The New Era of High Functionality Computing



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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?

Al 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)

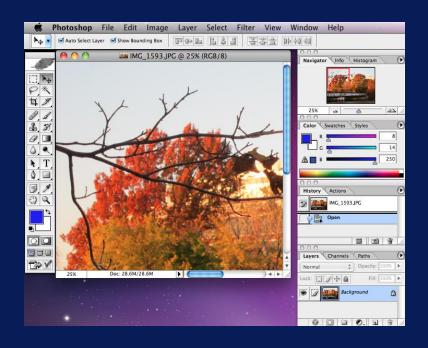


Only a small number of operations
What each operation does is "obvious"
Small number of intuitive data types
Little potential for human error

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 A and HCl for hi-fun interfaces



AI stuck on "Turing Test" complete AI

AI stuck on math+algorithms

HCI paralyzed by fear of AI failures

HCI stuck on designing for low-functionality interfaces.

Not on a sustainable path for interface innovation

Complexity



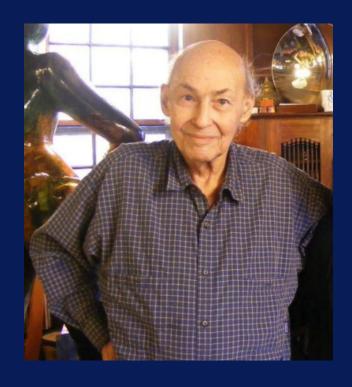
Can we manage complexity with "good design" according to "user-centered" principles?

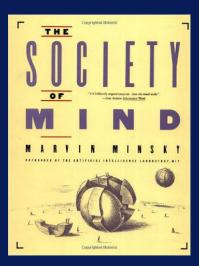


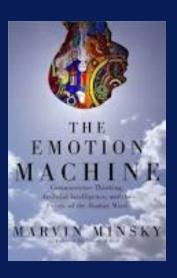
"Simplify" interfaces – small number of operations Organize logically – "affordances"

Marvin Minsky, 1926-2016









Reflective software



SELF-IDEALS

Concerned with relationship between this mind and others, including self-appraisal by comparing one's abilities and goals with those of others.

SELF-CONSCIOUS

Concerned with relationship between this mind and others, including self-appraisal by comparing one's abilities and goals with those of others.

SELF-REFLECTIVE

Concerned with larger scale models of 'self', including the extent and boundaries of one's physical and cognitive abilities and knowledge.

REFLECTIVE

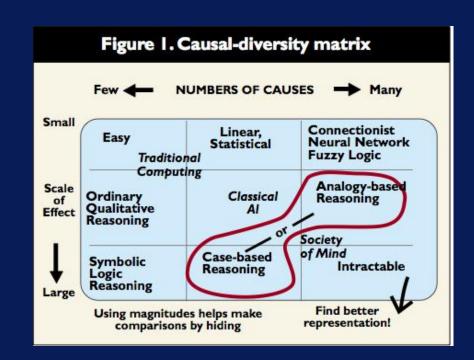
Reflects on and manages deliberative activity, including assigning credit to inference methods, selecting suitable representations, and so forth.

DELIBERATIVE

Reasons about the situations and events in the external world, e.g. prediction, explanation, planning, diagnosis, generalization.

REACTIVE

Reflexes and scripted, automatic responses to opportunities and emergencies that occur in the external world.



