



# A Big-Brother Revolution with Virtual Assistants

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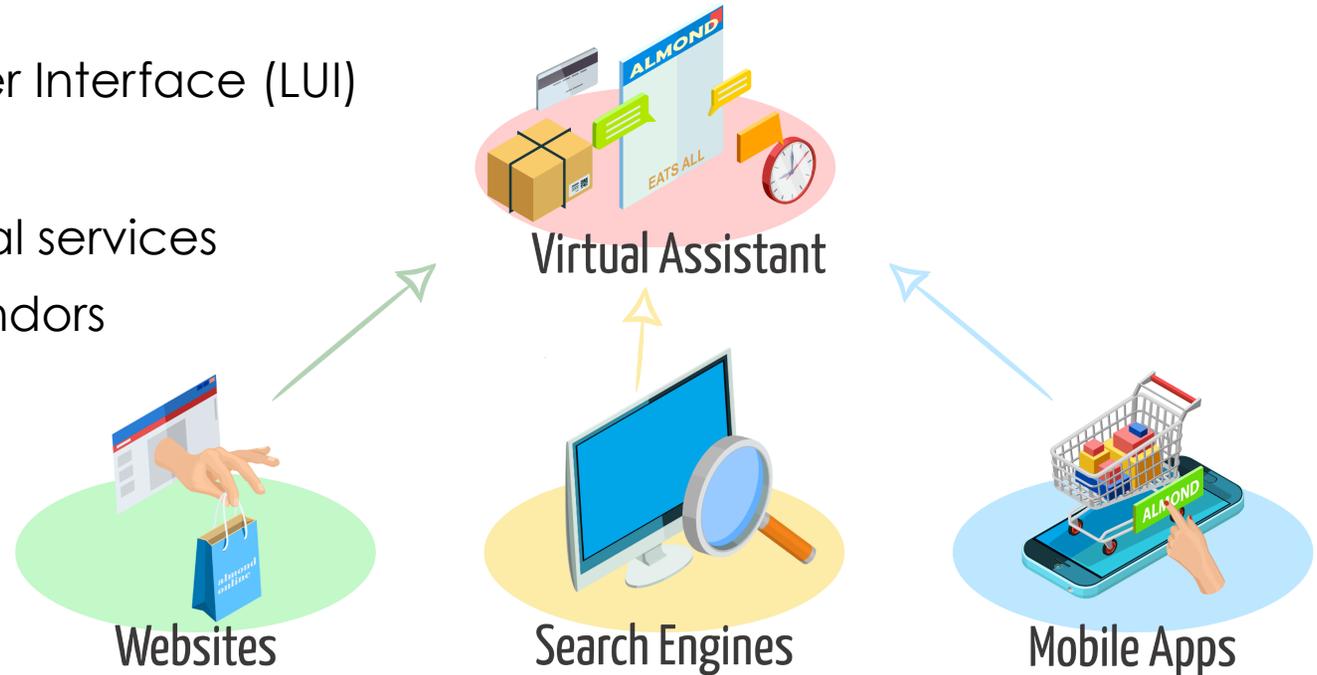
With Giovanni Campagna, Michael Fischer, Mehrad Moradshahi, Rakesh Ramesh, Richard Socher, Silei Xu, Richard Yang  
Sponsors: Hitachi, UST Global

# Big-Brother Problem

- **Consumers: Data Privacy**
  - Facebook owns and sells 2-billion people's personal data
  - Cambridge Analytica incident
  - Big tech backlash
- **Unhealthy industrial ecosystem: Platform monopolies/duopolies**
  - Google and Apple app stores: 30% revenues
  - Google and Facebook: 60% digital marketing revenues
    - Newspaper ad revenues: \$50B (2006) → \$18B (2016)

# Biggest Brother: Virtual Assistants

Personal, Linguistic User Interface (LUI)  
Sees all personal info  
Intermediates all digital services  
Controls choice of vendors



