How to mine an event network

Dustin Smith,
MIT Media Lab
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Reasoning with Text Workshop, ICT USC Los Angeles

Tuesday, March 1, 2011
Jack was having a birthday party. Mother baked a cake.

Sally said, "Oh, Spot! Look in here. Do you see what I see? It is something we like."
Jack was having a birthday party. Mother baked a cake.

• What is the relationship between Jack and Mother?
• Who will eat the cake?
• Where was Mother when she was baking the cake?
• Where was Jack?
Eugene Charniak’s Ph.D. [1] “the chief concern motivating the model discussed here is relating a large body of knowledge to a particular story”

By preschool, children can represent and remember event sequences [2].

By the time they are reading, children have acquired a lot of world knowledge already!

Big Question

Characterizing the problem:

How can we acquire knowledge by reading, when reading itself requires knowledge?
Big Question

Characterizing the problem:

How can we acquire knowledge by reading, when reading itself requires knowledge?

- Bootstrap solution: Gradually *compose* more new (more complex) representations out of existing (simpler) representations.
Jack was having a birthday party. Mother baked a cake.

- Jack is a boy's name.
- Is a nickname for John.
- Is a children's game.
- Is a childhood game.
- Is a lifting device.
- Is kind of nickname.

Jack was having a birthday party. Mother baked a cake.

bake a cake because you want to balloon used for likely to find at toy balloon likely to find at helium balloon buying presents is for are fun

is a game is a children’s game is a nickname for John. is a boy’s name is a childhood game. is a lifting device. is kind of nickname.

(40) (17)
Jack was having a birthday party. Mother baked a cake.

is a game
is a children’s game
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is a boy’s name
is a childhood game.
is a lifting device.
is kind of nickname.

bake a cake because you want to balloon used for likely to find at toy balloon likely to find at helium balloon buying presents is for are fun

(17)

can care for a child
is a woman
take care of their children
loves her child
is part of my family

(40)

(260)
Using common sense KB?

Jack was having a birthday party. Mother **baked a cake**.

- is a game
- is a children’s game
- is a nickname for John.
- is a boy’s name
- is a childhood game.
- is a lifting device.
- is kind of nickname.

(40)

- can care for a child
- is a woman
- take care of their children
- loves her child
- is part of my family

(260)

- you should have an oven
- a birthday may make you want to
- because you want to
- celebrate a birthday
- first thing add flour

(19)

- bake a cake because you want to
- balloon used for
- likely to find at toy balloon
- likely to find at helium balloon
- buying presents is for
- are fun

(17)
Using common sense KB?

Problem: Retrieving only the relevant knowledge

Jack was having a birthday party. Mother baked a cake.

<table>
<thead>
<tr>
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</tr>
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<tbody>
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<td>is a lifting device.</td>
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<td></td>
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</tbody>
</table>

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<td>is part of my family</td>
<td></td>
</tr>
</tbody>
</table>

(260)

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<th>balloon used for</th>
</tr>
</thead>
<tbody>
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<td>likely to find at helium balloon</td>
</tr>
<tr>
<td>buying presents is for</td>
<td>are fun</td>
</tr>
</tbody>
</table>

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</thead>
<tbody>
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<td>celebrate a birthday</td>
</tr>
<tr>
<td>first thing</td>
<td>add flour</td>
</tr>
</tbody>
</table>

(19)
Approach: use plans

- and variants: plans, event chains, stories, scripts, narratives, procedures, task networks, sequential decision processes, ...

- Unite procedural and declarative semantic knowledge.

- Structure what is problematic, what questions are worth asking; embedding knowledge in a goal-driven problem solving context.

"Questions arise from a point of view—from something that helps to structure what is problematical, what is worth asking, and what constitutes an answer (or progress). It is not that the view determines reality, only what we accept from reality and how we structure it..."