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



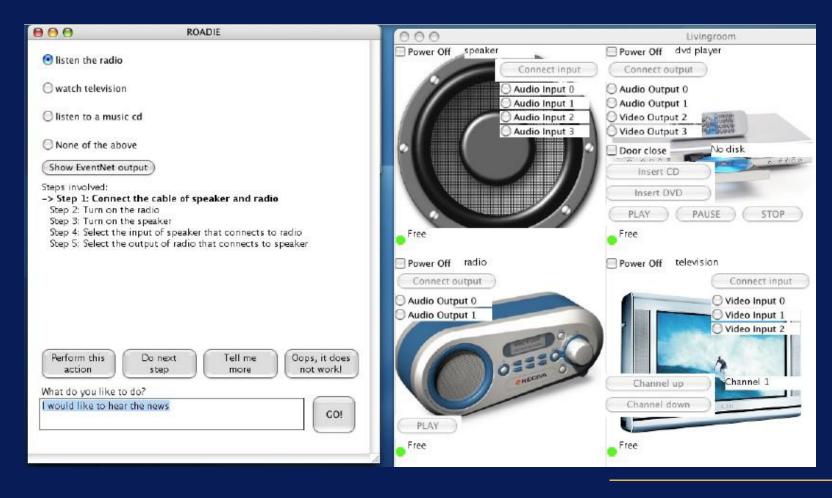
Natural language and commonsense knowledge for goal recognition

Partial-order planning for goal satisfaction

Help, debugging tools when things go wrong

Roadie



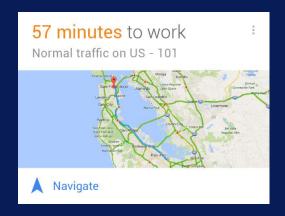


Siri, Google Now



First commercial appearance of goal-oriented interfaces





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

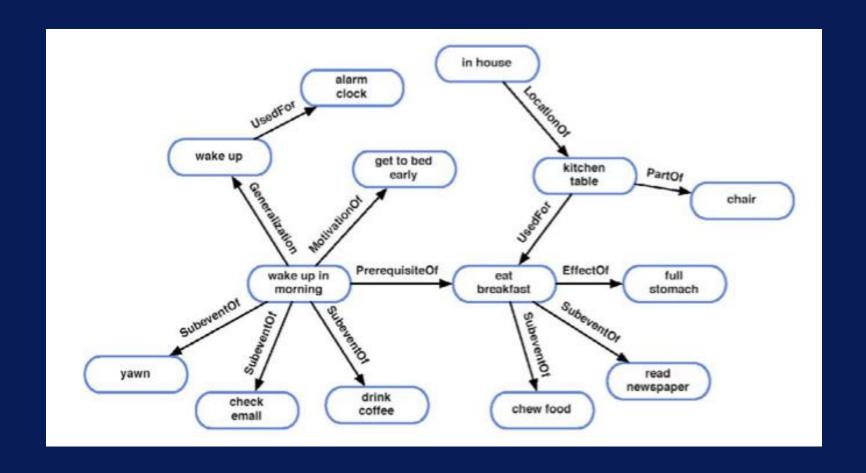
Open Mind Commonsense – Speer, Havasi



Open Mind Commons Explain your world.		Logged in as rspeer. Log out
Home Add new knowledge Highest rated	My contributions	Search
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		Recently learned → taking final exams is for passing a class. (by rspeer) → dish could be broken. (by rspeer)
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. Teach OpenMind You are likely to find a fruit in Teach OpenMind fruit can be Teach OpenMind a fruit is used for Teach OpenMind	 → You would study because you have a test. (by Frspeer) → You would take final exams because you are being tested. (by havasi) → the beach is wet. (by havasi) → Cookles are sugary. (by rspeer) → apricots are a kind of fruit. (by rspeer) → a laptop is a kind of portable computer. (by rspeer)
Current knowledge		\rightarrow <u>a laptop</u> is a kind of <u>computer</u> . (by <u>Greeer</u>)
→ An apple is a kind of <u>fruit</u> . by \bigcirc kly → <u>orange</u> is a type of <u>a fruit</u> . by \bigcirc jagan		→ <u>A lake</u> is <u>wet</u> . (by rspeer)