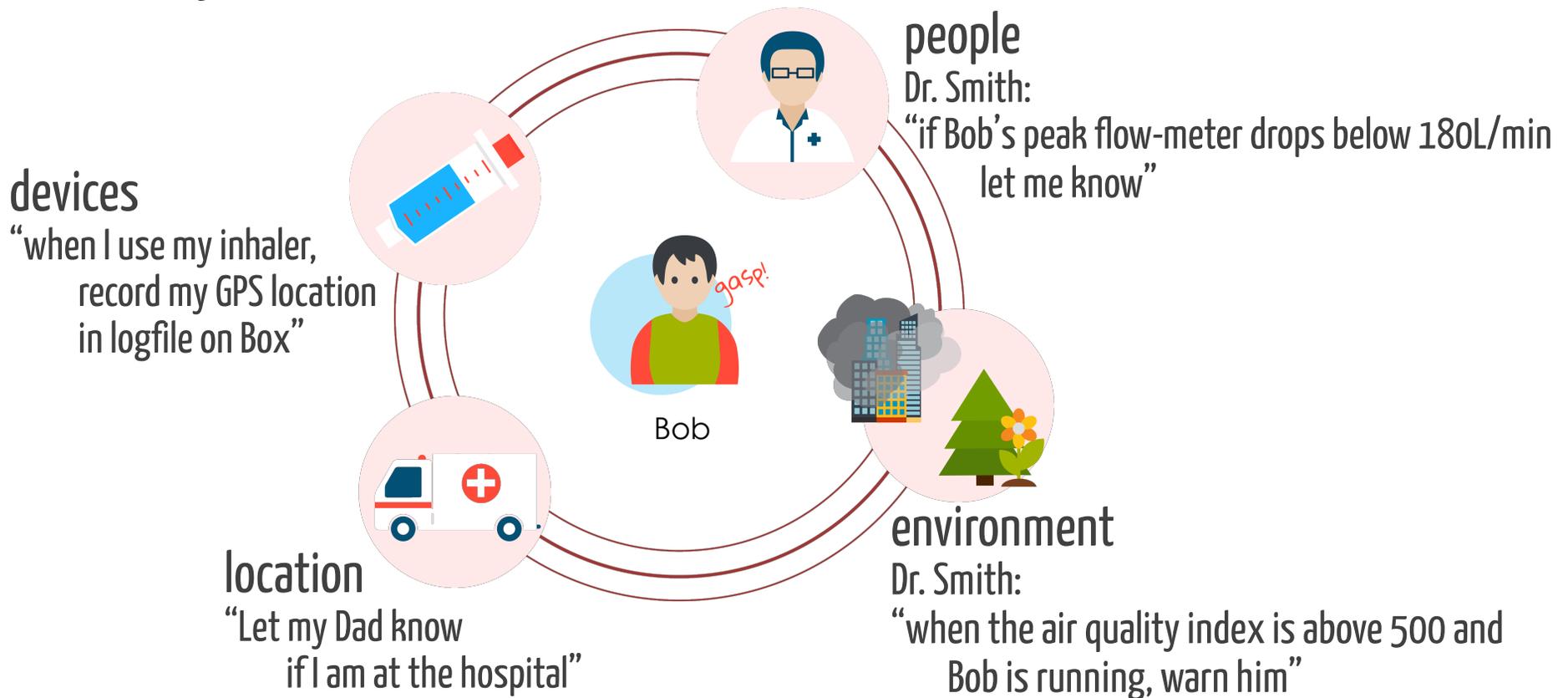
**Amazon, Facebook, Google combined**

# Make Virtual Assistants our Ally

Privacy	Open-source decentralized virtual assistants	Almond
Non-Proprietary	Open, crowdsourced skill repository	Thingpedia
Expressiveness	Open LUI technology & training data	LUInet