-- Alan Newell in *Artificial Intelligence and the Concept of Mind*
My approach

- **Goal:** Build an event network of human goals by combining information from many sources:
43 Things is the world's largest goal-setting community. People here want to:

Become a model  pass my exams  draw more  stop scratching my eczema  grow marijuana  archetypal wants to Save money  listen to french rap music  know what I want  get engaged  visit europe  suzieslobo wants to grow my hair long  control my emotions  be bold  watch The Notebook  get corrective eye surgery or lasik  master photoshop  Watch all the episodes of Dr.Who  move to the country  be more charitable  watch greys anatomy episodes  stop being a shop-a-holic  increase my typing speed  make my dad proud  pierce something  learn the thriller dance  try a new recipe once a month  memorize more scripture  run a farm  move to Canada  go to Italy  The reward for conformity was that everyone liked you except yourself. wants to buy a laptop  Never stop learning  make a song  meditate  lose 15 pounds  create my own computer game  Lose 60 lbs  learn a Justin Timberlake dance  be more social  Leah wants to get a different job  Stop being angry at my ex  Read 20 books this summer  lose 50 lbs  aprender a dibujar Overcome Being Shy  Add album art to my MP3 files  Read more books  make an effort to be more social  Design and build my own house  Kyrandia wants to Stop trying to impress people  figure out what i want to do with my life  Change the way people view Christianity  Stress less  go to the beach  meditate every day  Increase my English vocabulary  Ride a horse wake up when my alarm clock goes off  create a computer game  become a great programmer  Keith Pitty wants to Become a better programmer  work as a flight attendant  create a list of 100 must-read books and read them.  Dye my hair black  watch "House Of Wax"  ~M.Ile Vanigliavvelenata~ wants to bake cookies  see jim gaffigan live  be happy with myself  take more photographs  Take a cooking class  touch my toes  watch free episodes of friends  Get a Nikon D70  learn to screamo scream  get my own apartment  write creatively  always be honest with everyone, including myself  make everyone visit my website! www.idiot-99.piczo.com  Design my own house  Design a virtual house with virtual people  learn kung fu  seg263 wants to laugh until it hurts at least once a day.  Attend a fashion show  fall...
Popular Goals in Los Angeles

Most popular goals here

1. stop procrastinating
2. write a book
3. lose weight
4. Fall in love
5. drink more water
6. Buy a House
7. Learn Spanish
8. see the northern lights
9. travel the world
10. get out of debt

Goals unique to here

1. spend a day exploring Los Angeles's subway system
2. take a train up the coast
3. write more articles for my website
4. exchange info on restaurants in LA
5. Write A TV Spec Script
6. get the hell out of los angeles
7. Get a job in academia
8. workout 3 to 5 times a week
9. continue to perform to an audience
10. go to the Getty Villa

