Functional Object-Oriented Network

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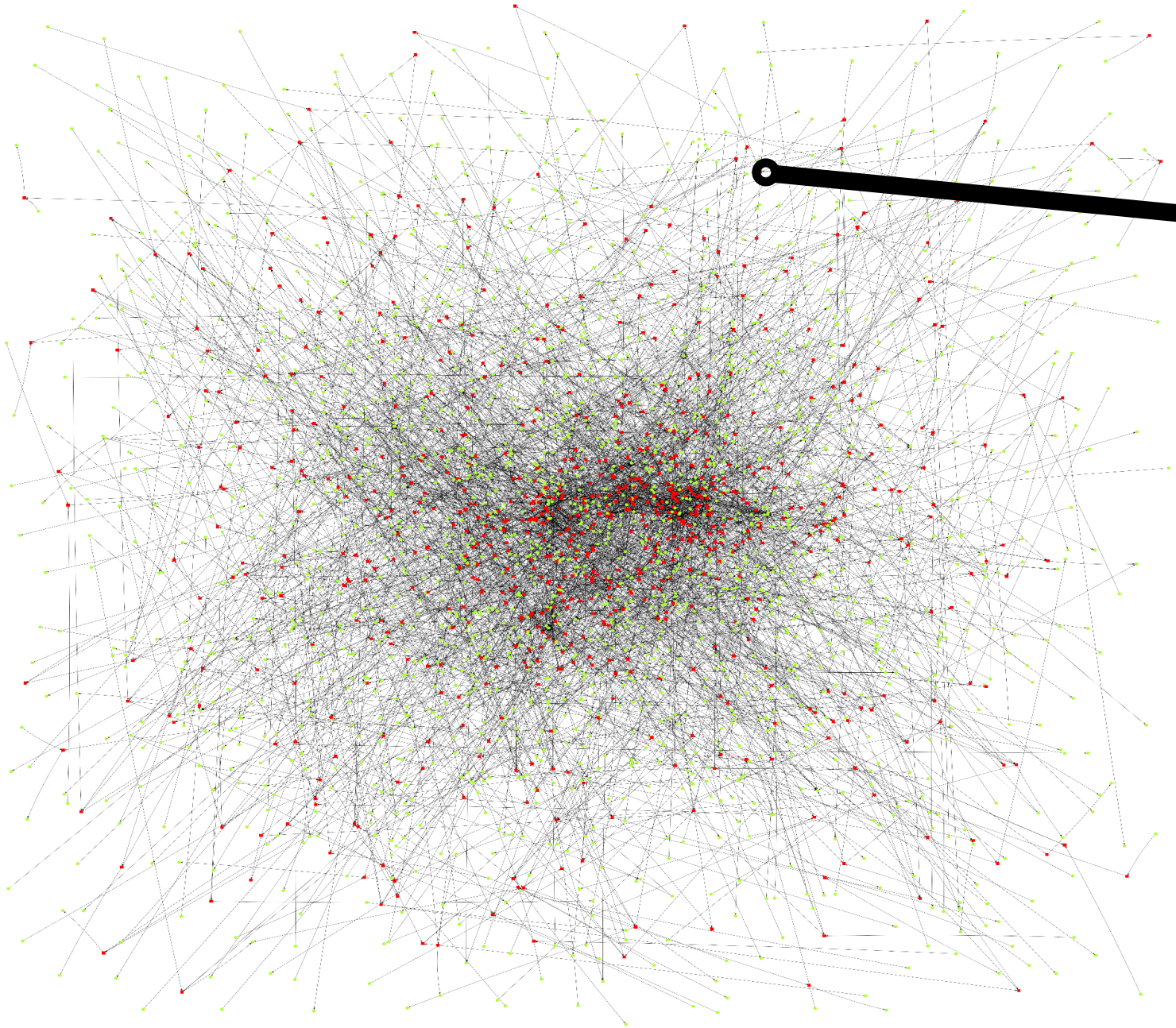
USFRPAL

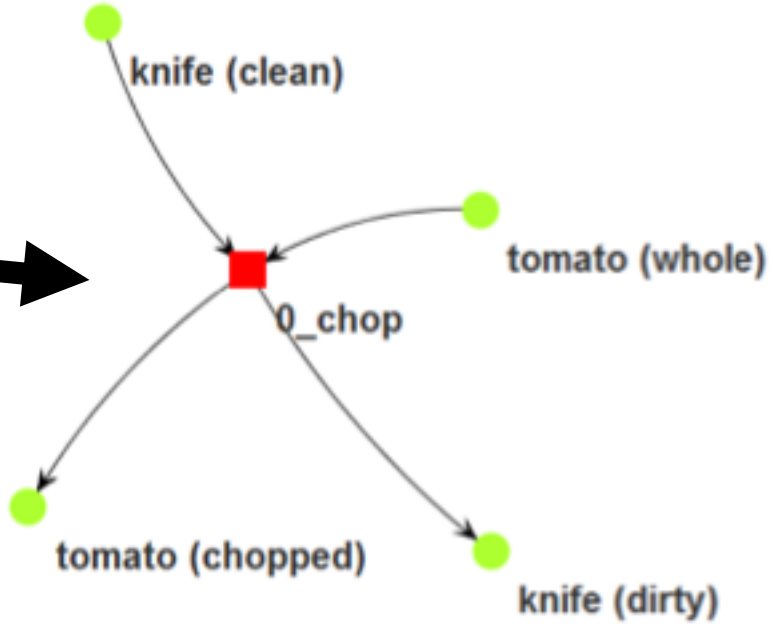
Robot Perception and Action Lab

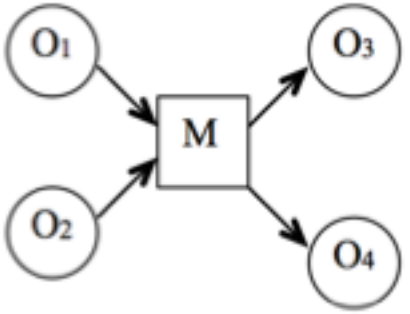
Learn by Watching Instructional Videos

Constructing Sub-Graph, an Example

Functional Object-Oriented Network (FOON, foonets.com)