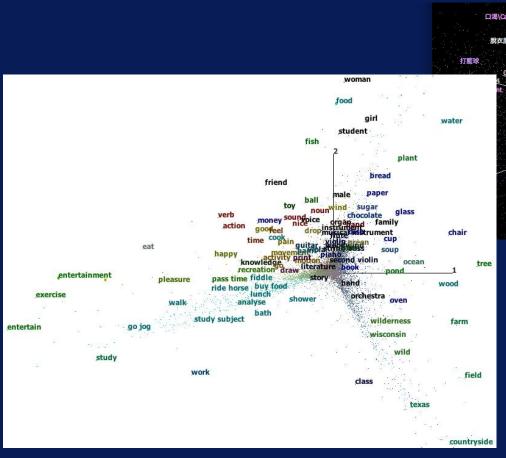
ConceptNet - Liu, Singh, Eslick

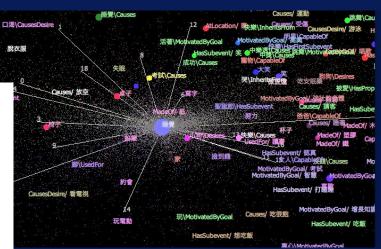




AnalogySpace – Speer, Havasi, Kuo









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

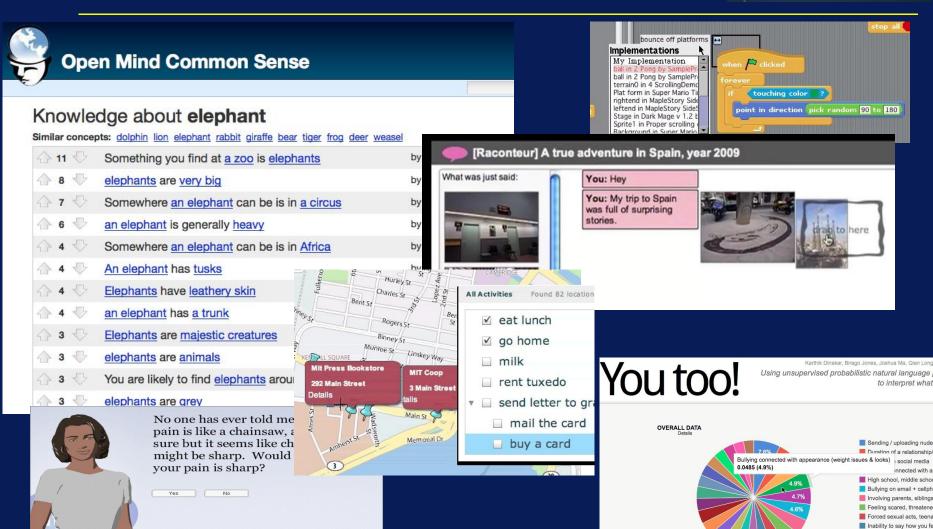
Applications in Interface Agents

Try Again



First dates and emotions

▲ 1/3 ▼



Cyberbullying



Problem of Cyberbullying

Affects 43% of kids

2011 White House Conference on Cyberbullying

NLP for identifying possible cyberbullying topics

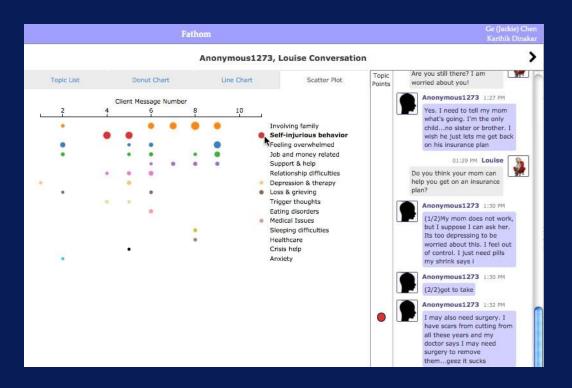




Fathom - Dinakar



Assistant for helping online counselors



Instructibility

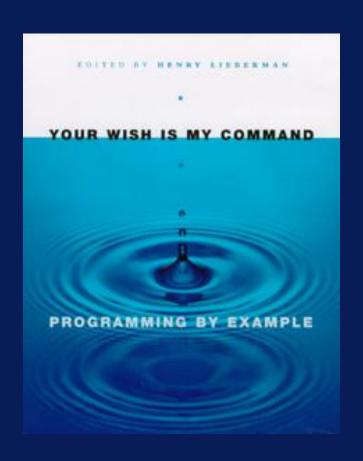


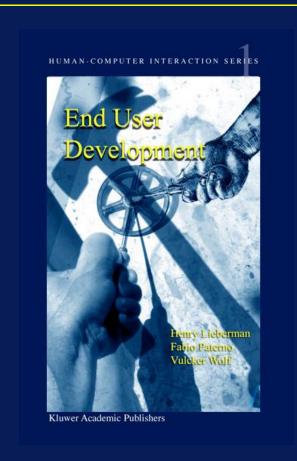
If you have a large or open-ended command set, how do you make it easily usable?

