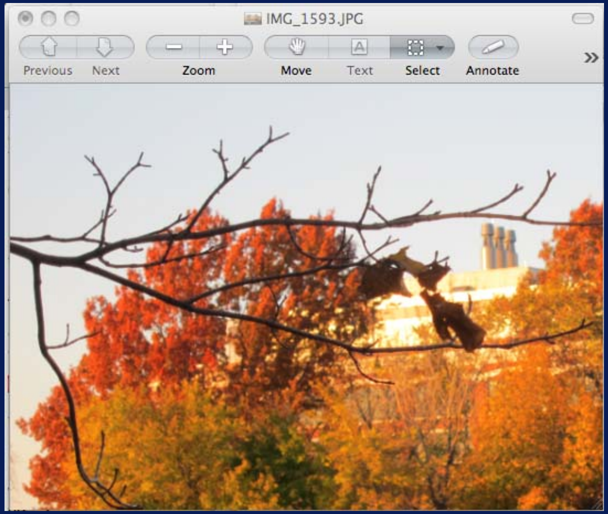
Only a small number of operations

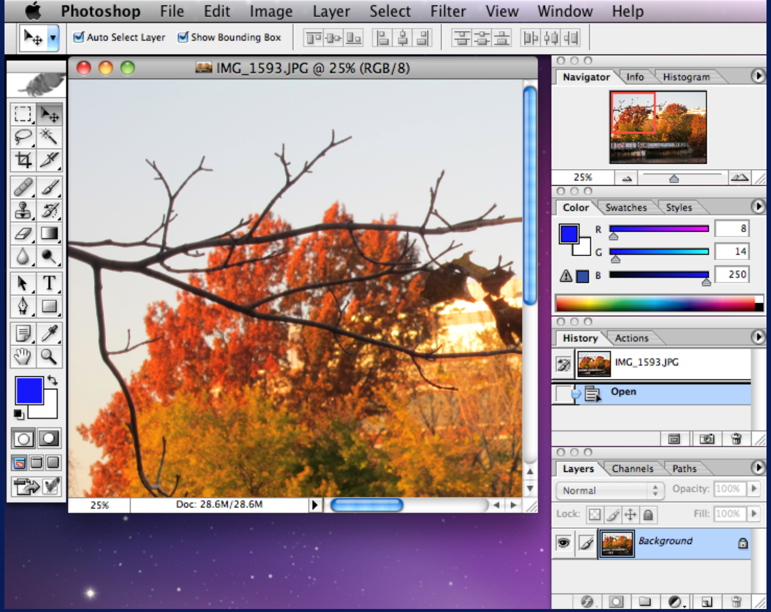
What each operation does is “obvious”

Small number of intuitive data types

Little potential for human error

Hi-fun vs. lo-fun (image editing)

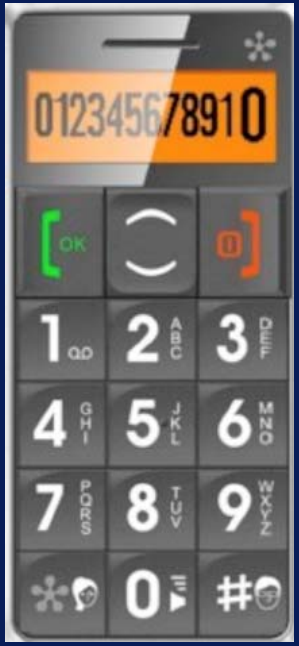




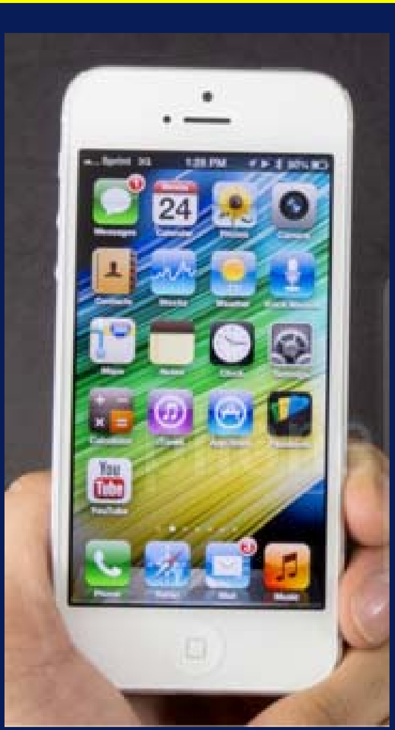
Preview

Photoshop

Hi-fun vs. lo-fun (phones)



Phone marketed to seniors



Android phone

We need a new synthesis of AI and HCI for hi-fun interfaces

AI stuck on “Turing Test” complete AI

AI stuck on math+algorithms

HCI paralyzed by fear of AI failures (e.g. Clippy)

HCI stuck on designing for low-functionality interfaces. It’s not on a sustainable path for interface innovation

Complexity

Can we manage complexity with “good design” according to “user-centered” principles?

“Simplify” interfaces – small number of operations

Organize logically – “affordances”

Good design helps, but…

Conventional HCI design is based on

a *one-to-one* correspondence between controls and functions

But as functions grow, controls can't keep up

Each "app" might be simple, but what happens when you have hundreds, thousands of them?

Apps grow over time as features are added

How do they work together?

How do we get out of the dilemma?
Goal-Oriented Interfaces

People have *goals*

"I want to record some music on my piano and put it on my Web page"

Devices (or software) have *functions*

Record a MIDI file, play it through a synth, audio to MP3, upload to server, edit page

Whose job is it to map between goals and functions?

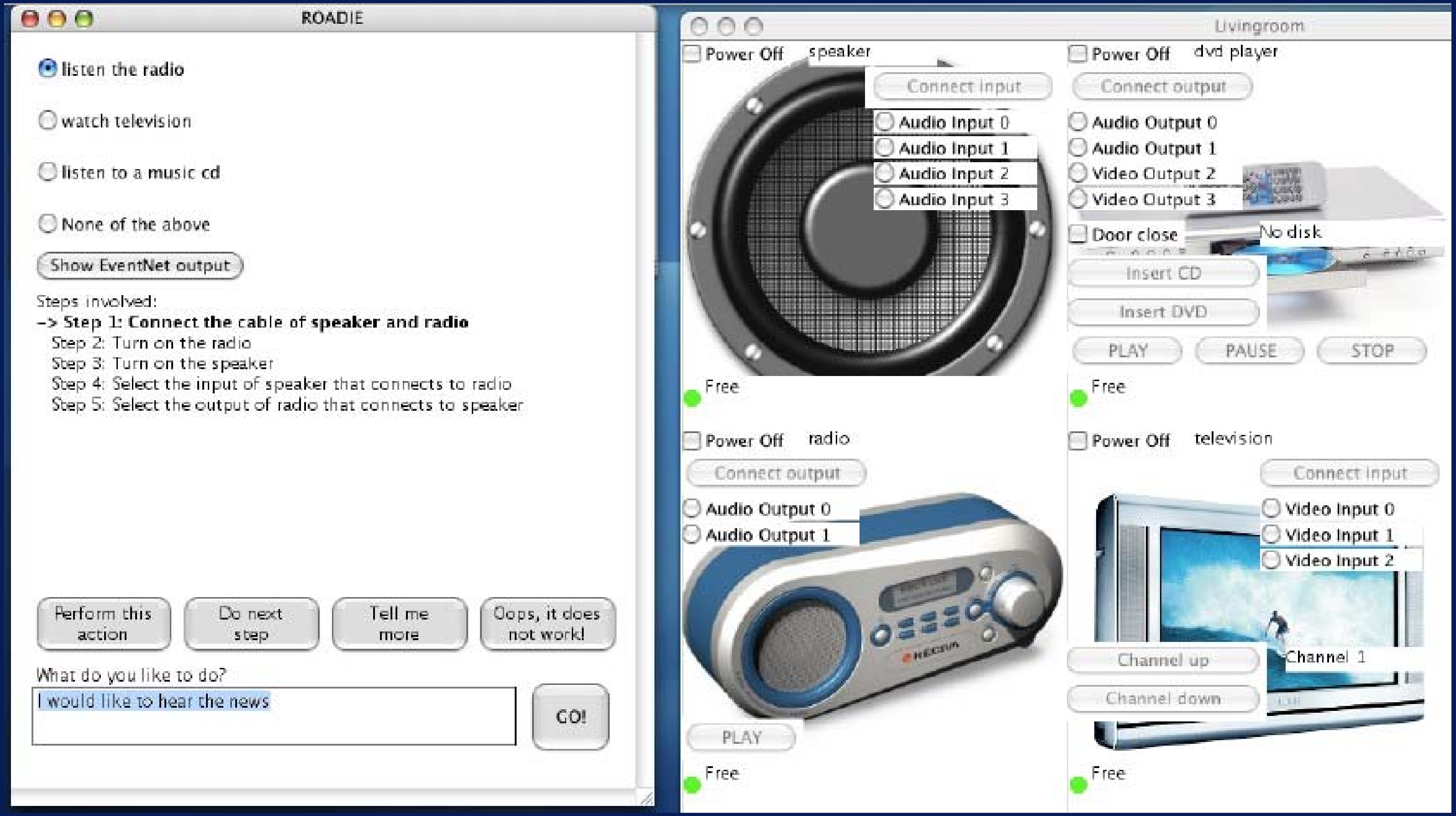
Roadie

Natural language and commonsense knowledge for *goal recognition*

Partial-order planning for goal satisfaction

Help, debugging tools when things go wrong

Roadie



ROADIE

● listen the radio

○ watch television

○ listen to a music cd

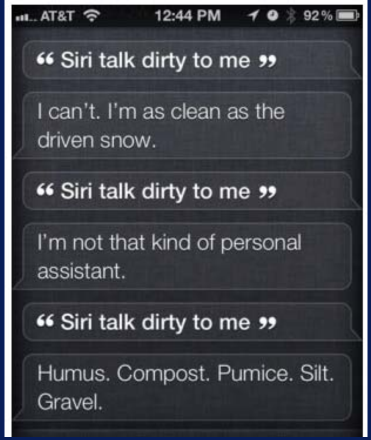
○ None of the above

Steps involved:
-> Step 1: Connect the cable of speaker and radio
Step 2: Turn on the radio
Step 3: Turn on the speaker
Step 4: Select the input of speaker that connects to radio
Step 5: Select the output of radio that connects to speaker

What do you like to do?
I would like to hear the news

Siri, Google Now

First commercial appearance of goal-oriented interfaces



“ Siri talk dirty to me ”

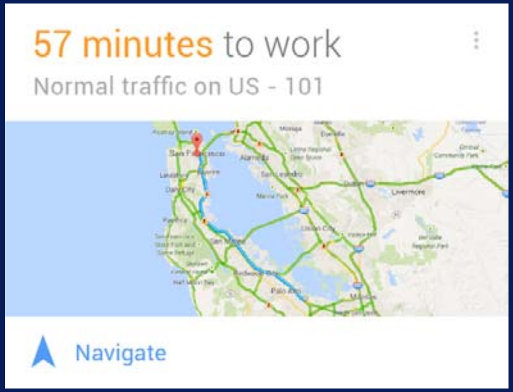
I can't. I'm as clean as the driven snow.