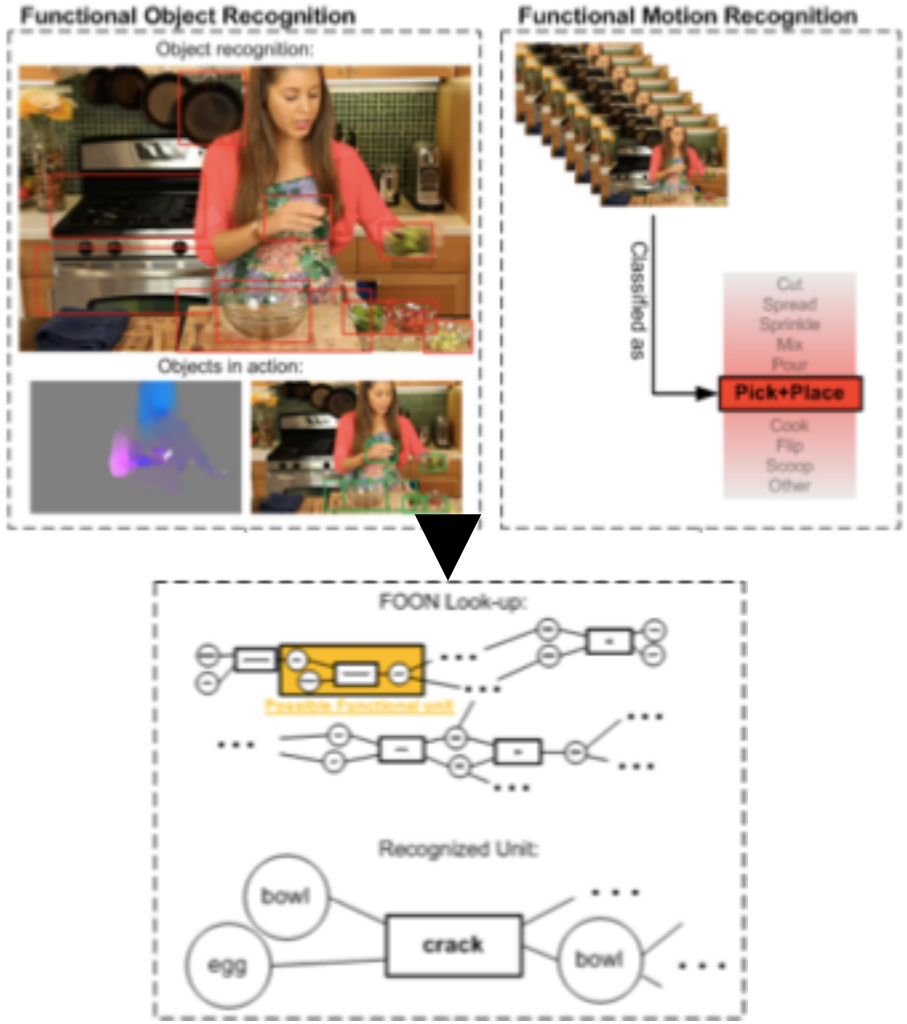


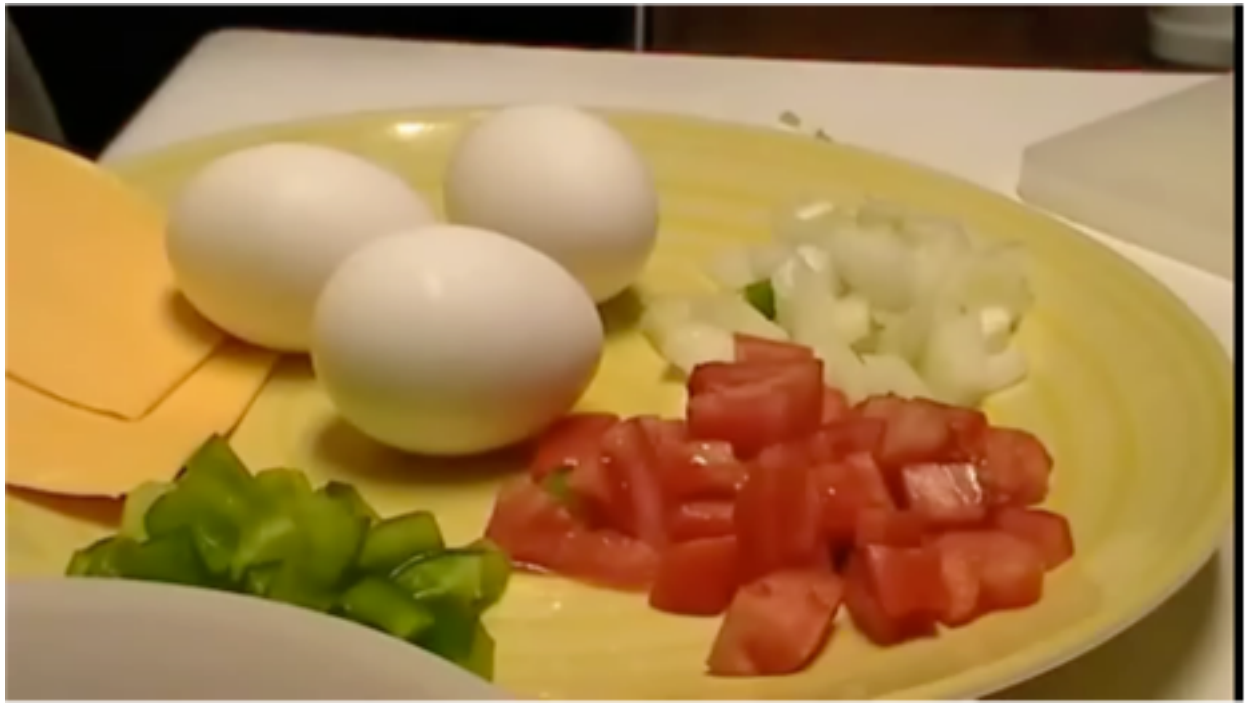
Functional Unit

Refer to [2,4,5,6]