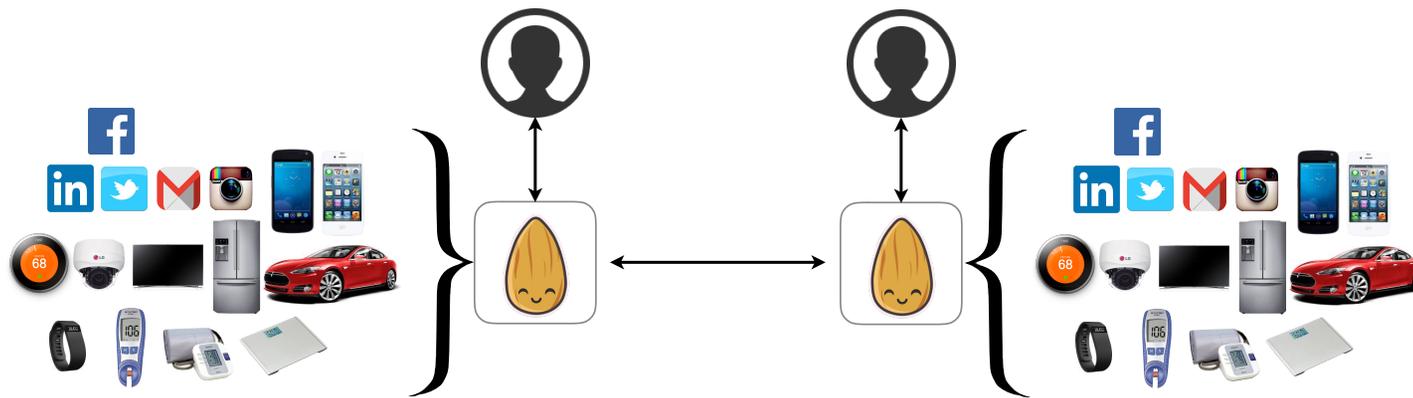
Giovanni, Ramesh, Xu, Fischer, Lam, WWW 2017

# Example: Asthma Patient





# Almond: Open-Source Decentralized Virtual Assistant



- Available as a demo web service/android app
- Decentralized: multiple vendors; personal devices
- Runs complex commands
- Supports sharing with inter-virtual assistant communication

# Thingpedia: Encyclopedia of Things

- Easy to enter primitive skills in Thingpedia
  - Usable in compound commands
  - API signatures, not just intent dispatches
- Open repository
  - Available to Alexa, Google Assistant, ...



50 devices + 200 functions

	Natural Language	Code
<b>WHEN</b>	@Stanford tweets	Monitor (@home_timeline(), ...) author=="Stanford"
<b>GET</b>	tweets matching "#Cardinal"	search(...), contains (hashtag, ...)
<b>DO</b>	tweet "Stanford won!"	post (status)

## ALMOND

### Examples

Tweet the latest NASA Astronomy Picture of the Day  
Auto reply to my emails  
Set my phone to vibrate every day at 9 am  
Turn on my TV if there is a person in the room  
Translate Washington Post headlines to "Chinese"  
Post my new Instagram pictures on Twitter  
get a snapshot from my security camera every hour  
Play some video from YouTube on my TV  
Send me a daily cat picture

### Almond Bike Market

WHEN: monitor second hand bike posts  
WHEN: monitor bike posts of brand \_\_  
WHEN: monitor bikes for \_\_  
GET: search second hand bikes  
GET: search bike posts of brand \_\_  
GET: search bikes for \_\_  
DO: post on almond bike market  
DO: post a bike for \_\_ dollars on almond bike market

### Almond Dates

WHEN: monitor date posts on almond dates  
WHEN: monitor date posts about \_\_  
GET: search partners on almond dates  
GET: search \_\_ partners  
DO: post on almond dates  
DO: post on almond dates to find partners for \_\_

### Bing Search

GET: search \_\_ on bing  
GET: search \_\_ images on bing  
GET: search images matching \_\_ with size \_\_ x \_\_ on bing

### Bluetooth Speaker

DO: set my speaker as default  
DO: play music on my speaker  
DO: increase volume on my speaker  
DO: decrease volume on my speaker  
DO: set volume on my speaker to \_\_%

### BodyTrace Scale

WHEN: my weight updates

### Dropbox

GET: my dropbox quota  
GET: file list in folder \_\_ on dropbox  
GET: file named \_\_ on dropbox  
DO: move file \_\_ to \_\_ in dropbox  
DO: rename file \_\_ in dropbox  
DO: create a folder with name \_\_ in my dropbox

### Facebook

DO: post on facebook saying \_\_  
DO: post a picture on facebook  
DO: post a picture on facebook with caption \_\_

### Giphy

GET: a nanDom gif from giphy  
GET: a gif with tag \_\_ from giphy

### GitHub

WHEN: a new issue opened in github repository \_\_  
WHEN: \_\_ opens an issue on github  
WHEN: user \_\_ opens an issue in github repository \_\_  
WHEN: there is a new commit for github repository \_\_  
WHEN: user \_\_ commits in github repository \_\_  
WHEN: a new milestone is created in github repository \_\_  
WHEN: user \_\_ create a new milestone in github repository \_\_