“ Siri talk dirty to me ”

I'm not that kind of personal assistant.

“ Siri talk dirty to me ”

Humus. Compost. Pumice. Silt. Gravel.



57 minutes to work

Normal traffic on US - 101

What’s next?

Integrate with broad spectrum of applications

Integrate speech and visual interface

Multiple step and parameterized procedures

Programming by example and automation

Personalization

Critique and dialogue

Commonsense as key

Hypothesis: Common sense reasoning is the key to making usable/helpful applications

Minority viewpoint: Minsky, Lenat…

So, let’s collect Commonsense and figure out how to

- Reason with it
- Integrate it into interfaces

Applications in Interface Agents

Predictive typing, Speech recognition

Storytelling with Media Libraries

Detection and mitigation of online bullying

Opinion Analysis

Goal-oriented interfaces for Consumer Electronics

Mobile to-do lists, location-aware context-sensitive maps

Translation, language learning & multi-lingual communication

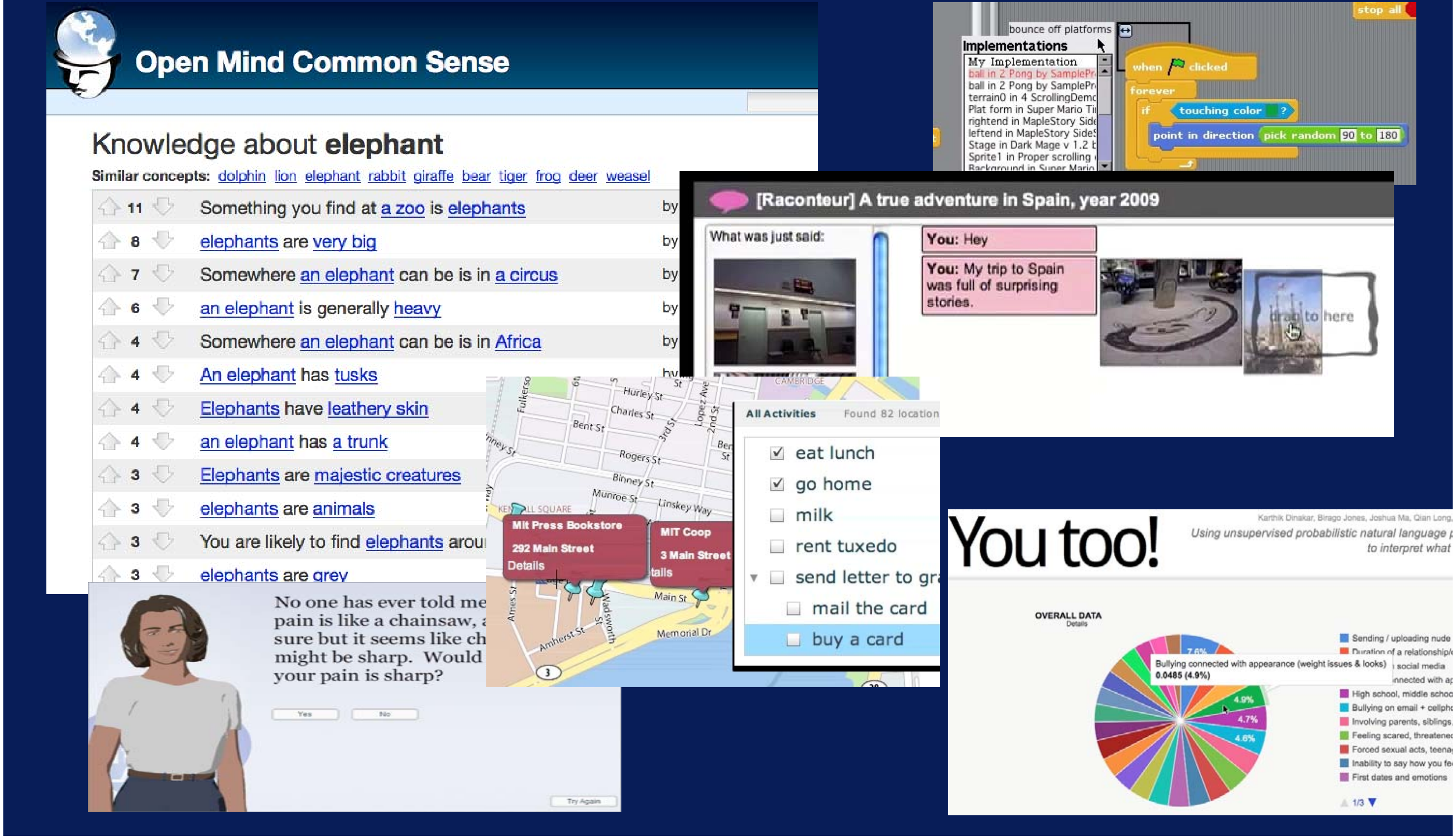
Help and customer service

Recommendation systems, scenario-based recommendation

Programming and code sharing in natural language

… and more

Applications in Interface Agents



Open Mind Common Sense

Knowledge about **elephant**

Similar concepts: dolphin lion elephant rabbit giraffe bear tiger frog deer weasel

11	Something you find at a zoo is elephants	by
8	elephants are very big	by
7	Somewhere an elephant can be is in a circus	by
6	an elephant is generally heavy	by
4	Somewhere an elephant can be is in Africa	by
4	An elephant has tusks	by
4	Elephants have leathery skin	
4	an elephant has a trunk	
3	Elephants are majestic creatures	
3	elephants are animals	
3	You are likely to find elephants arou	
3	elephants are grey	

bounce off platforms

Implementations

My Implementation
ball in 2 Pong by SamplePr
ball in 2 Pong by SamplePr
terrain0 in 4 ScrollingDemo
Plat form in Super Mario Ti
rightend in MapleStory Side
leftend in MapleStory SideS
Stage in Dark Mage v 1.2 b
Sprite1 in Proper scrolling
Background in Super Mario

```
when 🏳 clicked
forever
  if touching color ? 
    point in direction pick random 90 to 180
```

[Raconteur] A true adventure in Spain, year 2009

What was just said:

You: Hey

You: My trip to Spain was full of surprising stories.

Mit Press Bookstore
292 Main Street
Details

MIT Coop
3 Main Street
tails

All Activities Found 82 location

☑ eat lunch
☑ go home
□ milk
□ rent tuxedo
□ send letter to gra
□ mail the card
□ buy a card

No one has ever told me pain is like a chainsaw, a sure but it seems like ch might be sharp. Would your pain is sharp?

You too!

Karthik Dinakar, Birago Jones, Joshua Ma, Qian Long,

Using unsupervised probabilistic natural language p to interpret what

OVERALL DATA
Details

Bullying connected with appearance (weight issues & looks)
0.0485 (4.9%)

7.6%
4.9%
4.7%
4.6%
Sending / uploading nude
Duration of a relationship/
social media
nnected with ap
High school, middle schoo
Bullying on email + cellpho
Involving parents, siblings,
Feeling scared, threatened
Forced sexual acts, teena
Inability to say how you fe
First dates and emotions
1/3

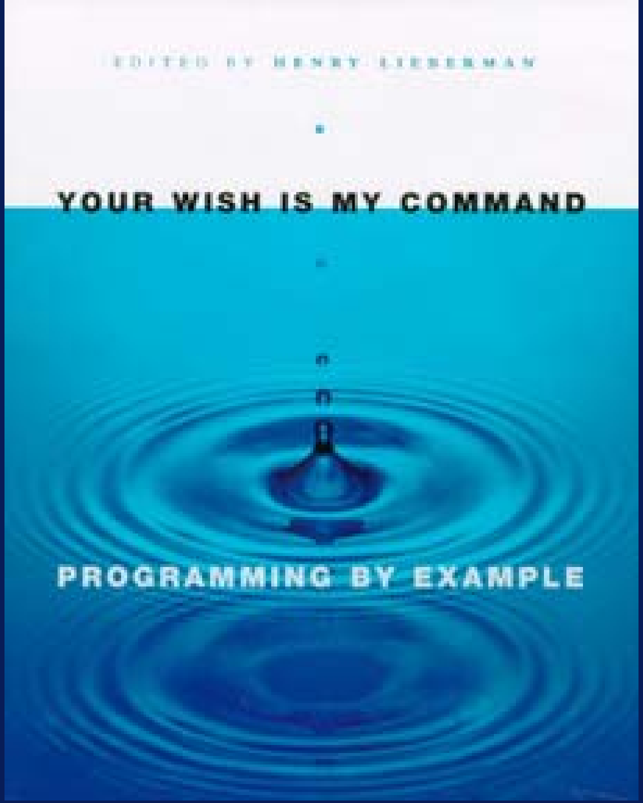
Instructibility

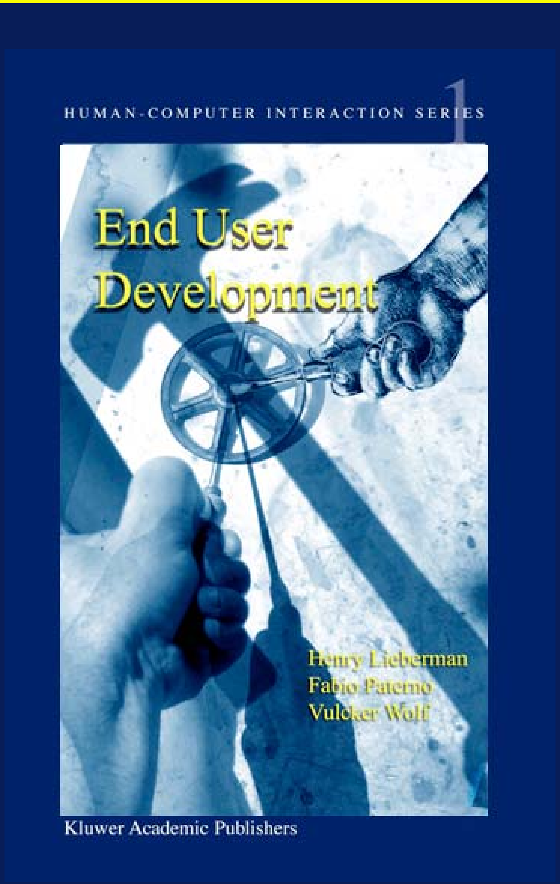
If you have a large or open-ended command set, how do you make it easily usable?