Generating FOON Subgraphs From Videos

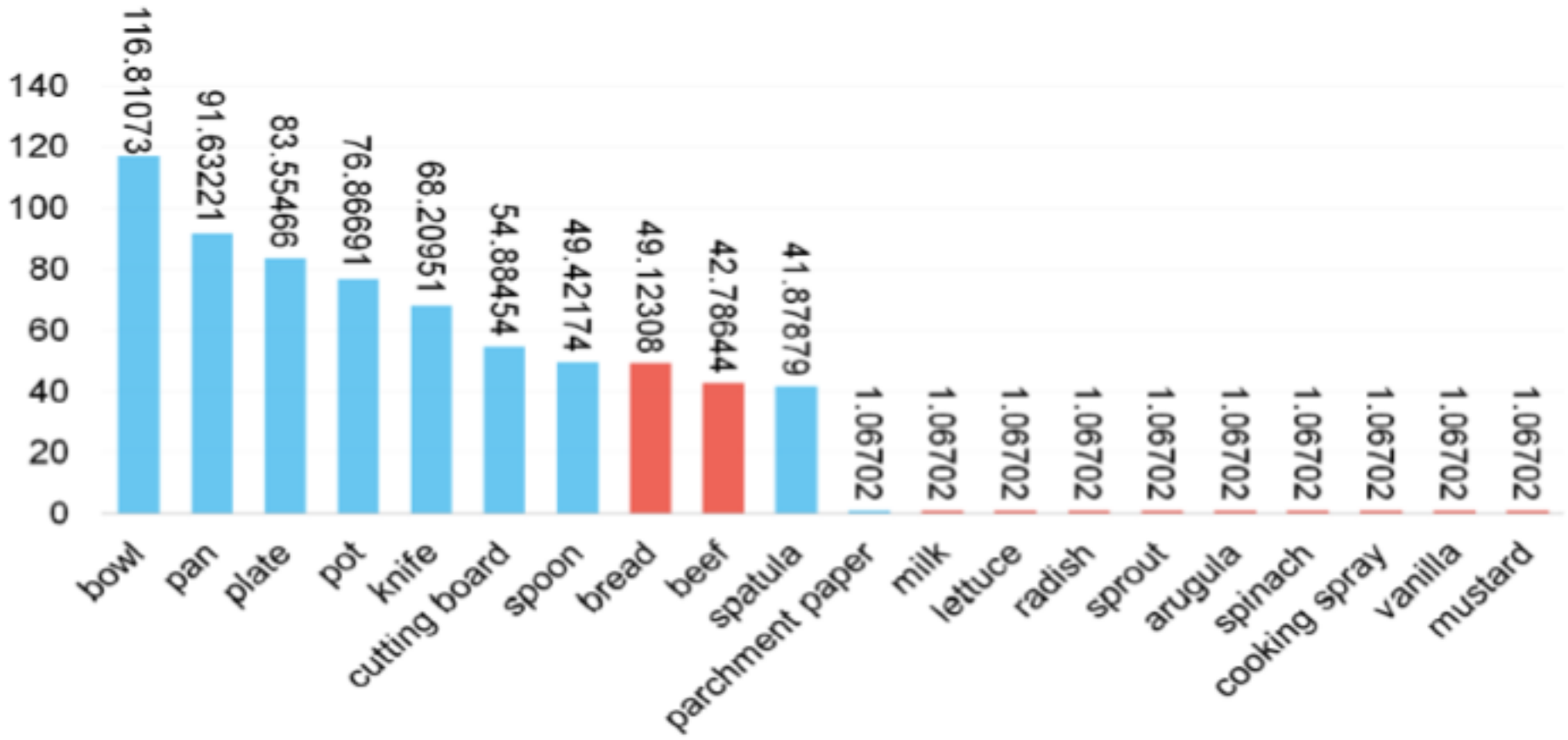
Semi-Automatic FOON Labeling





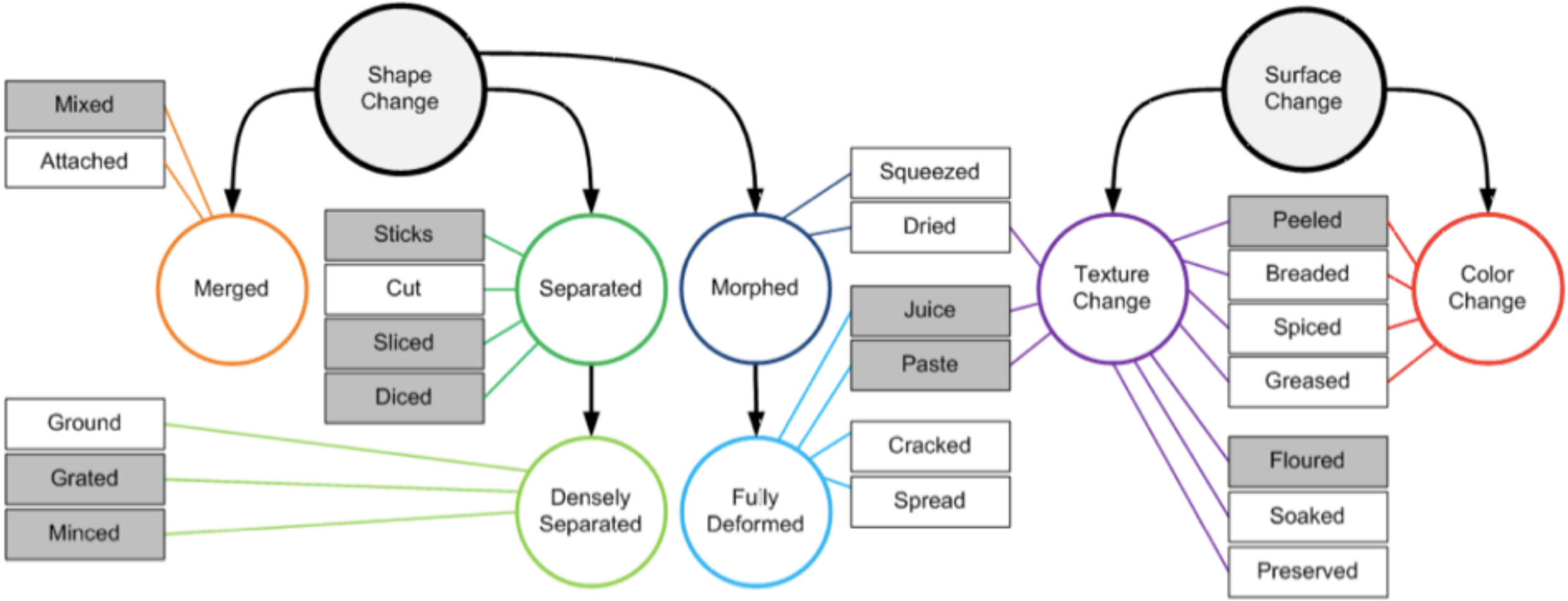
Jelodar, Ahmad Babaeian, David Paulius, and Yu Sun, Long Activity Video Understanding using Functional Object-Oriented Network, IEEE