The goal completion rate in Los Angeles is 36%
<table>
<thead>
<tr>
<th>Access the internet</th>
<th>Feed a child</th>
<th>Make a presentation</th>
<th>Raise the blinds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act as a security guard</td>
<td>Feed a pet cat</td>
<td>Make a shopping list</td>
<td></td>
</tr>
<tr>
<td>Answer the doorbell</td>
<td>Feed a dog</td>
<td>Make a tossed salad</td>
<td></td>
</tr>
<tr>
<td>Answer the phone</td>
<td>Feed infant</td>
<td>Make baby sleep</td>
<td></td>
</tr>
<tr>
<td>Apply band aid</td>
<td>Feed the fish</td>
<td>Make breakfast</td>
<td></td>
</tr>
<tr>
<td>Assist person standing up</td>
<td>Fetch a cold drink</td>
<td>Make coffee</td>
<td></td>
</tr>
<tr>
<td>Assist someone in walking</td>
<td>Fetch a ladder</td>
<td>Make fresh orange juice</td>
<td></td>
</tr>
<tr>
<td>Boil the milk</td>
<td>Fetch an object</td>
<td>Make hot dog</td>
<td></td>
</tr>
<tr>
<td>Buy from vending machine</td>
<td>Fill water in container</td>
<td>Make soup</td>
<td></td>
</tr>
<tr>
<td>Call 911</td>
<td>Find a person</td>
<td>Make sure children fed</td>
<td></td>
</tr>
<tr>
<td>Calm an infant</td>
<td>Find an object</td>
<td>Make tea</td>
<td></td>
</tr>
<tr>
<td>Change a baby diaper</td>
<td>Find out more information</td>
<td>Make toasted bread</td>
<td></td>
</tr>
<tr>
<td>Change a bulb</td>
<td>Find the time</td>
<td>Making omelette</td>
<td></td>
</tr>
<tr>
<td>Change bed sheets</td>
<td>Fold clothes</td>
<td>Move furniture</td>
<td></td>
</tr>
<tr>
<td>Charge a cell phone</td>
<td>Follow someone around</td>
<td>Mow the lawn</td>
<td></td>
</tr>
<tr>
<td>Check for intruders</td>
<td>Gather all scattered toys</td>
<td>Open a web page</td>
<td></td>
</tr>
<tr>
<td>Check for weather</td>
<td>Get food from refrigerator</td>
<td>Open a package</td>
<td></td>
</tr>
<tr>
<td>Check if a store is open</td>
<td>Get mail</td>
<td>Open the garage</td>
<td></td>
</tr>
<tr>
<td>Chop vegetables</td>
<td>Get the newspaper</td>
<td>Open the mail</td>
<td></td>
</tr>
<tr>
<td>Clean a spill</td>
<td>Give a medicine</td>
<td>Pack a mailing box</td>
<td></td>
</tr>
<tr>
<td>Clean the dishes</td>
<td>Give a message</td>
<td>Pack a suitcase</td>
<td></td>
</tr>
<tr>
<td>Clean the floor</td>
<td>Give a message on phone</td>
<td>Paint a wall</td>
<td></td>
</tr>
<tr>
<td>Clean the shower</td>
<td>Go outside</td>
<td>Pay bills</td>
<td></td>
</tr>
<tr>
<td>Clean the table</td>
<td>Greet a visitor</td>
<td>Perform research on spec</td>
<td></td>
</tr>
<tr>
<td>Clean up</td>
<td>Guard the house</td>
<td>Photocopy a paper</td>
<td></td>
</tr>
<tr>
<td>Clean up toys</td>
<td>Handle toxic materials</td>
<td>Pick up dishes</td>
<td></td>
</tr>
<tr>
<td>Close the blinds</td>
<td>Hang clothes</td>
<td>Place ladder near wall</td>
<td></td>
</tr>
<tr>
<td>Close the curtains</td>
<td>Heat food in microwave</td>
<td>Play a game on the comp</td>
<td></td>
</tr>
<tr>
<td>Cook fish</td>
<td>Heat food on kitchen gas</td>
<td>Play a movie</td>
<td></td>
</tr>
<tr>
<td>Cook noodle</td>
<td>Help someone carry thing</td>
<td>Play a song</td>
<td></td>
</tr>
<tr>
<td>Cook pasta</td>
<td>Iron clothes</td>
<td>Play piano</td>
<td></td>
</tr>
<tr>
<td>Cook rice</td>
<td>Keep the dog away</td>
<td>Plug an electric appliance</td>
<td></td>
</tr>
<tr>
<td>Dance with the children</td>
<td>Kick a ball</td>
<td>Trash an object</td>
<td></td>
</tr>
<tr>
<td>Do laundry</td>
<td>Load the dishwasher</td>
<td>Turn music system off</td>
<td></td>
</tr>
<tr>
<td>Draw the curtains</td>
<td>Lock up the house</td>
<td>Turn music system on</td>
<td></td>
</tr>
<tr>
<td>Dry clothes</td>
<td>Lock windows</td>
<td>Pour beer into a glass</td>
<td></td>
</tr>
<tr>
<td>Dust an object</td>
<td>Mail a letter</td>
<td>Push someone in a wheel</td>
<td></td>
</tr>
<tr>
<td>Empty the kitchen sink</td>
<td>Make a bed</td>
<td>Push something</td>
<td></td>
</tr>
<tr>
<td>Empty the trash</td>
<td>Make a dinner reservation</td>
<td>Put away groceries</td>
<td></td>
</tr>
<tr>
<td>Entertain children</td>
<td>Make a flight reservation</td>
<td>Put object away</td>
<td></td>
</tr>
<tr>
<td>Erase the whiteboard</td>
<td>Make a list</td>
<td>Put up a painting</td>
<td></td>
</tr>
</tbody>
</table>