- Natural Language interfaces / Speech reco
- End-User Programming

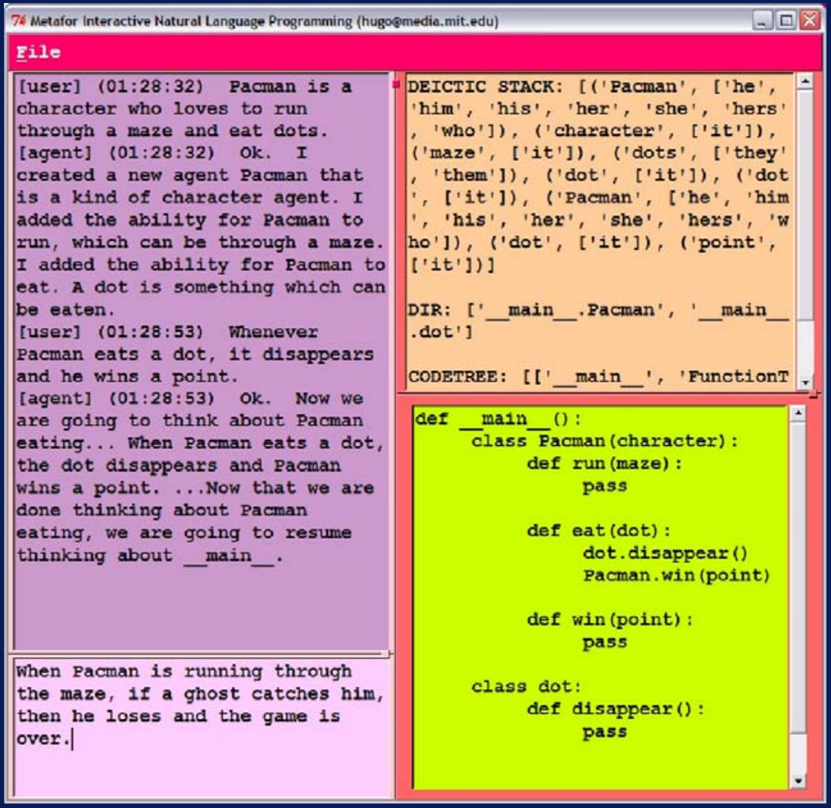
  Programming by Example
- Dynamic / Adaptable command sets
- Self-teaching interfaces, personalization

Books


EDITED BY HENRY LIEBERMAN
YOUR WISH IS MY COMMAND
PROGRAMMING BY EXAMPLE


HUMAN-COMPUTER INTERACTION SERIES
1
End User Development
Henry Lieberman
Fabio Paterno
Vulcker Wolf
Kluwer Academic Publishers

Programming in Natural Language


Metafor Interactive Natural Language Programming (hugo@media.mit.edu)
File

[user] (01:28:32) Pacman is a character who loves to run through a maze and eat dots.
[agent] (01:28:32) Ok. I created a new agent Pacman that is a kind of character agent. I added the ability for Pacman to run, which can be through a maze. I added the ability for Pacman to eat. A dot is something which can be eaten.
[user] (01:28:53) Whenever Pacman eats a dot, it disappears and he wins a point.
[agent] (01:28:53) Ok. Now we are going to think about Pacman eating... When Pacman eats a dot, the dot disappears and Pacman wins a point. ...Now that we are done thinking about Pacman eating, we are going to resume thinking about __main__.

When Pacman is running through the maze, if a ghost catches him, then he loses and the game is over.

```
DEICTIC STACK: [('Pacman', ['he',
'him', 'his', 'her', 'she', 'hers'
, 'who']), ('character', ['it']),
('maze', ['it']), ('dots', ['they'
, 'them']), ('dot', ['it']), ('dot
', ['it']), ('Pacman', ['he', 'him
', 'his', 'her', 'she', 'hers', 'w
ho']), ('dot', ['it']), ('point',
['it'])]

DIR: ['__main__.Pacman', '__main__
.dot']

CODETREE: [['__main__', 'FunctionT
```

```
def __main__():
    class Pacman(character):
        def run(maze):
            pass

        def eat(dot):
            dot.disappear()
            Pacman.win(point)

        def win(point):
            pass

    class dot:
        def disappear():
            pass
```

Computers need to instruct humans in hi-fun interfaces

Programming is the human instructing the computer

But the computer also needs to instruct the human

Collaborative problem solving around shared goals

The world seems to have given up on help systems ?!

How do you learn a hi-fun interface?

… or any complex topic?

Learn by example, a little bit at a time…

Experience success quickly on a simple, but nontrivial example

Learn essential concepts that will enable you to learn more over time

Dimensions in learning

Autonomy: You do it / I do it?

Context: In-context / out of context?

Risk: Works / Doesn’t work?

Style: Top-down / Bottom-up?

The “Paradox of Help”

You can be shown how to do something

But then you don’t get the feeling of DIY

You can try by yourself

But then you might get lost or stuck

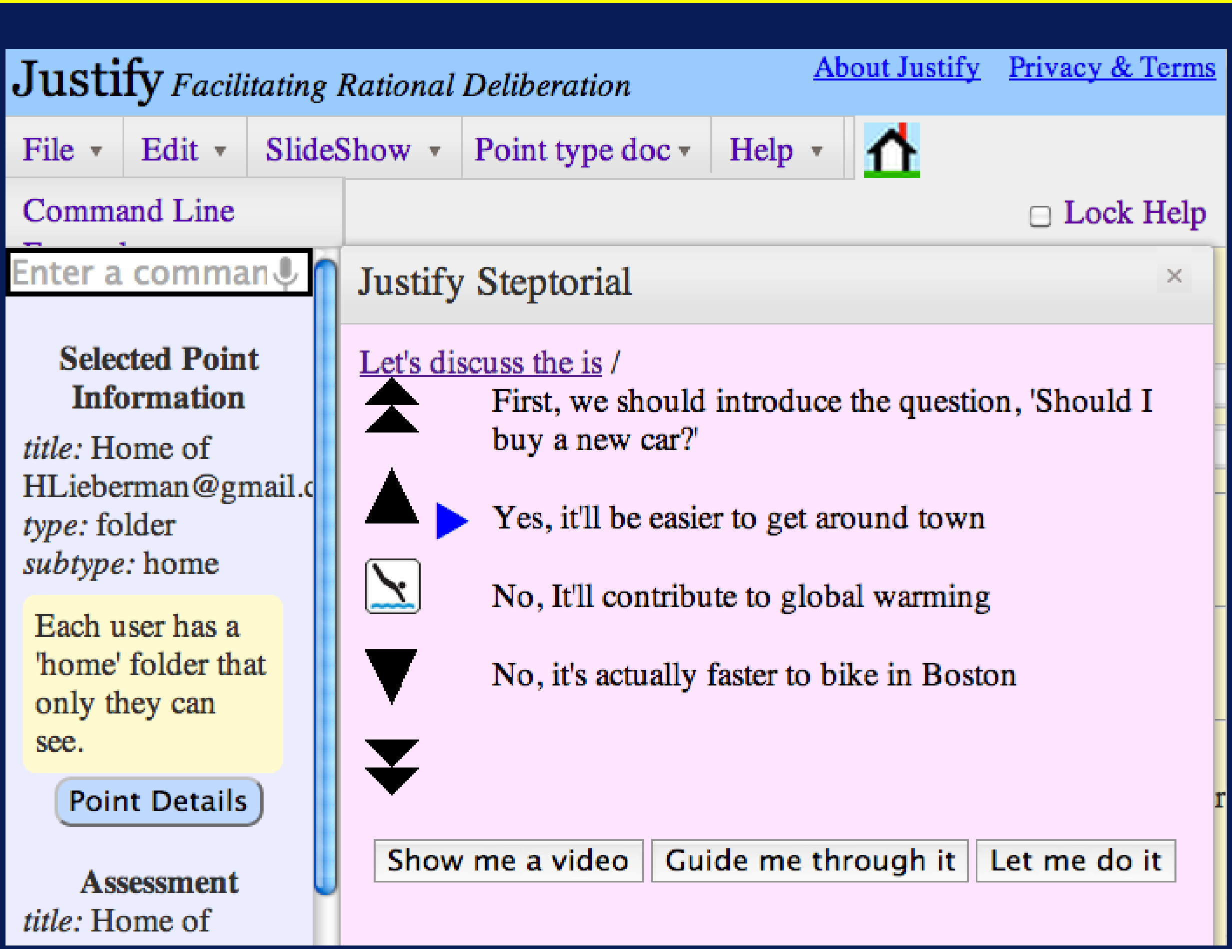
Why choose in advance?

But why should you be forced to make these choices in advance?

Suppose we

- Give you a variety of choices?
- Let you choose at each step?
- Change your mind if you get it wrong?

Steptorials (Stepper tutorial)



Selected Point Information

title: Home of HLieberman@gmail.c

type: folder

subtype: home

Each user has a 'home' folder that only they can see.

Assessment

title: Home of

Justify Steptorial

Let's discuss the is /

First, we should introduce the question, 'Should I buy a new car?'