Transactions on Multimedia, pp. 1-12 (Accepted)

Objects, States, and Motions

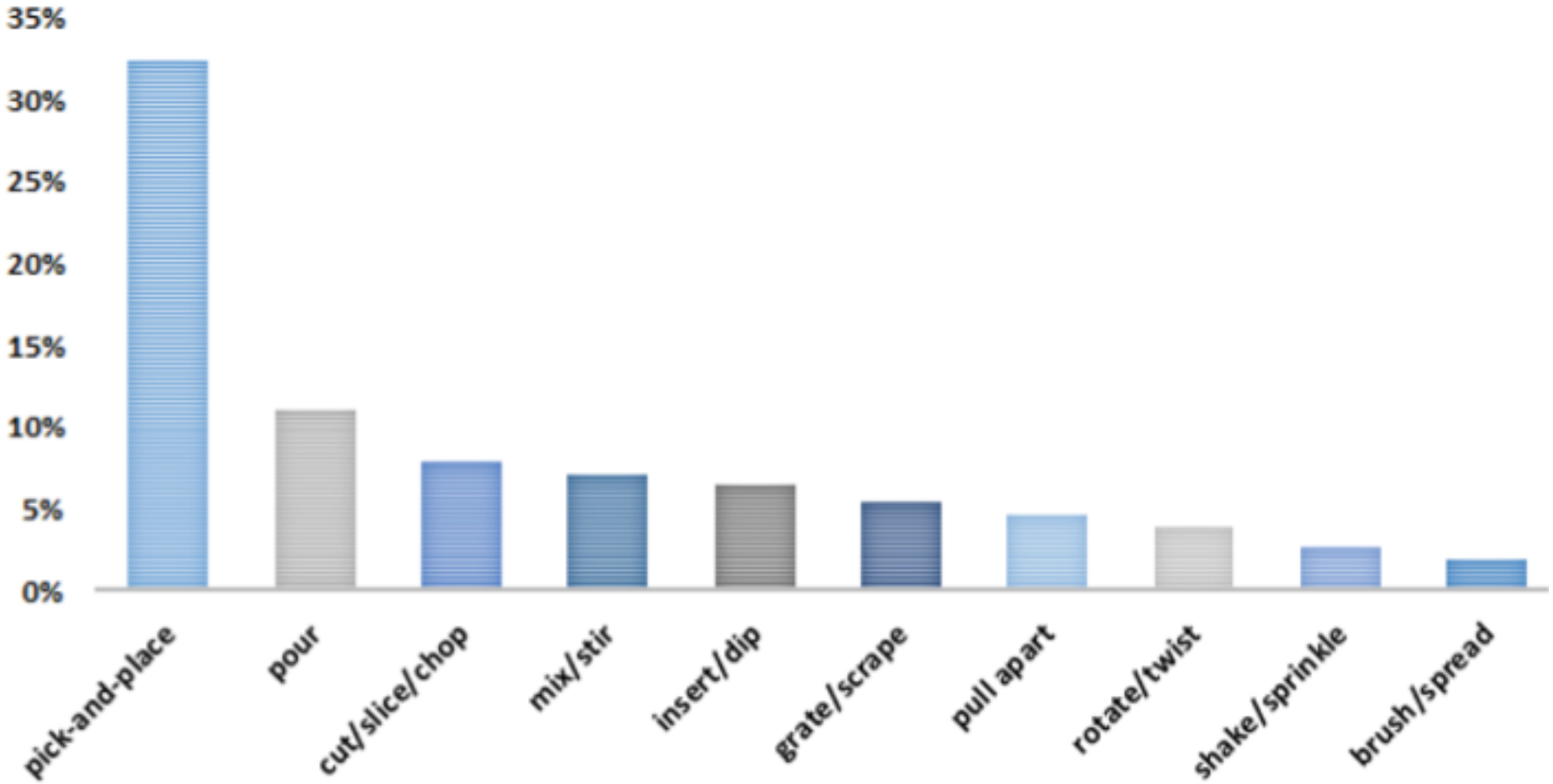


Paulius, D. Huang, Y., Milton, R., Buchanan, W.D., Sam J., and Sun, Y. (2016) Functional Object-Oriented Network for Manipulation Learning, IROS, 3655-3662.