- Natural Language interfaces / Speech reco
- End-User Programming
 Programming by Example
- Dynamic / Adaptable command sets
- Self-teaching interfaces, personalization

Books

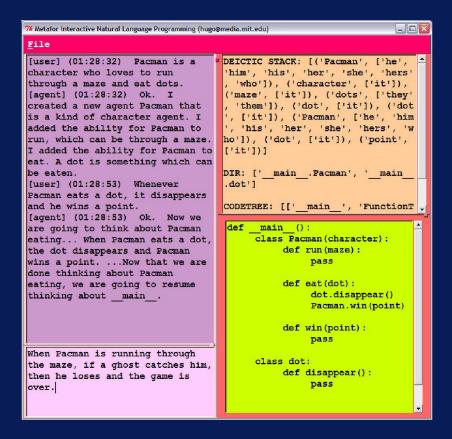






Programming in Natural Language





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?



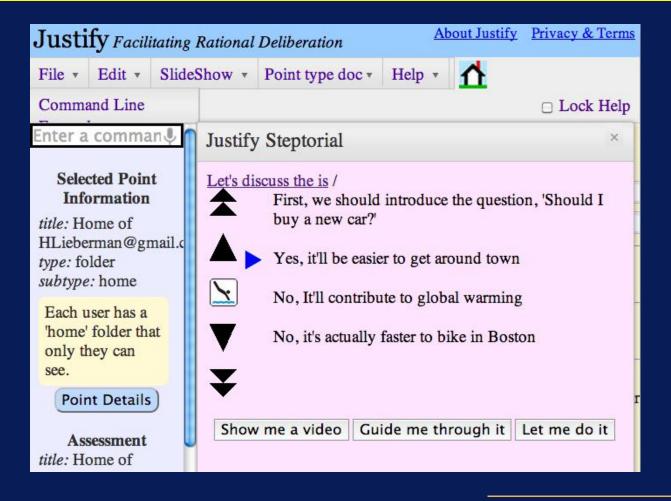
But why should you be forced to make these choices in advance?

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)





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

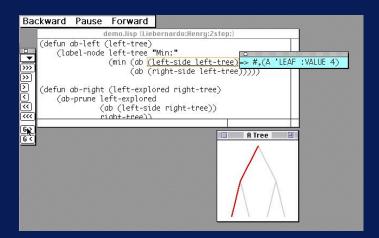
End-User Debugging



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

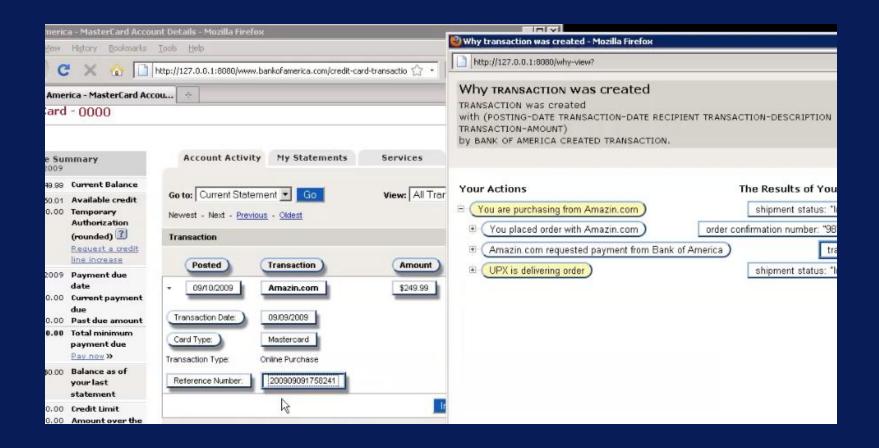
Gotta (re-)construct the program based on user interaction