▶ Yes, it'll be easier to get around town

No, It'll contribute to global warming

No, it's actually faster to bike in Boston

Risk

Hi-fun interfaces involve more risk, because there are more wrong paths than right paths

Reduce risk by giving the user the ability to deal with problems as they arise

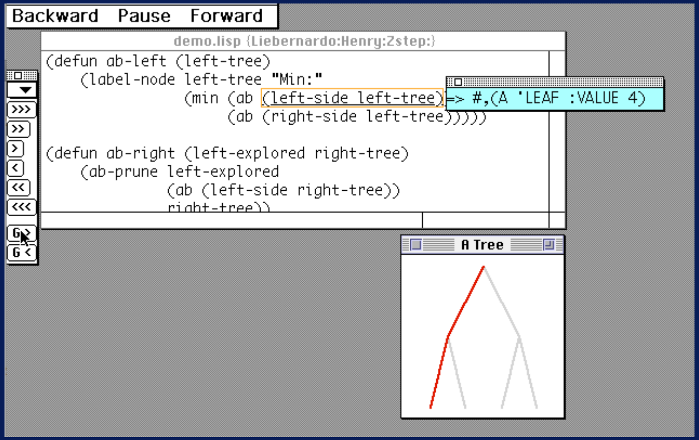
Remove fear of trying new technology

End-User Debugging

Like program debugging, except the user can’t see the program!

Gotta (re-)construct the program based on user interaction

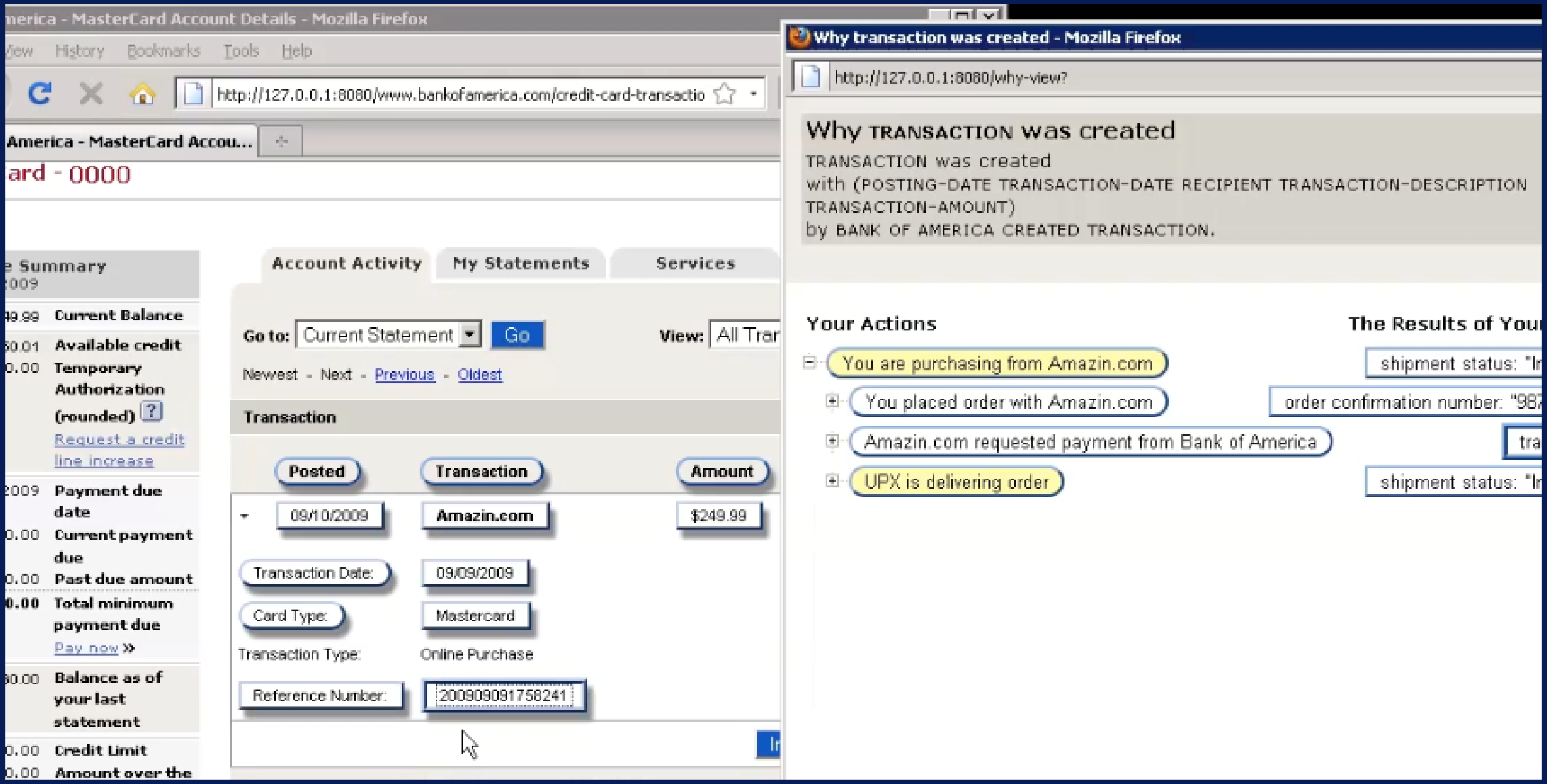
Provide reversible stepper



```
(defun ab-left (left-tree)
    (label-node left-tree "Min:"
                (min (ab (left-side left-tree)) => #,(A 'LEAF :VALUE 4)
                     (ab (right-side left-tree)))))

(defun ab-right (left-explored right-tree)
    (ab-prune left-explored
              (ab (left-side right-tree))
              right-tree))
```

Woodstein



merica - MasterCard Account Details - Mozilla Firefox
View History Bookmarks Tools Help
America - MasterCard Accou...
Account Activity
My Statements
Services
Go
Why transaction was created - Mozilla Firefox

http://127.0.0.1:8080/www.bankofamerica.com/credit-card-transactio

ard - 0000

e Summary
2009

49.99	Current Balance
50.01	Available credit
0.00	Temporary Authorization (rounded) ?
	Request a credit line increase
2009	Payment due date
0.00	Current payment due
0.00	Past due amount
0.00	Total minimum payment due
	Pay now »
50.00	Balance as of your last statement
0.00	Credit Limit
0.00	Amount over the

Go to: Current Statement View: All Trar

Newest - Next - Previous - Oldest

Transaction

Posted	Transaction	Amount
09/10/2009	Amazin.com	$249.99

Transaction Date: 09/09/2009

Card Type: Mastercard

Transaction Type: Online Purchase

Reference Number: 200909091758241

http://127.0.0.1:8080/why-view?

Why TRANSACTION was created

TRANSACTION was created
with (POSTING-DATE TRANSACTION-DATE RECIPIENT TRANSACTION-DESCRIPTION TRANSACTION-AMOUNT)
by BANK OF AMERICA CREATED TRANSACTION.

Your Actions	The Results of You
⊟ You are purchasing from Amazin.com	shipment status: "I
⊞ You placed order with Amazin.com	order confirmation number: "98
⊞ Amazin.com requested payment from Bank of America	tra
⊞ UPX is delivering order	shipment status: "I

Conclusion

We’re entering an era of high-functionality computing

That’s a good thing!

AI is crucial for dealing with major issues:

- Complexity
- Instructibility
- Risk

Commonsense as key

Hypothesis: Common sense reasoning is the key to making usable/helpful applications

Minority viewpoint: Minsky, Lenat…

So, let’s collect Commonsense and figure out how to

- Reason with it
- Integrate it into interfaces

But does it “make sense” to work on Common Sense?

How much Commonsense is in a person’s head?

Isn’t Commonsense knowledge hopelessly vague, ambiguous, context-dependent?

Isn’t it different for different people, cultures?

What if it makes a mistake in the interface?

Good news: It’s feasible

A person lives for 3 billion seconds

- CSK much less, maybe 10s to 100s millions
- Storing / search that much stuff OK today

Will show you many CSK applications to convince you of utility

Big Data / Machine Learning

Hot topic – where we are in Moore's Law

Learning from observation / learning from knowledge

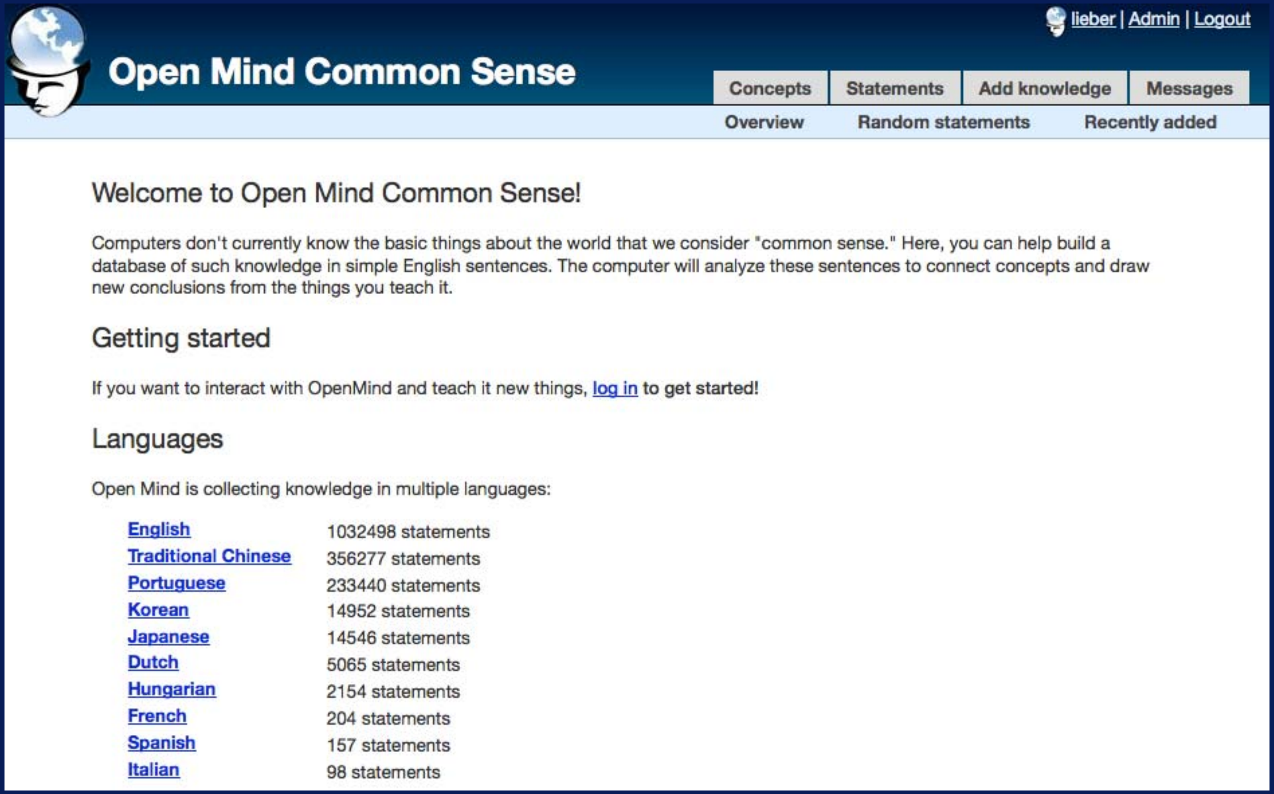
What's correlated / What's interesting/important

Complementary techniques, hijack math for aggregation

Some signs coming together, e.g. “~~deep learning~~”

Open Mind Common Sense

http://openmind.media.mit.edu



Welcome to Open Mind Common Sense!