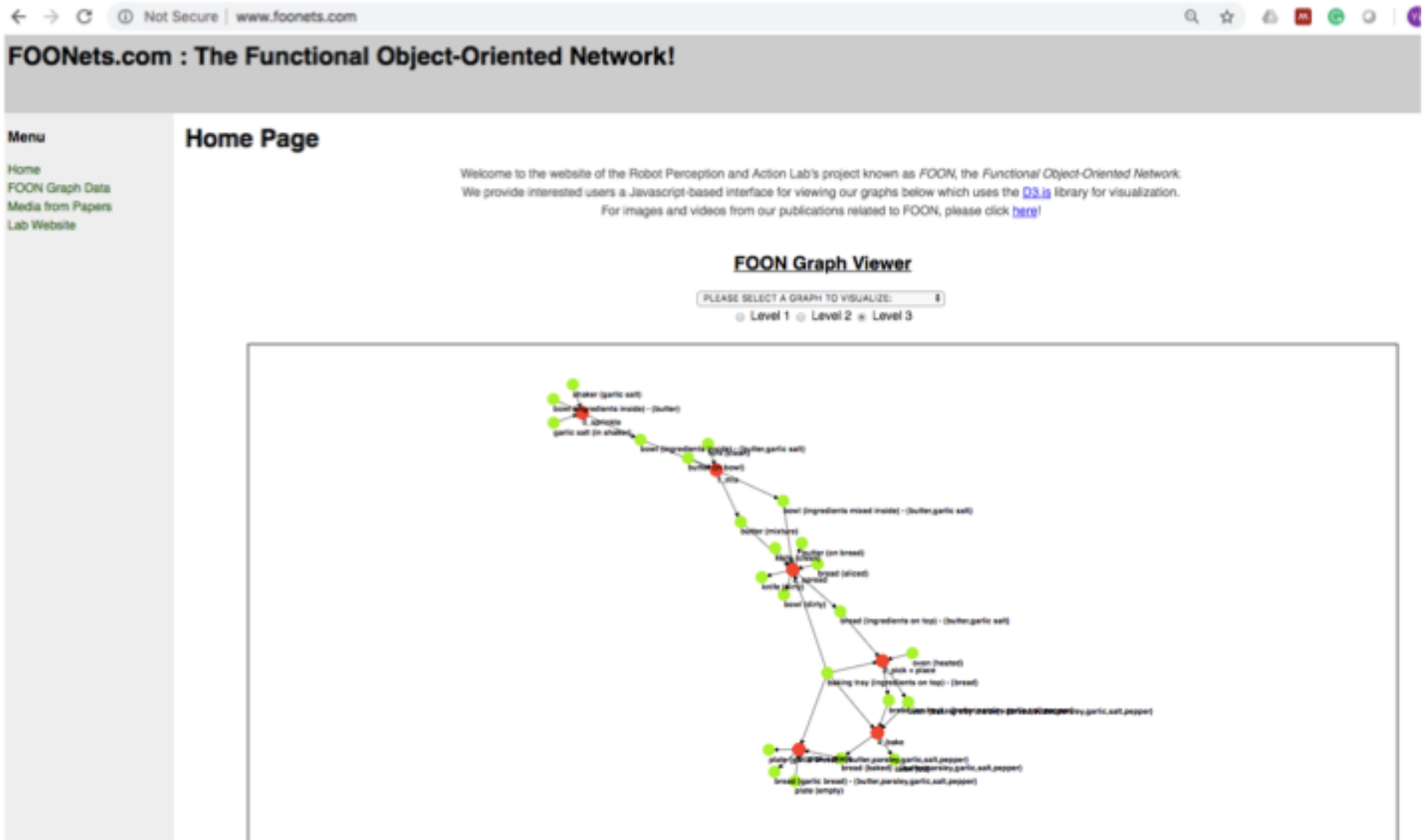
Objects, States, and Motions



Objects, States, and Motions



Videos, Labels, and Graphs @ foonets.com



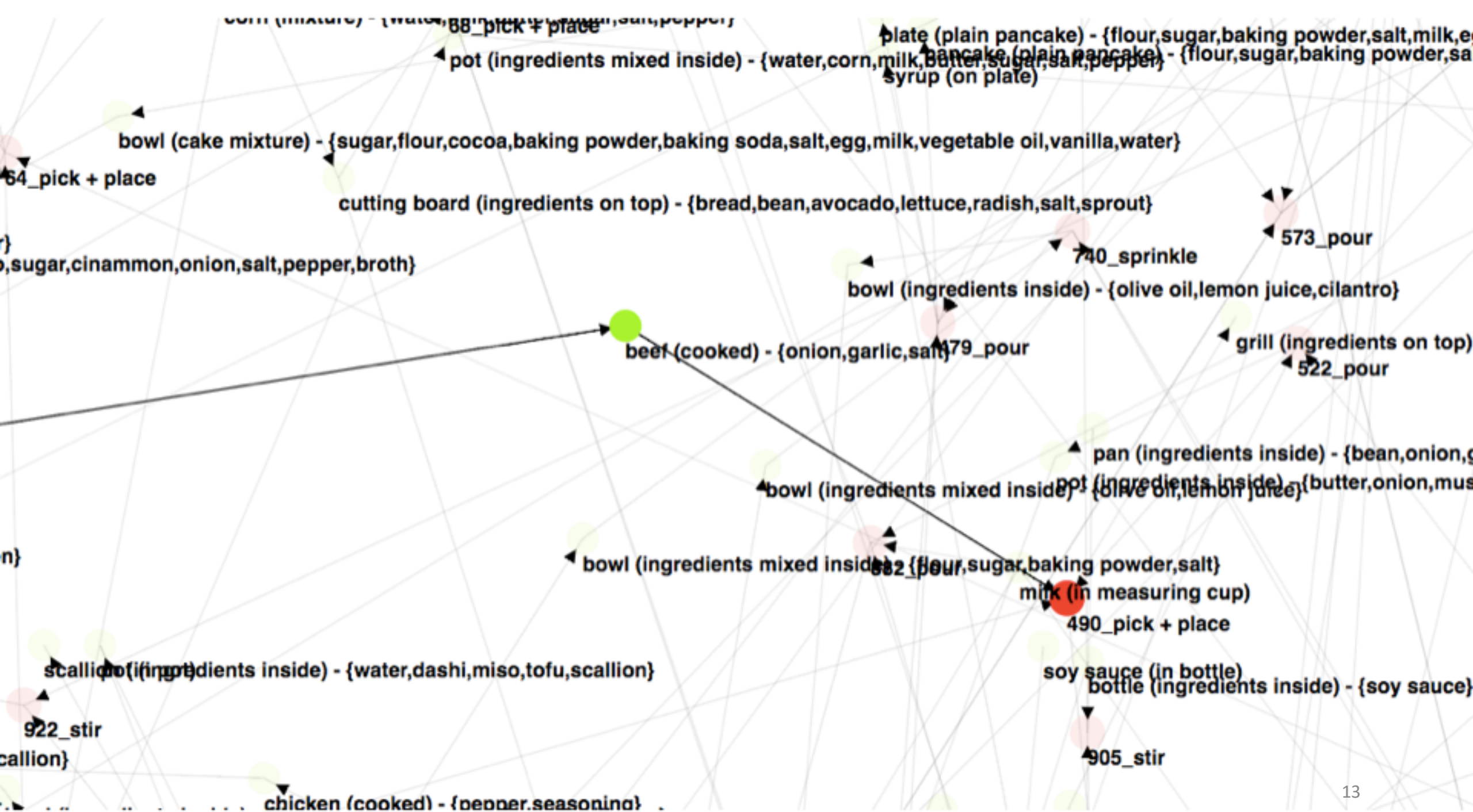
Home Page

Welcome to the website of the Robot Perception and Action Lab's project known as *FOON*, the *Functional Object-Oriented Network*.
We provide interested users a Javascript-based interface for viewing our graphs below which uses the D3.js library for visualization.
For images and videos from our publications related to FOON, please click here!

FOON Graph Viewer

Merged FOON (65 videos)

Level 1 Level 2 Level 3


88_pick + place
pot (ingredients mixed inside) - {water,corn,milk,butter,sugar,salt,pepper}
plate (plain pancake) - {flour,sugar,baking powder,salt,milk,e
pancake (plain pancake) - {flour,sugar,baking powder,sa
syrup (on plate)
bowl (cake mixture) - {sugar,flour,cocoa,baking powder,baking soda,salt,egg,milk,vegetable oil,vanilla,water}
64_pick + place
cutting board (ingredients on top) - {bread,bean,avocado,lettuce,radish,salt,sprout}
573_pour
740_sprinkle
,sugar,cinammon,onion,salt,pepper,broth}
bowl (ingredients inside) - {olive oil,lemon juice,cilantro}
beef (cooked) - {onion,garlic,salt}
479_pour
grill (ingredients on top)
522_pour
pan (ingredients inside) - {bean,onion,
pot (ingredients inside) - {butter,onion,mus
bowl (ingredients mixed inside) - {olive oil,lemon juice}
bowl (ingredients mixed inside) - {flour,sugar,baking powder,salt}
882_pour
milk (in measuring cup)
490_pick + place
soy sauce (in bottle)
bottle (ingredients inside) - {soy sauce}
scallion (ingredients inside) - {water,dashi,miso,tofu,scallion}
922_stir
905_stir
chicken (cooked) - {pepper,seasoning}

Menu

Home
FOON Graph Data
Media from Papers
Lab Website

FOON Graph Data

- List of objects, states and motions used in network.
- Use these files for mapping between ID numbers and labels.

Individual Subgraphs

Download all 65 subgraphs: [ANNOTATED FILES] [VIDEOS]

View all individual files **here**.

Each of the videos in the original FOON dataset come from instructional videos which can be found on YouTube. Refer to here for mappings between YouTube videos and our subgraph videos.

Universal FOON Graph (Merged from 65 videos)