WHEN: there is a new comment in github repository \_\_  
WHEN: user \_\_ comments on some issue in repository \_\_  
WHEN: there is a new comment on issue \_\_ in repository \_\_  
DO: add email \_\_ to my github account  
DO: comment on issue \_\_ in github repository \_\_

### Gmail

WHEN: receive an email on gmail  
WHEN: receive an email from \_\_ on gmail  
WHEN: receive an email marked as important  
WHEN: receive an email marked as important from \_\_  
WHEN: receive an email in category primary  
WHEN: receive an email from \_\_ in category primary  
GET: the latest email  
GET: the latest email with label \_\_  
GET: the latest email from \_\_  
GET: the latest email with subject \_\_  
DO: send an email to \_\_ with subject \_\_ with message \_\_  
DO: send a picture to \_\_ with subject \_\_

### Google Drive

WHEN: a new file or folder is created on google drive  
DO: create a new file with name \_\_ on google drive

### Holidays Calendar

WHEN: it's a holiday in the uk  
WHEN: it's a holiday in the us  
GET: the next uk holiday  
GET: the next us holiday

### iCalendar Events

WHEN: an event on my calendar begins  
WHEN: an event on my calendar at location \_\_ begins  
WHEN: an event on my calendar organized by \_\_ begins  
GET: list my calendar events  
GET: my calendar events organized by \_\_  
GET: my calendar events at \_\_

### Imgflip Meme Generator

GET: all meme templates  
GET: meme template named \_\_  
GET: generate meme on template \_\_ with text \_\_ at the top and text \_\_ at the bottom

### Instagram

WHEN: i upload a picture on instagram  
WHEN: i upload a picture with filter \_\_ on instagram  
GET: my recent instagram pictures  
GET: \_\_ many recent instagram pictures  
GET: my instagram pictures with filter \_\_

### Jawbone UP

WHEN: my steps on activity tracker updates  
WHEN: i walked for \_\_ steps  
WHEN: i walked for \_\_ distance  
WHEN: my weight updates on my fitness tracker  
WHEN: my weight is \_\_ on my fitness tracker  
WHEN: my bmi is \_\_ on my fitness tracker  
WHEN: my body fat is \_\_ on my fitness tracker  
WHEN: my heart rate updates  
WHEN: my heart rate is \_\_  
WHEN: my sleep status updates on my sleep tracker  
WHEN: i sleep for \_\_ time

### LG WebOS TV

DO: turn \_\_ my lg tv  
DO: raise the volume of my lg tv  
DO: lower the volume of my lg tv  
DO: set the volume of my lg tv to \_\_  
DO: mute my lg tv

DO: unmute my lg tv  
DO: play link \_\_ on my lg tv

### LinkedIn

GET: my linkedin profile  
DO: post \_\_ on linkedin

### Miscellaneous Interfaces

WHEN: it's \_\_ o'clock every day  
GET: current time  
GET: current date  
GET: give me a random number  
GET: give me a random number between \_\_ and \_\_  
DO: debug log \_\_  
DO: send me a message \_\_

### NASA Daily

WHEN: an asteroid passes close to earth  
GET: nasa's astronomy picture of the day  
GET: a picture from curiosity rover  
GET: \_\_ many pictures from curiosity rover  
GET: a picture from curiosity rover taken on \_\_

### Nest

WHEN: the temperature on my thermostat updates  
WHEN: the humidity on my thermostat updates  
WHEN: there is a new event detected on my security camera  
WHEN: my security camera detects something and has person is \_\_  
WHEN: my security camera detects something and has motion is \_\_  
WHEN: my security camera detects something and has sound is \_\_  
GET: the temperature on my thermostat  
GET: the humidity on my thermostat  
GET: the state of my hvac  
GET: my security camera live feed  
GET: me a snapshot of my security camera  
DO: set temperature to \_\_ on my thermostat  
DO: set my temperature between \_\_ and \_\_ on my thermostat  
DO: set my hvac to \_\_  
DO: turn \_\_ my security camera

### Omlet

WHEN: i receive a message on omlet  
WHEN: i receive a message on omlet in feed \_\_  
WHEN: i receive a \_\_ message on omlet  
DO: send an omlet to \_\_ saying \_\_  
DO: send a picture on omlet to \_\_ with caption \_\_