Computers don't currently know the basic things about the world that we consider "common sense." Here, you can help build a database of such knowledge in simple English sentences. The computer will analyze these sentences to connect concepts and draw new conclusions from the things you teach it.

Getting started

If you want to interact with OpenMind and teach it new things, log in to get started!

Languages

Open Mind is collecting knowledge in multiple languages:

English	1032498 statements
Traditional Chinese	356277 statements
Portuguese	233440 statements
Korean	14952 statements
Japanese	14546 statements
Dutch	5065 statements
Hungarian	2154 statements
French	204 statements
Spanish	157 statements
Italian	98 statements

Open Mind Common Sense

"Crowdsourced" Common Sense

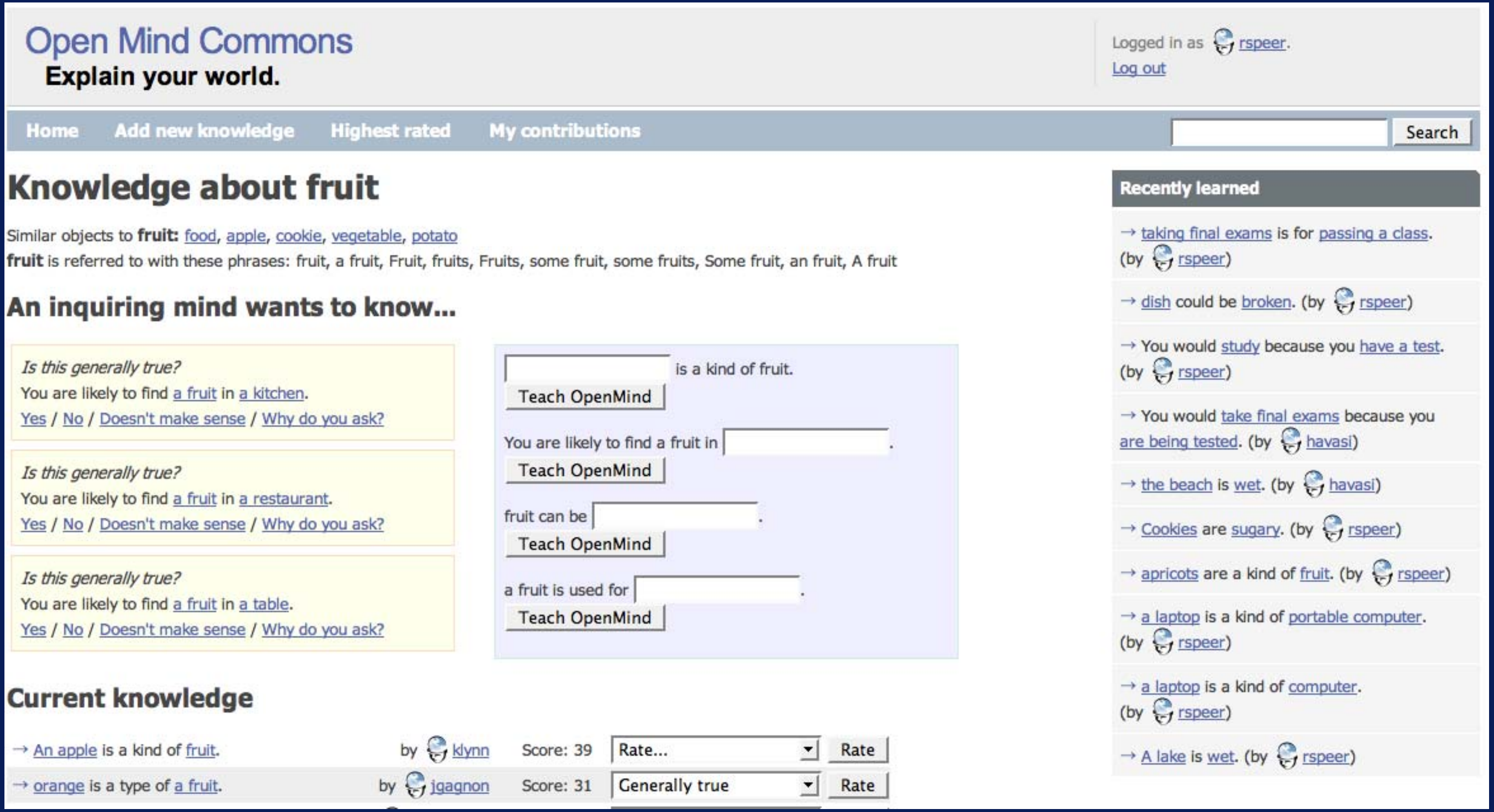
Direct typein, games, mining

12 years, 20K users

1 Million English statements, + other languages

CN5 on order of 10 million + web resources

Open Mind Commons - Speer



Open Mind Commons

Explain your world.

Logged in as rspeer.

Log out

Knowledge about fruit

Similar objects to **fruit:** food, apple, cookie, vegetable, potato

fruit is referred to with these phrases: fruit, a fruit, Fruit, fruits, Fruits, some fruit, some fruits, Some fruit, an fruit, A fruit

An inquiring mind wants to know...

Is this generally true?
You are likely to find a fruit in a kitchen.
Yes / No / Doesn't make sense / Why do you ask?

Is this generally true?
You are likely to find a fruit in a restaurant.
Yes / No / Doesn't make sense / Why do you ask?

Is this generally true?
You are likely to find a fruit in a table.
Yes / No / Doesn't make sense / Why do you ask?

_____ is a kind of fruit.

You are likely to find a fruit in _____.

fruit can be _____.

a fruit is used for _____.

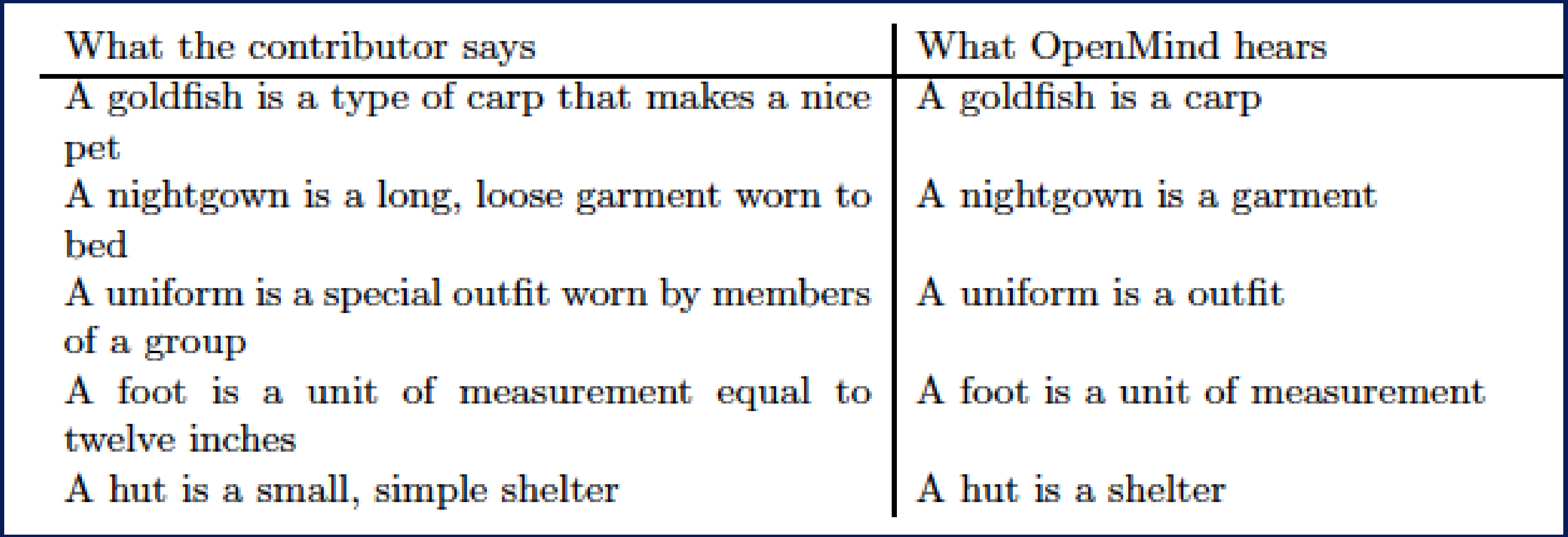
Current knowledge

→ An apple is a kind of fruit.	by klynn	Score: 39	Rate...	Rate
→ orange is a type of a fruit.	by jgagnon	Score: 31	Generally true	Rate