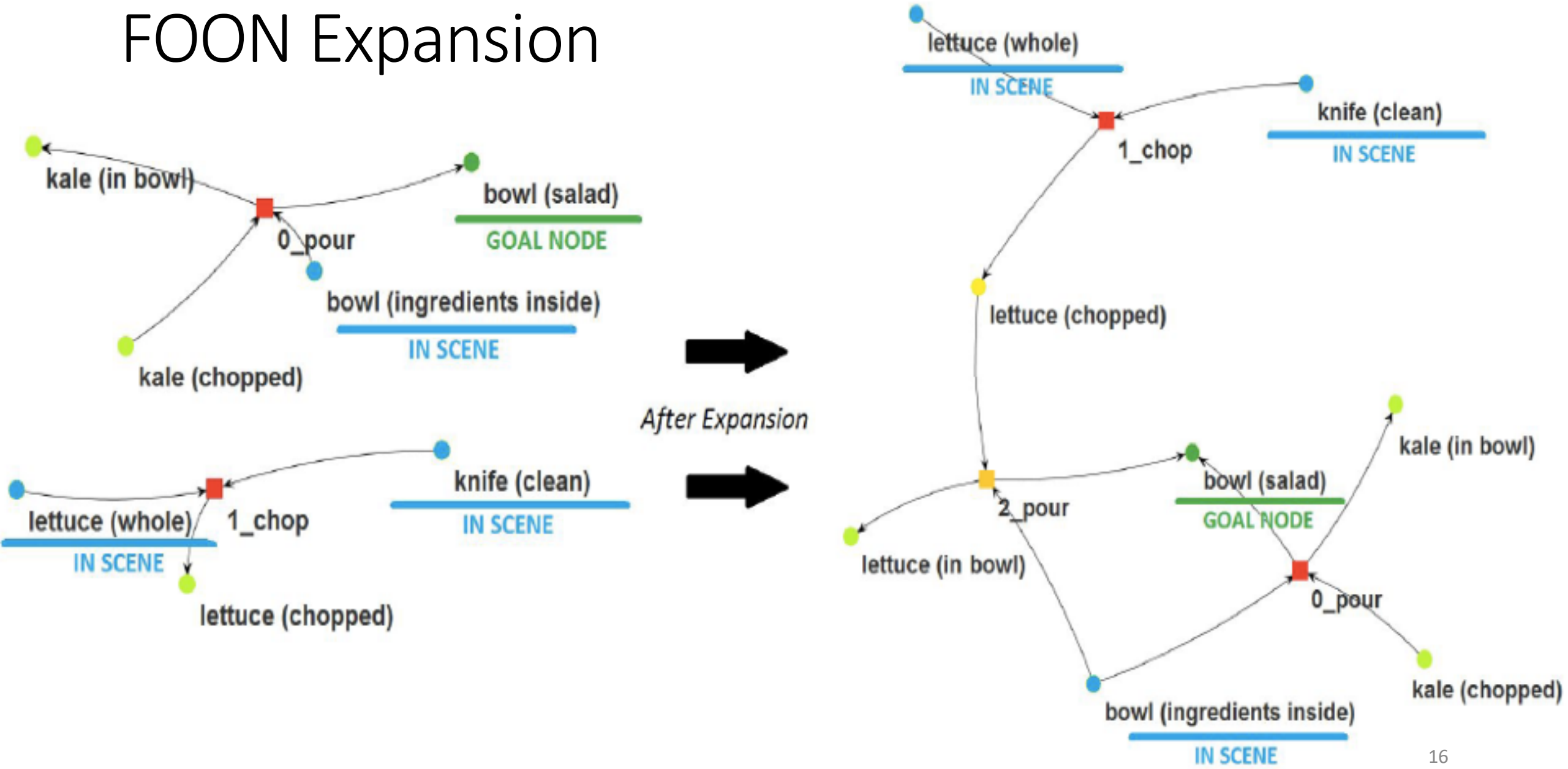
Download file: **[ANNOTATED]**

Label files

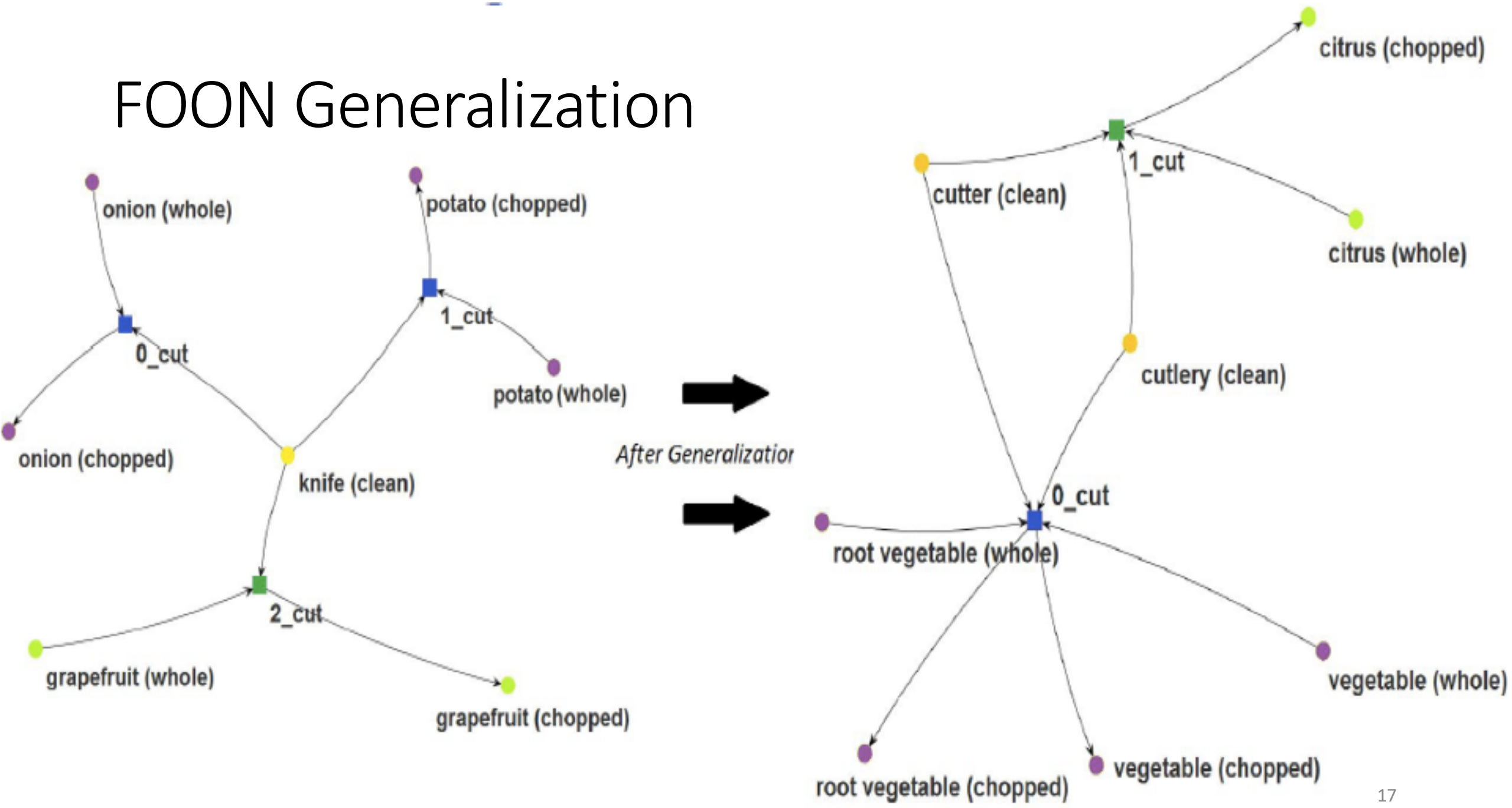
Parent Directory		-
0001-whipped-cream-u..>	2018-06-22 14:00	1.0K
0001-whipped-cream.mp4	2018-06-22 14:03	61M
0002-bacon-mac-and-c..>	2018-06-22 14:00	6.1K
0002-bacon-mac-and-c..>	2018-06-22 14:03	60M
0003-barbecue-ribs-N..>	2018-06-22 14:00	2.5K
0003-barbecue ribs.mp4	2018-06-22 14:04	13M
0004-batter.mp4	2018-06-22 14:04	18M
0004-pancake-batter-..>	2018-06-22 14:00	819
0005-chipotle-bean-s..>	2018-06-22 14:00	4.5K
0005-chipotle-bean-s..>	2018-06-22 14:05	30M
0006-blood-orange-sa..>	2018-06-22 14:00	2.5K
0006-blood-orange-sa..>	2018-06-22 14:05	17M
0007-carrot-salad-up..>	2018-06-22 14:00	3.8K
0007-carrot-salad.mp4	2018-06-22 14:05	21M
0008-buckeye-candy-u..>	2018-06-22 14:00	3.2K
0008-buckeye-candy.mp4	2018-06-22 14:06	48M
0009-potato-salad-up..>	2018-06-22 14:00	8.1K
0009-potato-salad.mp4	2018-06-22 14:06	46M
0010-cheesy-garlic-b..>	2018-06-22 14:00	4.3K