Gupta and Kochenderfer 2006
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chop vegetables
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clean the dishes
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clean up toys
close the blinds
close the curtains
cook fish
cook noodle
cook pasta
cook rice
dance with the children
do laundry
draw the curtains
dry clothes
dust an object
empty the kitchen sink
empty the trash
entertain children
erase the whiteboard
feed a child
feed a pet cat
feed a pet dog
feed infant
feed the fish
fetch a cold drink
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fill water in container
find a person
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go outside
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handle toxic materials
hang clothes
heat food in microwave
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kick a ball
load the dish
lock up the
dedicate windows
mail a letter
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paint a wall
pay bills
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photocopy a paper
pick up dishes
place ladder near wall
play a game on the comp
play a movie
play a song
play piano
raise the blinds
read a story to a child
recharge batteries
remove and replace garbage
replace a refrigerator
replace a water tap filter
replace batteries in the
replace heater filter
retrieve a tool
secure all exits
secure all windows
secure the perimeter of
send a fax
send party invitations
serve a drink
serve a meal
set a wake up alarm
set the dining table
set up presentation
equipment
sharpen a pencil
shred paper
sing a song
sweep floor
take a photograph
take care of plants
take out the garbage
teach a song to a child
tell a story
throw an object
Welcome dustin!  5 accepted / 0 under review

People

Describe the activity of people in a home or office (e.g. People eat food when they are hungry)

People    when they    

Teach Open Mind!

Skip.

This doesn't make sense.
Welcome dustin!  5 accepted / 0 under review

Information

What is Open Mind Indoor Common Sense?

Browsing

Top Teachers - our top 100 list!
Past Winners - winners from the August 03 and February 04 contests
Random Sample - browse the knowledge people have entered
Database Statistics - how big is the database?

More Information

Learn More! - a collection of essays on Common Sense
Links - related web sites
E-Mail us - have any questions or issues? drop us a note!

For Researchers

Download - download our database!
Sunday To-Do

- Bathe Brandon
- Bathe Samantha
- Finish Laundry
- wash clothes for tomorrow
- pack baby bags
- Clean out car
- Print map
- print nanny forms
- Wash bedding
- set out breakfast
- move Brandon's dresser to
- sign forms
- clean bathroom ensuite
- vacuum
- load Bran's seat in Sebring
- photocopy insurance cards
- leave B's card with Keven
- finish letter to Ericka
- Put purse, nametag, sweaters
- burn new CDs
- Put away laundry
- wash Sam's laundry
- pick up laundry from Bedrooms
- sort laundry
- wash out clothes for Brandon
- To Do List
  - Pay Credit Card Bills
  - Post cards to Reecie
  - Print Black Luke
  - Feed fruit & Vegetables
  - Toiletries from Ross's Health Shop
  - Credit for plane - text study
  - UI Work - lots of
  - Finish book & Post to Lissa:
  - Clean kitchen before 4pm
  - Shower & Shawl
  - go out. Buy trout ticket?

- go art gallery
- buy cosmetics bottles
- make an umburellor bag
- go to gym /swimming
- go best buy
- keep 4 hours eat schedule
- sending sound file to work
- one
in(kitchen,Joan)
holding(Joan,cup)
possesses(Joan,cup)
cabinet(open)
unwatered(plant)

in(kitchen,Joan)
at(sink,Joan)
on(sink)
under(cup,sink)
into(water,sink,cup) ...

at(plant,Joan)
has(Joan,cup)
owns(Joan,plant)
watered(plant)
Joan grabs a cup.

She fills it with water.

She pours the water on her plant.
Joan grabs a cup.

She fills it with water.