Provide reversible stepper



Woodstein





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

Henry Lieberman • MIT CSAIL

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

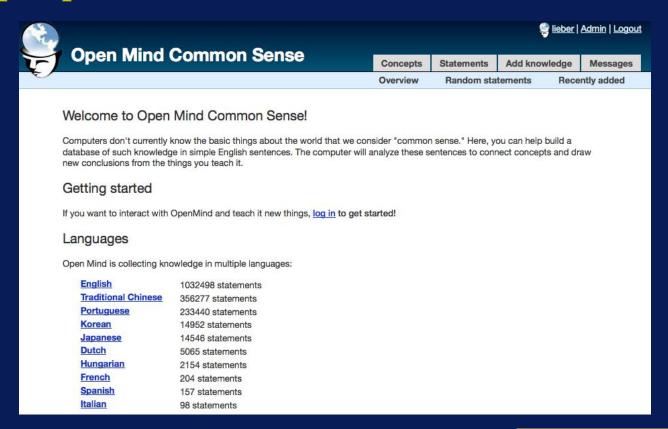
Complementary techniques, hijack math for aggregation

Some signs coming together, e.g. "deep learning"

Open Mind Common Sense



http://openmind.media.mit.edu



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
Home Add new knowledge Highest rated	My contributions	Search
Knowledge about fruit		Recently learned
Similar objects to fruit: <u>food</u> , <u>apple</u> , <u>cookie</u> , <u>vegetable</u> , <u>potato</u> fruit is referred to with these phrases: fruit, a fruit, Fruit, fruit	\rightarrow taking final exams is for passing a class. (by \bigcirc rspeer)	
An inquiring mind wants to know		\rightarrow <u>dish</u> could be <u>broken</u> . (by \bigcirc <u>rspeer</u>)
Is this generally true? You are likely to find a fruit in a kitchen. Yes / No / Doesn't make sense / Why do you ask?	Teach OpenMind You are likely to find a fruit in	 → You would <u>study</u> because you <u>have a test</u>. (by rspeer) → You would <u>take final exams</u> because you are being tested. (by havasi)
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Is this generally true? You are likely to find a fruit in a table. Yes / No / Doesn't make sense / Why do you ask?	a fruit is used for . Teach OpenMind	\rightarrow <u>apricots</u> are a kind of <u>fruit</u> . (by \bigodot <u>rspeer</u>) \rightarrow <u>a laptop</u> is a kind of <u>portable computer</u> . (by \bigodot <u>rspeer</u>)
Current knowledge		\rightarrow <u>a laptop</u> is a kind of <u>computer</u> . (by \bigcirc <u>rspeer</u>)
$ ightarrow$ An apple is a kind of fruit. by $\begin{center} \line \lin$	ynn Score: 39 Rate Rate	→ A lake is wet. (by 😭 rspeer)
→ <u>orange</u> is a type of <u>a fruit</u> . by ⊖ jgag	non Score: 31 Generally true Rate	

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	A nightgown is a garment
bed	A
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