Recently learned

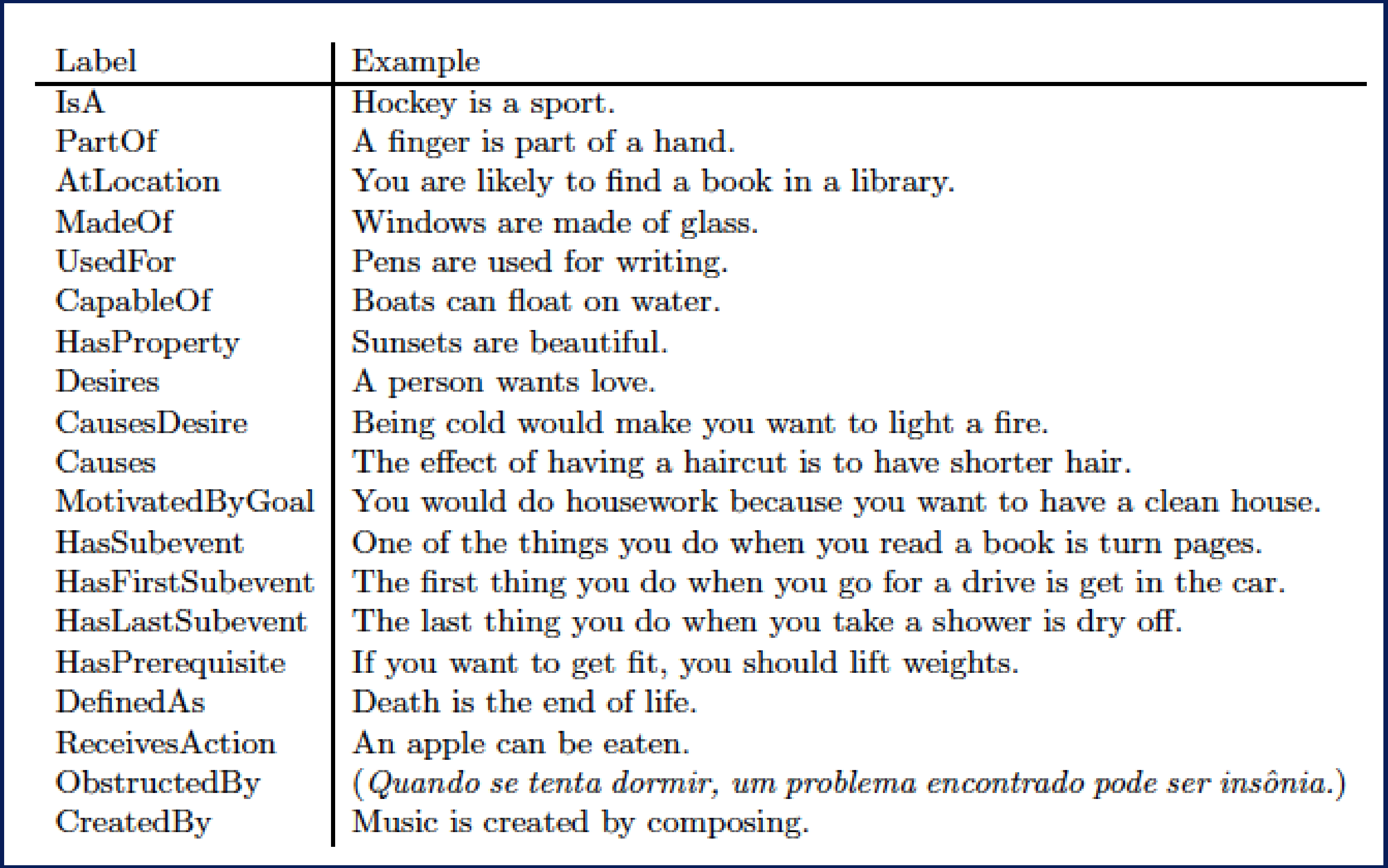
- → taking final exams is for passing a class. (by rspeer)
- → dish could be broken. (by rspeer)
- → You would study because you have a test. (by rspeer)
- → You would take final exams because you are being tested. (by havasi)
- → the beach is wet. (by havasi)
- → Cookies are sugary. (by rspeer)
- → apricots are a kind of fruit. (by rspeer)
- → a laptop is a kind of portable computer. (by rspeer)
- → a laptop is a kind of computer. (by rspeer)
- → A lake is wet. (by rspeer)

Effect of the parser



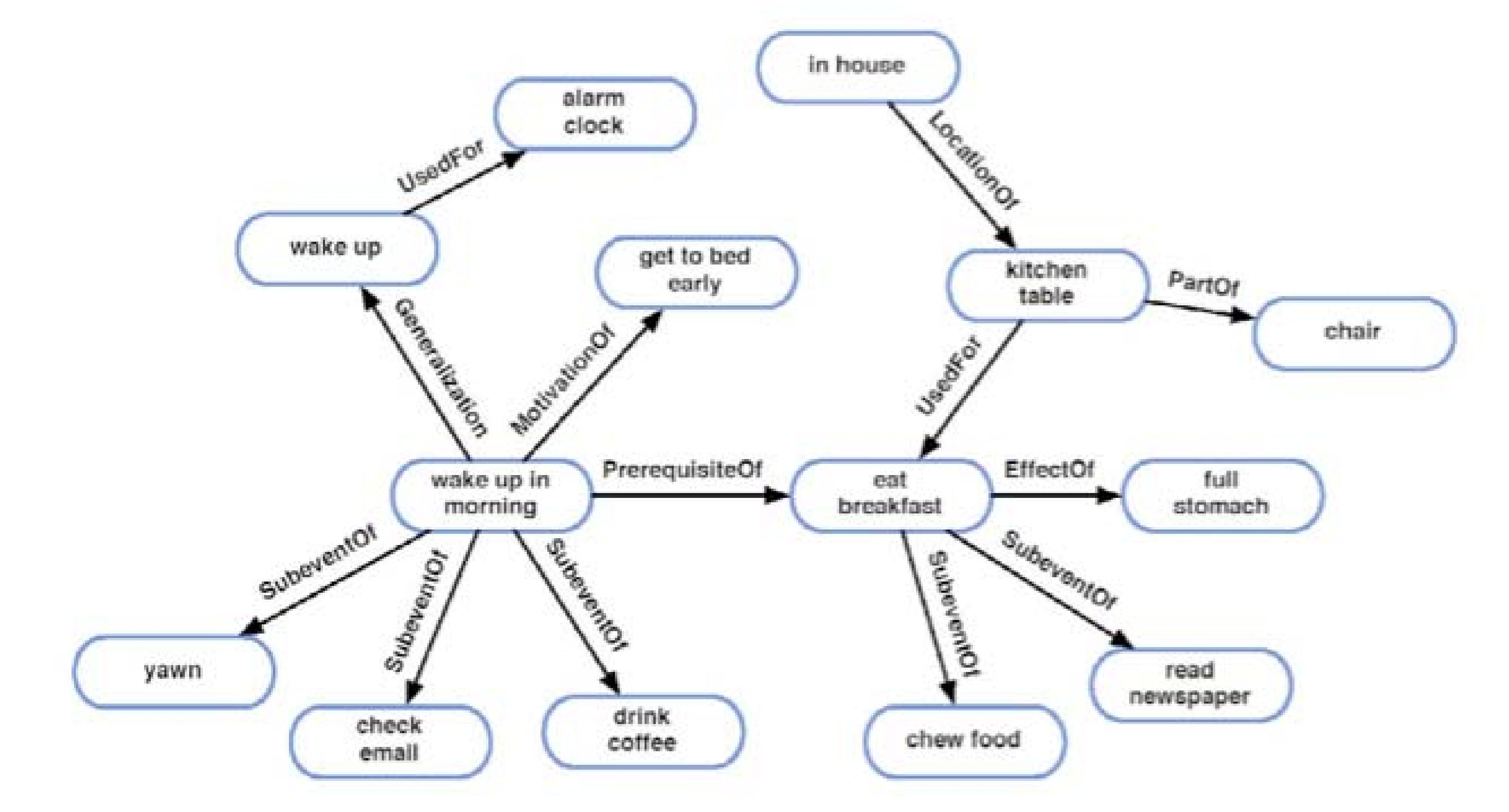
What the contributor says	What OpenMind hears
A goldfish is a type of carp that makes a nice pet	A goldfish is a carp
A nightgown is a long, loose garment worn to bed	A nightgown is a garment
A uniform is a special outfit worn by members of a group	A uniform is a outfit
A foot is a unit of measurement equal to twelve inches	A foot is a unit of measurement
A hut is a small, simple shelter	A hut is a shelter