### OneDrive

WHEN: a new file is created on onedrive  
WHEN: a file is modified on onedrive  
WHEN: file \_\_ on onedrive is modified  
DO: create a new file on onedrive named \_\_ containing \_\_  
DO: delete \_\_ from my onedrive  
DO: rename \_\_ to \_\_ on my onedrive  
DO: upload a picture to onedrive with name \_\_

### Parklon Iris Warm Water Mat

DO: turn \_\_ my heatpad  
DO: turn \_\_ my parklon heatpad

### PHD Comics

WHEN: there is a new post on phd comics

### Philips Hue

DO: turn \_\_ my lightbulb  
DO: disco lights  
DO: flash the lightbulb

### Phone Companion

WHEN: my location changes  
WHEN: i receive a sms

WHEN: i receive a sms from \_\_  
DO: show a popup with title \_\_ and body \_\_  
DO: send an sms to \_\_ saying \_\_  
DO: set my phone to \_\_  
DO: call number \_\_  
DO: call 911

### Reddit Frontpage

WHEN: reddit front page updates  
WHEN: a new post in category \_\_ reaches reddit front page  
WHEN: a new post from user \_\_ reaches reddit front page

### RSS Feed

WHEN: there is a new post on rss feed

### Slack

WHEN: i receive a message on slack  
WHEN: i receive a message from \_\_ on slack  
WHEN: i receive a message in channel \_\_ on slack  
DO: send a message on slack to \_\_ saying \_\_  
DO: set the purpose for channel \_\_ to \_\_ on slack  
DO: set the topic for channel \_\_ to \_\_ on slack  
DO: set me as \_\_ on slack  
DO: send a picture on slack to \_\_ saying \_\_

### SportRadar

WHEN: nba team \_\_ plays  
WHEN: nba team \_\_ plays against \_\_  
WHEN: nba team \_\_ plays and the game is \_\_  
WHEN: nba team \_\_ a game  
WHEN: eu soccer team \_\_ plays  
WHEN: eu soccer team \_\_ plays against \_\_  
WHEN: eu soccer team \_\_ plays and the game is \_\_  
WHEN: eu soccer team \_\_ a game  
WHEN: us soccer team \_\_ plays  
WHEN: us soccer team \_\_ plays against \_\_  
WHEN: us soccer team \_\_ plays and the game is \_\_  
WHEN: us soccer team \_\_ a game  
WHEN: monitor us soccer games of tournament \_\_  
WHEN: monitor us soccer games of tournament \_\_  
WHEN: mlb team \_\_ plays  
WHEN: mlb team \_\_ plays against \_\_  
WHEN: mlb team \_\_ plays and the game is \_\_  
WHEN: mlb team \_\_ a game .  
WHEN: ncaa mens basketball team \_\_ plays  
WHEN: ncaa mens basketball team \_\_ plays against \_\_  
WHEN: ncaa mens basketball team \_\_ plays and the game is \_\_  
WHEN: ncaa mens basketball team \_\_ a game .  
WHEN: ncaaf team \_\_ plays  
WHEN: ncaaf team \_\_ plays against \_\_  
WHEN: ncaaf team \_\_ plays and the game is \_\_  
WHEN: ncaaf team \_\_ a game

### The Cat API

GET: a cat picture  
GET: \_\_ many cat pictures

### The Wall Street Journal

WHEN: there is a new article in wsj opinions section  
WHEN: there is a new article in wsj world news section  
WHEN: there is a new article in wsj us business section  
WHEN: there is a new article in wsj market news section  
WHEN: there is a new article in wsj technology section  
WHEN: there is a new article in wsj lifestyle section

### The Washington Post

WHEN: there is a new article in washington post \_\_ section  
WHEN: there is a new blog post in washington post \_\_ blog

### Tumblr

WHEN: there is a new post in blog \_\_ on tumblr

WHEN: there is a new picture uploaded in blog \_\_ on tumblr  
DO: post on tumblr with title \_\_ and body \_\_  
DO: post \_\_ on tumblr  
DO: post a picture with caption \_\_ on tumblr