She pours the water on her plant.
find water container.
fill with water.
go to the plant.
put some water in plant pot.
put water container back.

fill bucket with water.
go to plant.
poor water on plants.
repeat for all plants.
refill bucket if needed

remove watering pitcher from storage.
turn on water.
fill pitcher with water.
turn off water.
position pitcher over plants.
empty water onto plants.
return pitcher to storage

fill watering can with water.
pour water into pots until soil is saturated.

get water.
pour onto plant.

fill container with water.
add water to plants.
find water container.
fill with water.
go to the plant.
put some water in plant pot.
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fill watering can with water.
pour water into pots until soil is saturated.

get water.
pour onto plant.

fill container with water.
add water to plants.
“water indoor plants”

find water container.  
fill with water.  
go to the plant.  
put some water in plant pot.  
put water container back.  

find bucket with water.  
go to plant.  
poor water on plants.  
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pour onto plant.

fill container with water.
add water to plants.
find water container.
fill with water.
go to the plant.

**put some water in plant pot.**
put water container back.

fill bucket with water.
go to plant.
poor water on plants.
repeat for all plants.
refill bucket if needed

remove watering pitcher from storage.
turn on water.
fill pitcher with water.
turn off water.

**position pitcher over plants.**
empty water onto plants.
return pitcher to storage

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fill container with water.
add water to plants.
“water indoor plants”

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pour water into pots until soil is saturated.

get water.
pour onto plant.

fill container with water.
add water to plants.

P6: Plan divergence
(two different plans)
Actions from incomplete data

• Bi-directional mapping between events and language. Specifically: Mapping imperative sentences to action representations.

• No mind melding. Explanations and interpretations are influenced by communication goals.

• Lots of ways to dice up an event experience into a sequence of words. Language allows us to emphasize the relevant portions of an event.
Plan sources
Q1. How well do these plans cover peoples’ goals?

- Only 16,644, ~1.7%, of the eHow/WikiHow plans were found in 43things. But adjusting for pronouns (“clean your kitchen” / “clean my kitchen”) will improve coverage.

<table>
<thead>
<tr>
<th>WikiHow Page Visits</th>
<th>43Things User Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,080,708</td>
<td>lose weight</td>
</tr>
<tr>
<td>8,200,383</td>
<td>stop procrastinating</td>
</tr>
<tr>
<td>6,334,345</td>
<td>stop procrastinating!</td>
</tr>
<tr>
<td>6,004,720</td>
<td>write a book</td>
</tr>
<tr>
<td>5,441,880</td>
<td>fall in love</td>
</tr>
<tr>
<td>4,762,829</td>
<td>be happy</td>
</tr>
<tr>
<td>4,716,982</td>
<td>drink more water</td>
</tr>
<tr>
<td>4,696,644</td>
<td>learn spanish</td>
</tr>
<tr>
<td>4,360,939</td>
<td>save money</td>
</tr>
<tr>
<td>4,047,025</td>
<td>make new friends</td>
</tr>
<tr>
<td>3,549,807</td>
<td>buy a house</td>
</tr>
<tr>
<td>3,187,506</td>
<td>get a job</td>
</tr>
<tr>
<td>3,137,700</td>
<td>run a marathon</td>
</tr>
<tr>
<td>3,075,346</td>
<td>learn french</td>
</tr>
<tr>
<td>2,998,996</td>
<td>get out of debt</td>
</tr>
</tbody>
</table>

Tuesday, March 1, 2011
Most frequent first words
Entity resolution

Search results
"buy a home"

Goals matching "buy a home"
1 through 25 (out of 75024) I next page →
1. buy a home 1036 people
2. buy a vacation home 53 people
3. Buy my own home 281 people
4. buy my home 4 people
5. buy home 7 people
6. Buy my first home 124 people
7. buy our own home 7 people
8. buy a home for myself 1 person
9. Buy an Home theater for my home 1 person
10. Buy a home of our own 1 person
11. buy a home of my own 2 people
12. Buy our home 2 people
13. buy and own my own home 1 person
14. buy own home 3 people
15. buy a home / own a home 1 person

Search for "how to buy a house", showing results 1 through 30
How to Buy a House
How to Buy a House Using a Lease Option
How to Buy a House in the UK
How to Flip a House
How to Buy a House With Friends
How to Find Your Ideal House
How to Research the History of Your House
How to Sell Your House Using a Lease Option
How to Finance a Fixer Upper House With an FHA 203(K) Program ...
How to Sell Your Own House
Read something fun. This is "you" time, so use it to read something interesting - a book, a magazine, instruction manual, whatever.