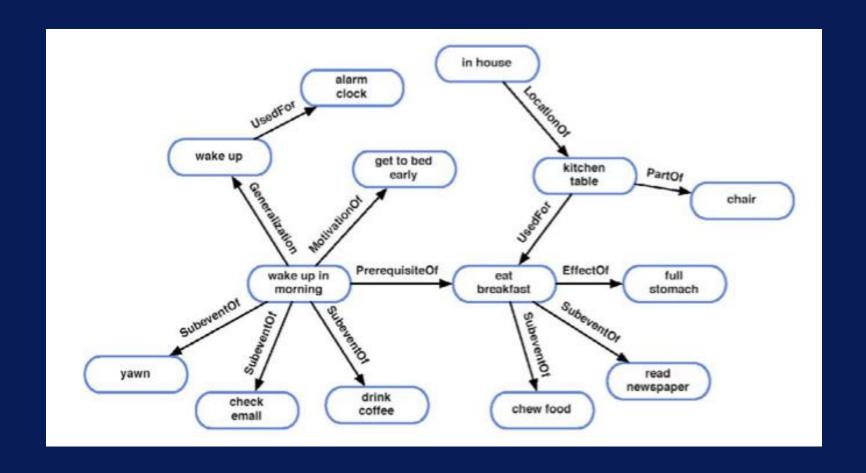
ConceptNet relations



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.

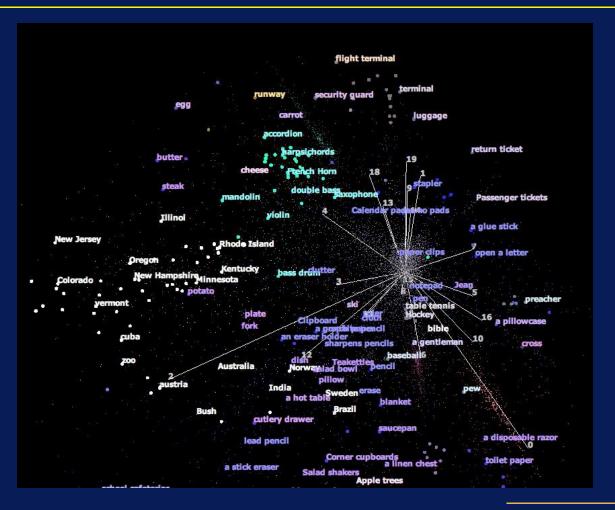
ConceptNet - Liu, Singh, Eslick





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

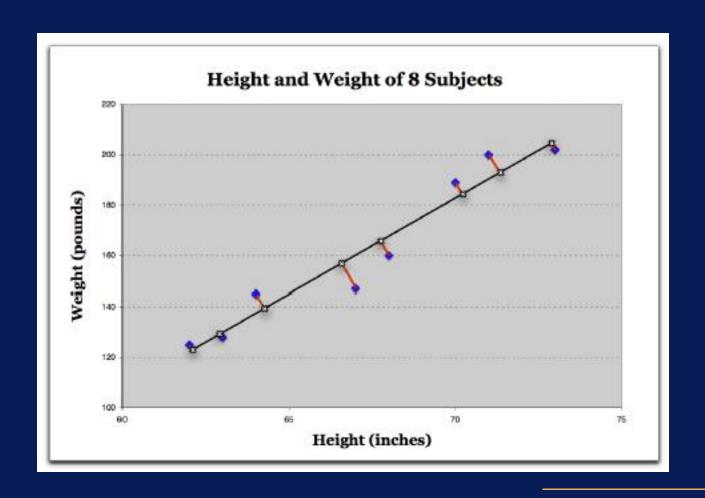


Features ♥/ Concepts →	Ice	Book	Magazine
? Used-For Cooling	1	-0.93	-0.879
? Has-Part Pages	-1	0.88	0.925
? Used-For Reading	-1	0.987	?