### Twitter

WHEN: someone i follow tweets  
WHEN: user \_\_ tweets  
WHEN: someone replies to user \_\_ on twitter  
WHEN: i receive a direct message on twitter  
WHEN: i receive a direct message from \_\_ on twitter  
WHEN: i tweet  
WHEN: i reply to \_\_ on twitter  
GET: search for \_\_ on twitter  
GET: \_\_ many recent tweets matching \_\_  
GET: recent tweets from \_\_  
GET: recent tweets from \_\_ matching \_\_  
GET: recent tweets in reply to \_\_  
GET: search for tweets with hashtag \_\_ on twitter  
GET: \_\_ many recent tweets with hashtag \_\_  
GET: tweets from \_\_ with hashtag \_\_  
GET: tweets with hashtag \_\_ in reply to \_\_  
DO: tweet \_\_  
DO: send a dm on twitter to \_\_ saying \_\_  
DO: tweet a picture with caption \_\_  
DO: follow user \_\_ on twitter  
DO: unfollow user \_\_ on twitter

### Uber

GET: time estimate for uber  
GET: give me a price estimate for uber from \_\_ to \_\_

### Weather

WHEN: it's \_\_ at location \_\_  
WHEN: monitor weather at \_\_  
GET: sunrise and sunset for location \_\_  
GET: sunrise and sunset for location \_\_ on date \_\_  
GET: moon phase for location \_\_  
GET: moon phase for location \_\_ on date \_\_  
GET: the weather in \_\_

### XKCD

WHEN: a new xkcd is out  
WHEN: a new xkcd is out in the what-if section  
GET: the latest xkcd  
GET: the xkcd number \_\_  
GET: a random xkcd

### Yahoo Finance

WHEN: the stock price of \_\_ changes  
WHEN: stock dividends for \_\_ changes

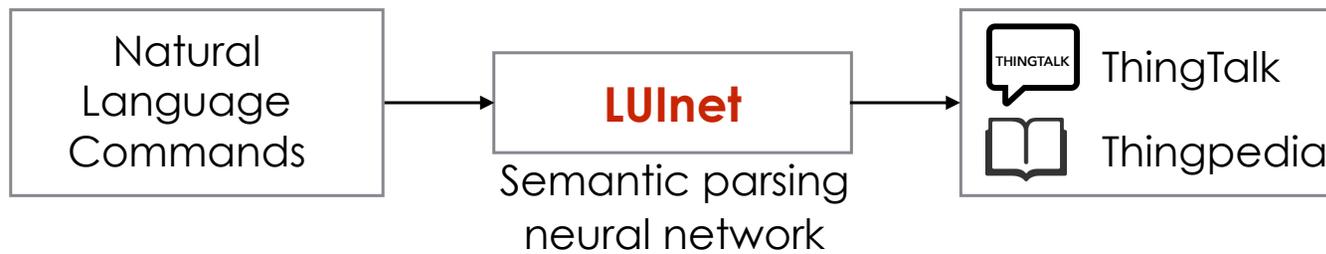
### Yandex Translate

GET: translate \_\_ to \_\_ with yandex  
GET: translate \_\_ from \_\_ to \_\_ with yandex  
GET: translate \_\_  
GET: translate something to \_\_  
GET: translate with yandex from \_\_ to \_\_  
GET: detect the language of \_\_

### Youtube

WHEN: there is a new video from youtube channels i follow  
WHEN: there is a new video from youtube channel \_\_  
GET: list channels in category \_\_ on youtube  
GET: list channels i am subscribed to on youtube  
GET: search \_\_ channels on youtube  
GET: search a \_\_ video on youtube  
GET: search a video from \_\_ matching \_\_ on youtube  
GET: search \_\_ many videos matching \_\_ on youtube

# LUInet: A Neural Network for LUIs



“When I use my inhaler,  
get my GPS location, if it is not home,  
write it to logfile in Box.”

- Event-driven program
- Multiple function calls
- Parameter passing
- Filters on values

```
monitor @Inhaler-use(),  
=> @GPS(), location <> “home”  
=> @Box-write(file=“logfile”, data=location)
```

```
WHEN [FILTERS]  
=> GET [FILTERS]  
=> DO
```



# ThingTalk Compound Statement

**WHEN** [FILTERS] → **GET** [FILTERS] → **DO**

**FILTERS:** =, <, >, <=, >=, <>, contains, starts with, ends with

When I use my inhaler, get my location, save them to Dropbox

If I get taken to a hospital, let my dad know.