Play a game or do a puzzle. Sudoku, solitaire, and crossword puzzles or all one-person activities, so it's better that there's no one to distract you anyway.

Do origami. If you can't make a swan, at least try folding a fan.

Create the best music playlist ever. Then come up with other "best ever" lists, like "best movies ever", "best pets ever", "best books ever", and so on.

Start writing your memoirs. Call it what you want - diary writing, journaling, or memoir writing - it's always cool to have a record of your thoughts and daily activities. You never know: Years from now what you're reading might be what someone reads during his lunch period!

Draw your own map of the world. Invent names for new countries, like Boredoutofmyheadistan and Someonecomesitwithmenya.

Instead of writing a private one, like Lizard the Saurus utens or what othername...
About these problems

They come down to an important distinction: are they \textbf{adding new information} to a partial description \textit{or} are they are mentioning a different event?

\textbf{Approach:} If two descriptions are refer to the same entity (an action) then replace both with the combined sum of their information. Use lexical generalization structures when possible in place of disjunctions.
Match Goals, Align Steps

- Goal-based: Goal string subsequence search.
- Plan-based: Pairwise global relational sequence alignment of plan steps.
String subsequence

1. Find subsequences in goal names.
String subsequence

1. Find subsequences in goal names.

31% of (first 20,000) goals appeared in subsequence. But some false positives:
Backgrounded Goals:

- Joe wants to “lose 40 pounds”
Backgrounded Goals:

- Joe wants to “lose 40 pounds”
- A binary classifier on world states:
Backgrounded Goals:

- Joe wants to “lose 40 pounds”
- A binary classifier on world states:

  - Joe has lost fewer than 40 lbs.
  - Joe has lost 40 lbs.
  - Joe has lost his legs.
  - Joe is deathly ill

References:
- Cohen and Levesque 1990
- Doyle 1999
- Bratman 1990
Sequence alignment

- Goal-based: Goal string subsequence search.
- Plan-based: Pairwise global relational sequence alignment of plan steps.

ATGGCGGT
*** !**
ATG–AGT
Sequence alignment

- Goal-based: Goal string subsequence search.
- Plan-based: Pairwise global relational sequence alignment of plan steps.

- get(mail) get(letter)
- open(box) open(mailbox)
- close(door) shut(door)
- return(home) go(inside)
Relational sequence alignment

- Relational (e.g. FOL), instead of propositional, descriptions of states.

  **Predicates/arity:** $vi/2$, $cd/1$, $ls/0$, $pdfview/2$

  **Ground atoms** -- predicates with non-variable terms:

    $vi(ch2, tex)$

  **Ground clauses:**

| 1:  | $vi(ch2, tex)$ $ls$ | latex($ch2, tex$) $xdvi(ch2, dvi)$ $dvipdf(ch2, dvi)$ $pdfview(ch2, pdf)$ |
| 2:  | $cd(thesis)$ $vi(ch1, tex)$ $bibtex(ch1)$ latex($ch1, tex$) $xdvi(ch1, dvi)$ $dvipdf(ch1, dvi)$ $pdfview(ch1, pdf)$ |
| 3:  | $-$ $-$ latex($ch2, tex$) $xdvi(pap2, dvi)$ $dvipdf(pap2, dvi)$ $pdfview(pap2, pdf)$ |
| 4:  | $cd(pap1)$ $-$ $-$ $vi(pap1, tex)$ latex($pap1, tex$) $dvipdf(pap1, dvi)$ $pdfview(pap1, pdf)$ |
| 5:  | $-$ $vi(rsl, tex)$ $latex(rsl, tex)$ $dvips(rsl, dvi)$ $-$ |