ConceptNet relations

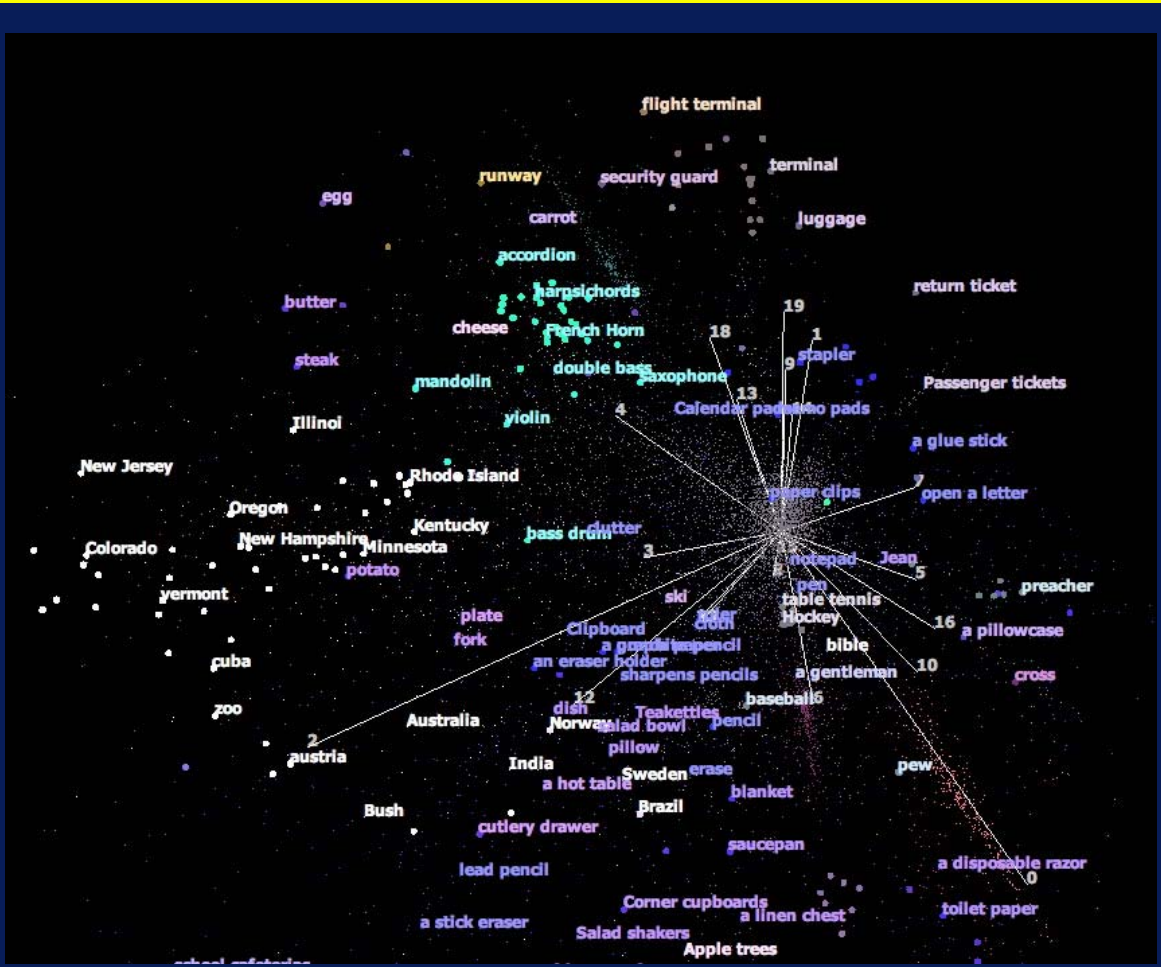


Label	Example
IsA	Hockey is a sport.
PartOf	A finger is part of a hand.
AtLocation	You are likely to find a book in a library.
MadeOf	Windows are made of glass.
UsedFor	Pens are used for writing.
CapableOf	Boats can float on water.
HasProperty	Sunsets are beautiful.
Desires	A person wants love.
CausesDesire	Being cold would make you want to light a fire.
Causes	The effect of having a haircut is to have shorter hair.
MotivatedByGoal	You would do housework because you want to have a clean house.
HasSubevent	One of the things you do when you read a book is turn pages.
HasFirstSubevent	The first thing you do when you go for a drive is get in the car.
HasLastSubevent	The last thing you do when you take a shower is dry off.
HasPrerequisite	If you want to get fit, you should lift weights.
DefinedAs	Death is the end of life.
ReceivesAction	An apple can be eaten.
ObstructedBy	(*Quando se tenta dormir, um problema encontrado pode ser insônia.*)
CreatedBy	Music is created by composing.

ConceptNet - Liu, Singh, Eslick



AnalogySpace – Speer, Havasi



What AnalogySpace can do

It can generalize from sparsely-collected knowledge

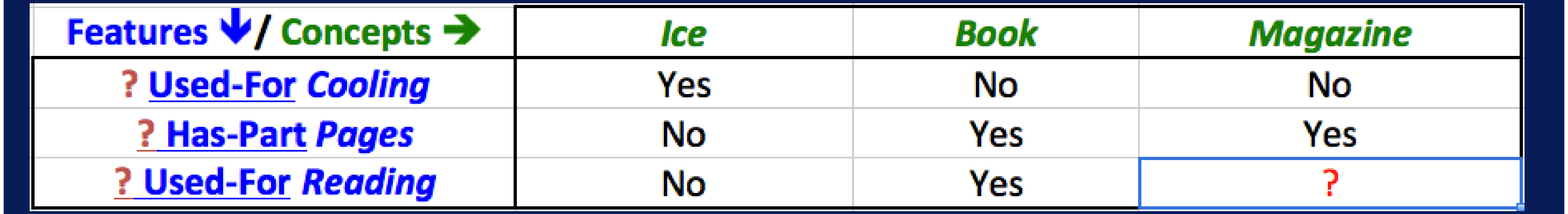
It can identify the most important dimensions in a knowledge space

It can classify concepts along those dimensions

It can create ad-hoc categories (and classify accordingly)

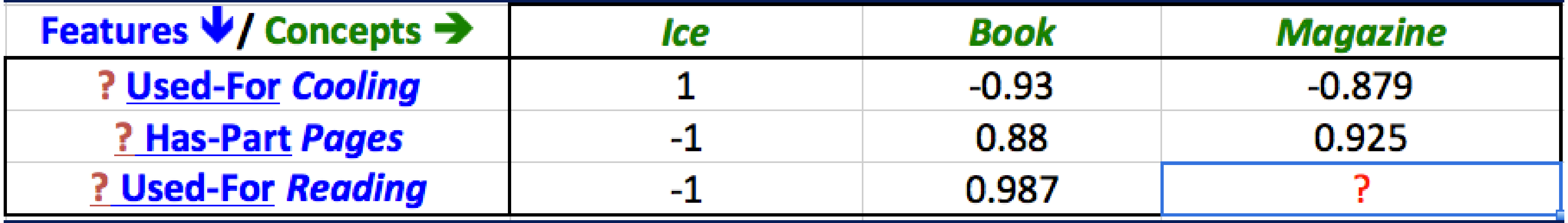
It can confirm or question existing knowledge

AnalogySpace matrix



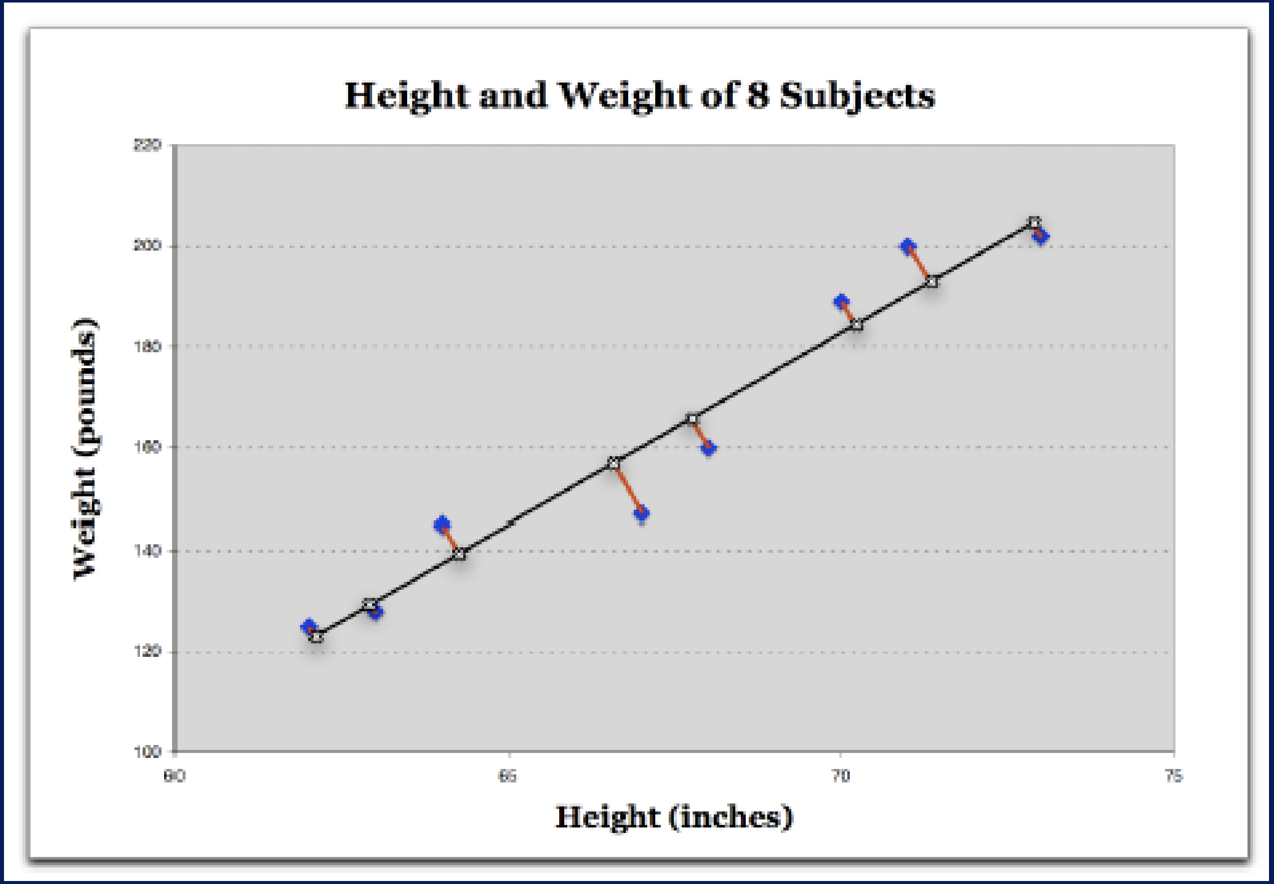
Features ↓/ Concepts →	*Ice*	*Book*	*Magazine*
? Used-For *Cooling*	Yes	No	No
? Has-Part *Pages*	No	Yes	Yes
? Used-For *Reading*	No	Yes	?

AnalogySpace matrix

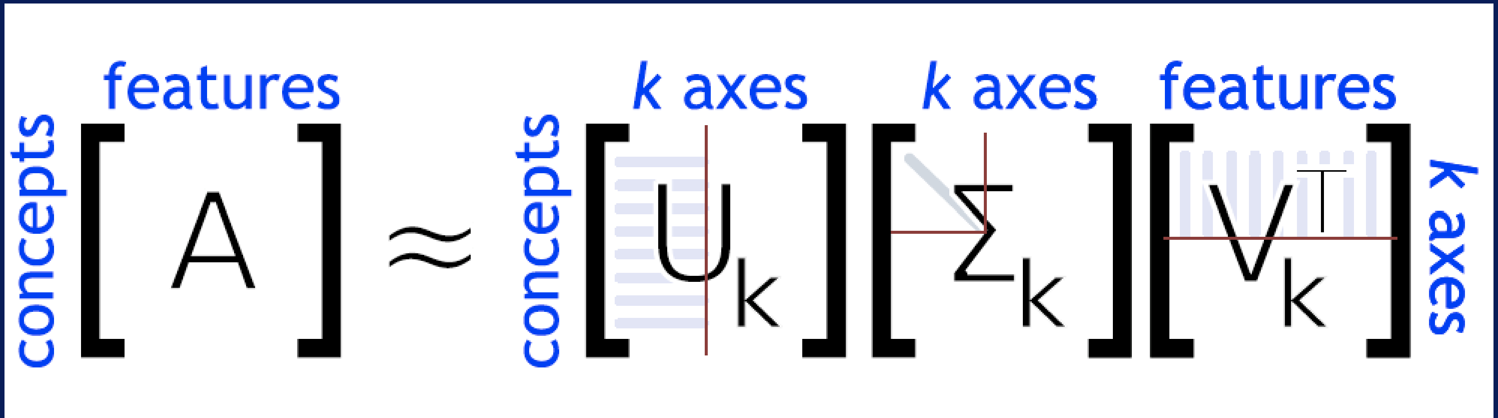


Features ↓/ Concepts →	*Ice*	*Book*	*Magazine*
? Used-For *Cooling*	1	-0.93	-0.879
? Has-Part *Pages*	-1	0.88	0.925
? Used-For *Reading*	-1	0.987	?