When the air quality index is above 500, and I am running, send me an SMS.

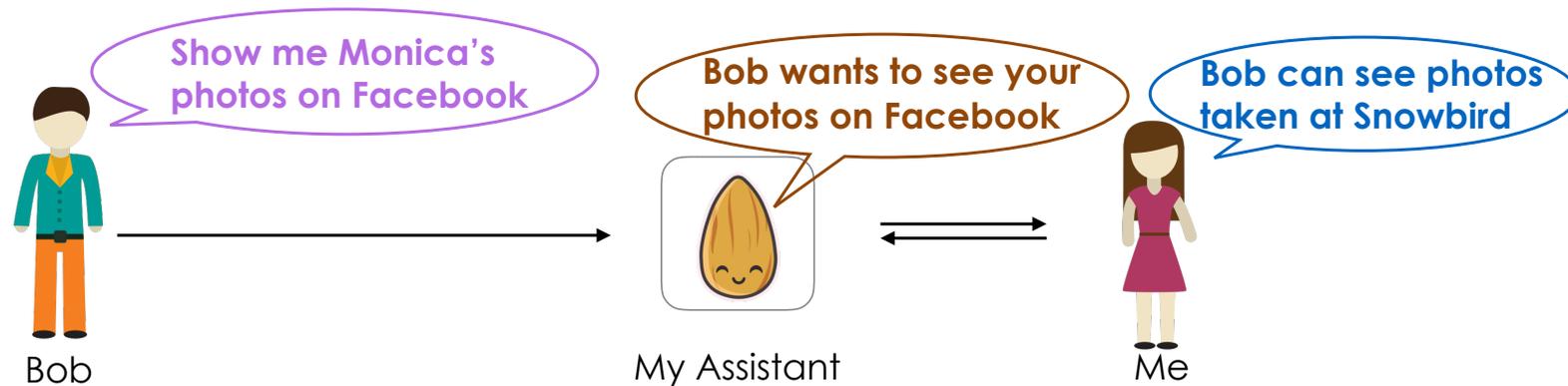
# LUInet

- World of digital interfaces and how they can be composed in NL
  - Consumers:  
long tail of functions, without relying on programmers
  - Corporate: work flows with confidential APIs
- Key technology: semantic parsing with compositionality
  - Feasibility demonstrated by preliminary deep learning models
  - Need usage data and research to improve accuracy

# Sharing is Broken Today

- Hard to share
  - Users give up ownership and privacy
  - Limited flexibility of access control
- LUI net + Almond: flexibility and privacy

# Fine-Grained Sharing with Privacy



Owner assistant performs tasks on behalf of requester,  
subject to approval of the owner

# Access Control: an Extension of ThingTalk

Requester:



GET-PREDICATE [FILTERS]



WHEN [FILTERS] → GET [FILTERS] → DO

FILTERS: =, <, >, <>, <=. >=, contains, starts with, ends with

Let Dr. Smith, monitor my peak-flow-meter, if it drops below 180L/min

Let my father, monitor my security camera for motion, only if I'm not home.

Let my accountant get my monthly statements

Let my daughter, from 6-8pm, watch Netflix

Let my boyfriend, get pictures from my dropbox, taken on Feb 14, and post them on Facebook

# Do Consumers Need Access Control?

**Role-Based Permission** ■

■ **Attribute-Based Permission**

Teenage daughter to use credit card



With a \$20 budget limit  
For restaurants only

Amazon courier to unlock door



If the package is over \$1000  
If your security camera is on

Friends to access cloud drive



Photos with their faces in them  
Photos in a specific folder

Parent/kid to see security cameras



If you are not at home  
Cameras facing the front yard/garage

10-year-old kid to use Netflix



Between 7 PM to 9 PM  
Free G or PG rated movies

0% 100%

% People comfortable in giving permission (200 person survey)

# A Research Agenda Proposal :

## Open-Source Decentralized Virtual Assistants

Privacy	Open-source decentralized infrastructure	Almond
Openness	Non-proprietary, crowdsourced skill repository	Thingpedia
Expressiveness	LUI technology & dataset in open domain	LUInet

**Put Users in the Driver Seat**