  **Generalized Clauses** (with variables):

  $$cd(X), \ vi(Y, \ tex), \ latex(Y, \ tex)$$

  Karwath and Kersting 2006
Relational substitution score

- Jiang & Conrath generalization similarity metric

\[
\text{rel}_{jcn}(c_1, c_2) \triangleq IC(c_1) + IC(c_2) - 2 \star \max_{c \in \text{LCS}(c_1, c_2)} (\text{IC}(c))
\]

The distance \(d_\wedge\) can now be defined in terms of the generality ordering \(\mathcal{L}, \preceq\) and size function \(|\cdot|\):

\[
\forall x, y \in \mathcal{L} : d_\wedge(x, y) = |x| + |y| - 2|m_{\text{gg}}(x, y)|
\]  

(7)

Jiang and Conrath 2001

De Raedt and Ramon 2009

Tuesday, March 1, 2011
get(letter)  open(container)  shut(door)  go(inside)

get(mail)  open(box)  close(door)  return(home)

get(communication.n)  open(container.n.01)  close.v.02(door)  travel.v.01(location.n.01)
Event Properties

Events represent changes over structured representations.

- **Ingredients**: agents, objects, their relations and properties
- **Preconditions** (or previous states using transitions)
- **Effects** (or next states using transitions)
- **Time**: average duration. Recurring? duration?
- **Costs-benefits**: are the effect beneficial and to whom?
- **Plan-theoretic**: reversible? resource dependencies?
Event-Event Relations

- **Taxonomic**: inheritance
- **Composition**: part-of
- **Temporal**: successor, causative
- **Plan-theoretic**: enables, clobbers-subgoal, ...
Relevant work

- Event ingredients
  
  Jung, Ryu, Kim, Mayeng 2010

- Durations of events
  
  - verb+obj pairs from search queries
    
    A. Gusev et al 2011
  
  - Annotated corpus
    
    Pang, Mulkar, Hobbs 2006

- Temporal Relations
  
  - sequences of verb + subject pairs
    
    Chambers and Jurafsky, 2008; 2009

- Event compositions
  
  - Classifying wholes from parts
    
    Mulkar-Mehta, Hobbs, Hovav 2011
Calendars with common sense?
Calendars with common sense?

Example: Dinner with Michael 7pm tomorrow

27 28 1 2 3 4 5
6 7 8 9 10 11 12

My calendars
dustinarthursmith@gm... Software Agents
Tasks
Add | Settings

Other calendars

Added dinner with ICT on Sat 2011-02-26 at 8am.
- Easy. Already existing examples:

Calendar and to-do entries tell us exactly what the user plans to do.

- dinner with Joe tomorrow
- buy milk

where? when? for how long?
what? why?
- Easy. Already existing examples:

where? when? for how long?

what? why?

Calendar and to-do entries tell us exactly what the user plans to do.

dinner with Joe tomorrow

buy milk
- Easy. Already existing examples:

  - Where?
  - When?
  - For how long?
  - What?
  - Why?

Examples:

- Dinner with Joe tomorrow
- Buy milk

Calendar and to-do entries tell us exactly what the user plans to do.
- Easy. Already existing examples:
  where?
  when?
  for how long?
  what?
  why?

Example: dinner with Joe tomorrow
Example: buy milk

Calendar and to-do entries tell us exactly what the user plans to do.
- Easy. Already existing examples:

where?
when?
for how long?
what?
why?

dinner with Joe tomorrow
buy milk

Calendar and to-do entries tell us exactly what the user plans to do.

Sterling Properties
875 Massachusetts Avenue
Details

Atlantis Real Estate
844 Massachusetts Avenue
Details

Sander Real Estate
277 Harvard Street
Details

Todo List

- mail the card
- buy a card
- clean shirt
- drop off clothing
- pick up clothing
- buy house
- see realtor
That looks heavy, let me lift it for you