Dimensionality Reduction



Singular Value Decomposition



Traditional Logical Inference

Inferences goes from

True assertion -> True assertion

via Inference Rules

Good news: Very precise and reliable

Bad news: Proof search blows up exponentially

Requires precise definitions and assertions

GIGO

AnalogySpace Inference

All possible assertions put in a (big, sparse) box

You can rearrange the box along semantic axes

Good news: Computationally efficient

- Tolerant of imprecision, contradiction, disagreement…

- Stronger than statistical inference

Bad news: Can't be guaranteed to be very precise

Not-so-Common Sense

Use Common Sense tools & methodology, but knowledge only common to a small group

Collect knowledge from natural language sources

Collect knowledge from games

Collect knowledge from existing DBs, Ontologies, ..

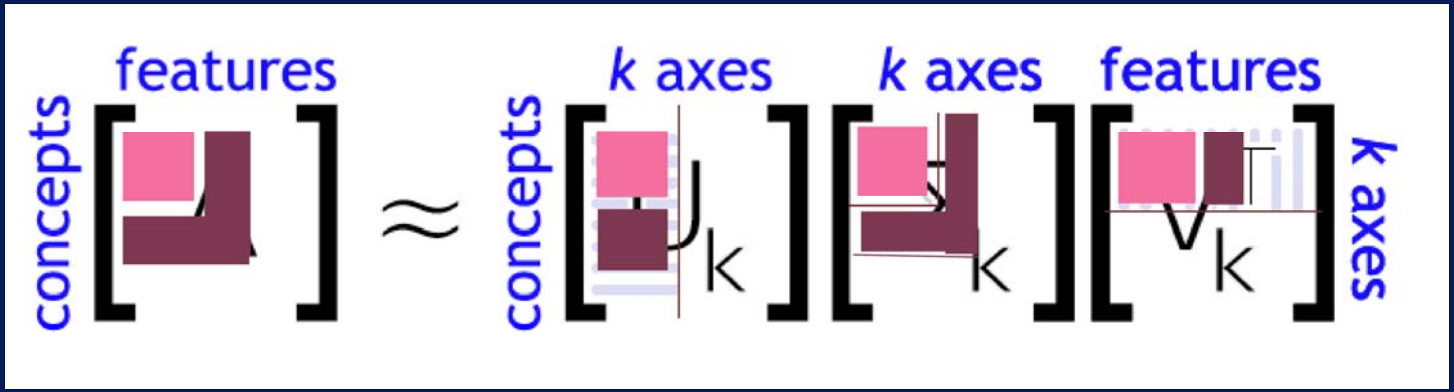
"Blend" with general Commonsense knowledge

-> AnalogySpace for specific domain

Blending - Havasi

Inference combining two AnalogySpaces

- Specialized and generalized knowledge bases
- Blending factor



AI in user interfaces

Intelligent defaults

Goal-oriented interfaces

Recommender systems

End-user programming

End-user debugging

Applications in Interface Agents

Predictive typing, Speech recognition

Storytelling with Media Libraries

Detection and mitigation of online bullying

Opinion Analysis

Goal-oriented interfaces for Consumer Electronics

Mobile to-do lists, location-aware context-sensitive maps

Translation, language learning & multi-lingual communication

Help and customer service

Recommendation systems, scenario-based recommendation

Programming and code sharing in natural language

… and more

Related Work

Cyc

Thought Treasure

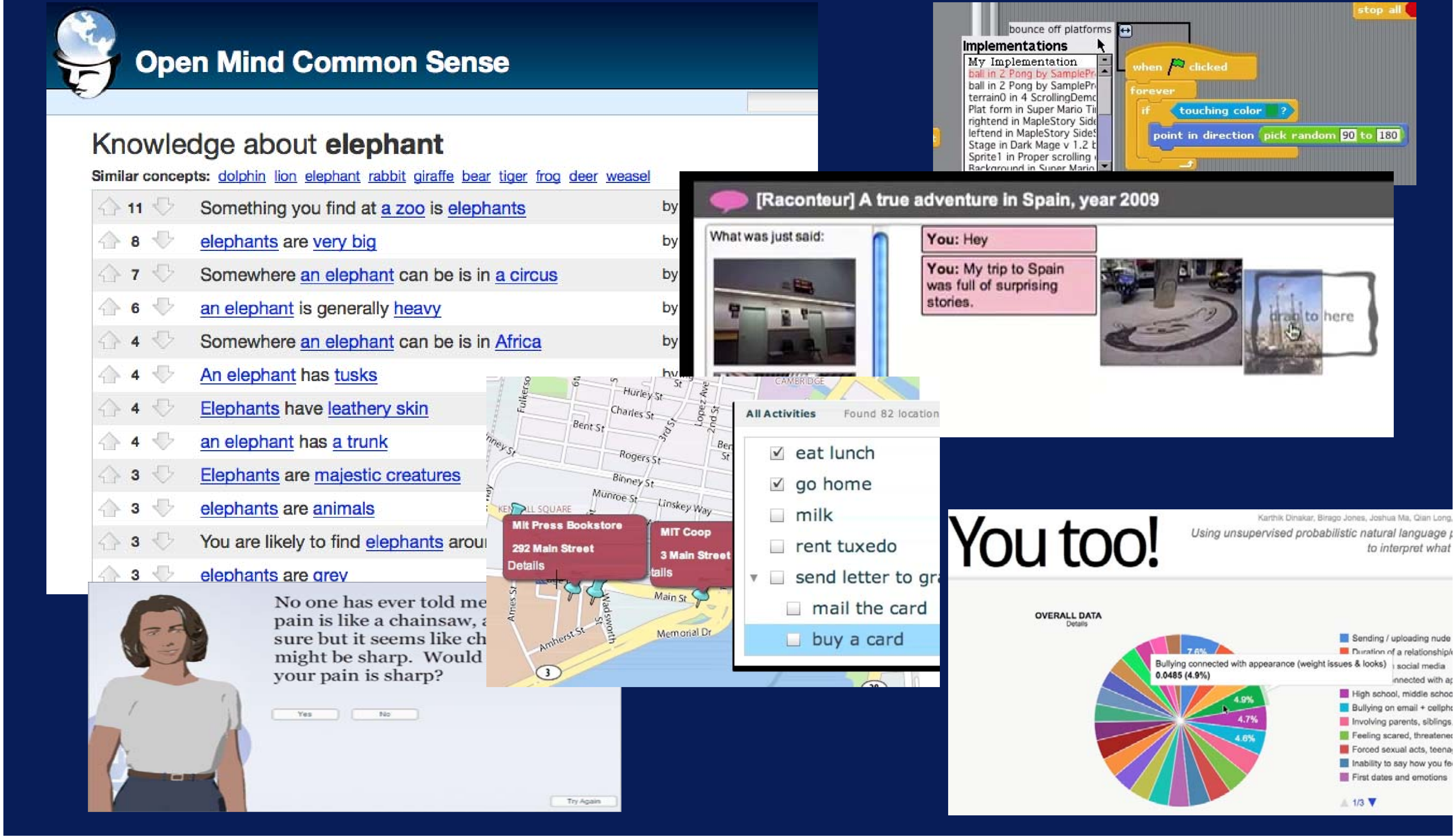
Logic, Axiomatization of Commonsense Domains

Semantic Web / Linked Data

Freebase, other curated collections

Nell, machine learning mining Web

Let’s beat some Common Sense into computers!



Open Mind Common Sense

Knowledge about **elephant**

Similar concepts: dolphin lion elephant rabbit giraffe bear tiger frog deer weasel

11	Something you find at a zoo is elephants	by
8	elephants are very big	by
7	Somewhere an elephant can be is in a circus	by
6	an elephant is generally heavy	by
4	Somewhere an elephant can be is in Africa	by
4	An elephant has tusks	by
4	Elephants have leathery skin	
4	an elephant has a trunk	
3	Elephants are majestic creatures	
3	elephants are animals	
3	You are likely to find elephants arou	
3	elephants are grey	

bounce off platforms

Implementations

My Implementation
ball in 2 Pong by SamplePr
ball in 2 Pong by SamplePr
terrain0 in 4 ScrollingDemo
Plat form in Super Mario Ti
rightend in MapleStory Side
leftend in MapleStory SideS
Stage in Dark Mage v 1.2 b
Sprite1 in Proper scrolling
Background in Super Mario

```
when [flag] clicked
forever
  if touching color ?
    point in direction pick random 90 to 180
```

[Raconteur] A true adventure in Spain, year 2009

What was just said:

You: Hey

You: My trip to Spain was full of surprising stories.

MIt Press Bookstore
292 Main Street
Details

MIT Coop
3 Main Street
tails

All Activities — Found 82 location

☑ eat lunch
☑ go home
☐ milk
☐ rent tuxedo
☐ send letter to gra
☐ mail the card
☐ buy a card

No one has ever told me pain is like a chainsaw, a sure but it seems like ch might be sharp. Would your pain is sharp?

You too!

Karthik Dinakar, Birago Jones, Joshua Ma, Qian Long,

Using unsupervised probabilistic natural language p to interpret what

OVERALL DATA
Details

Bullying connected with appearance (weight issues & looks)
0.0485 (4.9%)

7.6%
4.9%
4.7%
4.6%
Sending / uploading nude
Duration of a relationship/
social media
nnected with ap
High school, middle schoo
Bullying on email + cellph
Involving parents, siblings,
Feeling scared, threatened
Forced sexual acts, teena
Inability to say how you fe
First dates and emotions
1/3