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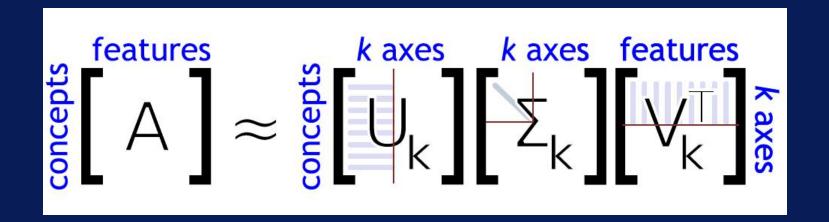
Dimensionality Reduction





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

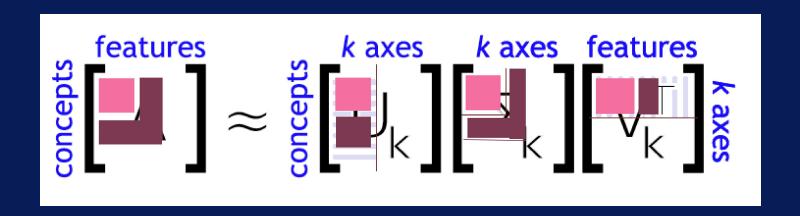
Blending - Havasi



Inference combining two AnalogySpaces

Specialized and generalized knowledge bases

Blending factor



Al in user interfaces



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Applications in Interface Agents



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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

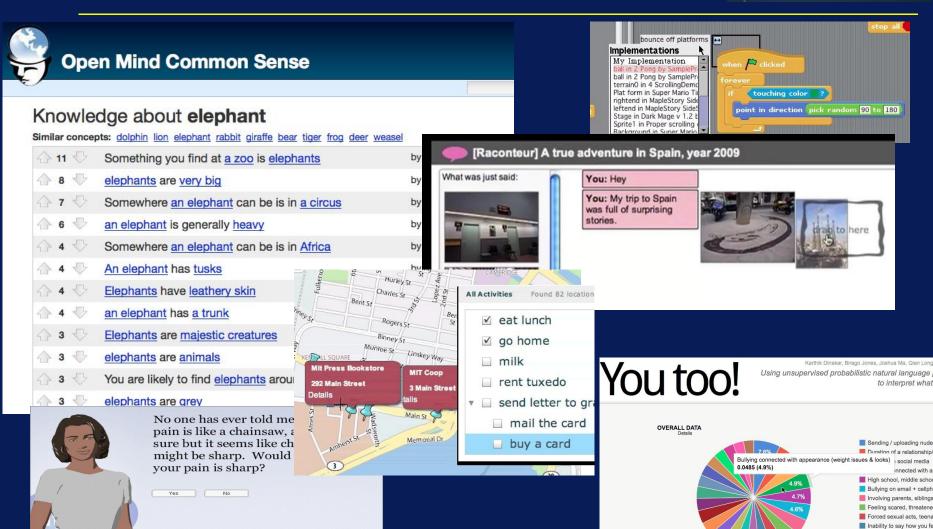
Let's beat some Common Sense into computers!

Try Again



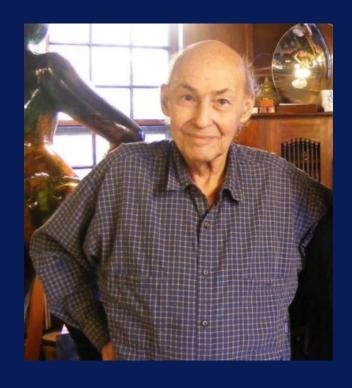
First dates and emotions

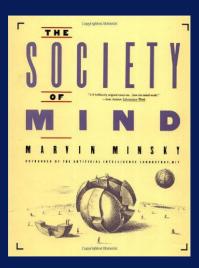
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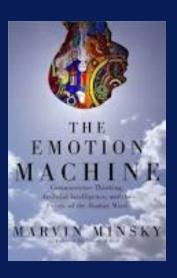


Marvin Minsky, 1926-2016









Society of Mind



"To see how minds are like societies, try this: pick up a cup of tea!

Your GRASPING agents want to keep hold of the cup. Your BALANCING agents want to keep the tea from spilling out... Yet none of these consume your mind. You scarcely think at all about Balance; Balance has no concern with Grasp; Why not? If each does its own little job, the really big job will get done by all of them: drinking tea."

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