O65 mixer 0
S325 with bowl {}
O2 bowl 0
S326 with mixer {}
O64 cup 1
S182 ingredients inside {cream}
O66 cream 1
S195 liquid
M4 pour 1:15 1:17
O65 mixer 0
S182 ingredients inside {cream}
O2 bowl 0 S326 with mixer {cream}
O66 cream 1 S159 in mixer
//

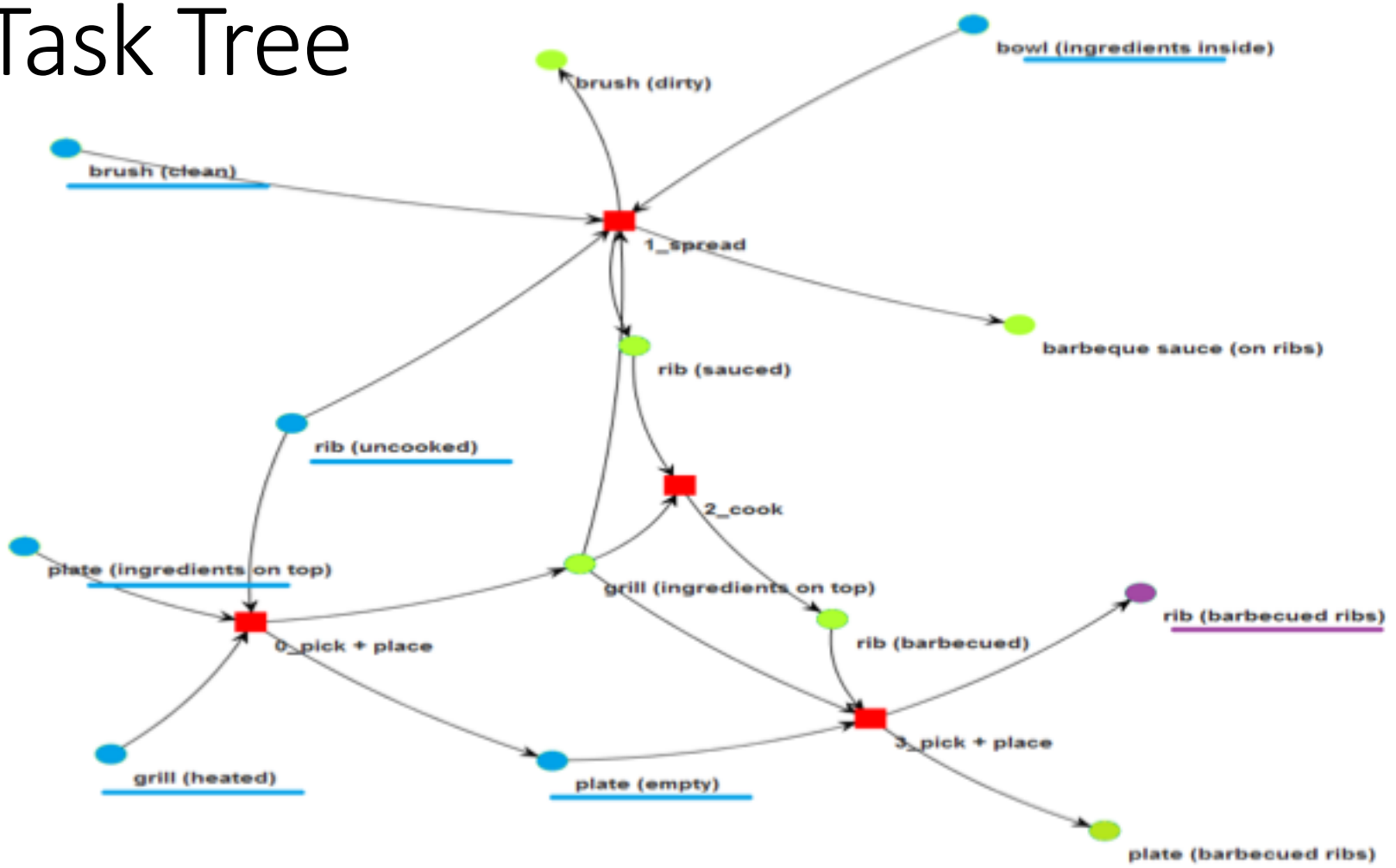
FOON Expansion



FOON Generalization



Retrieving Task Tree



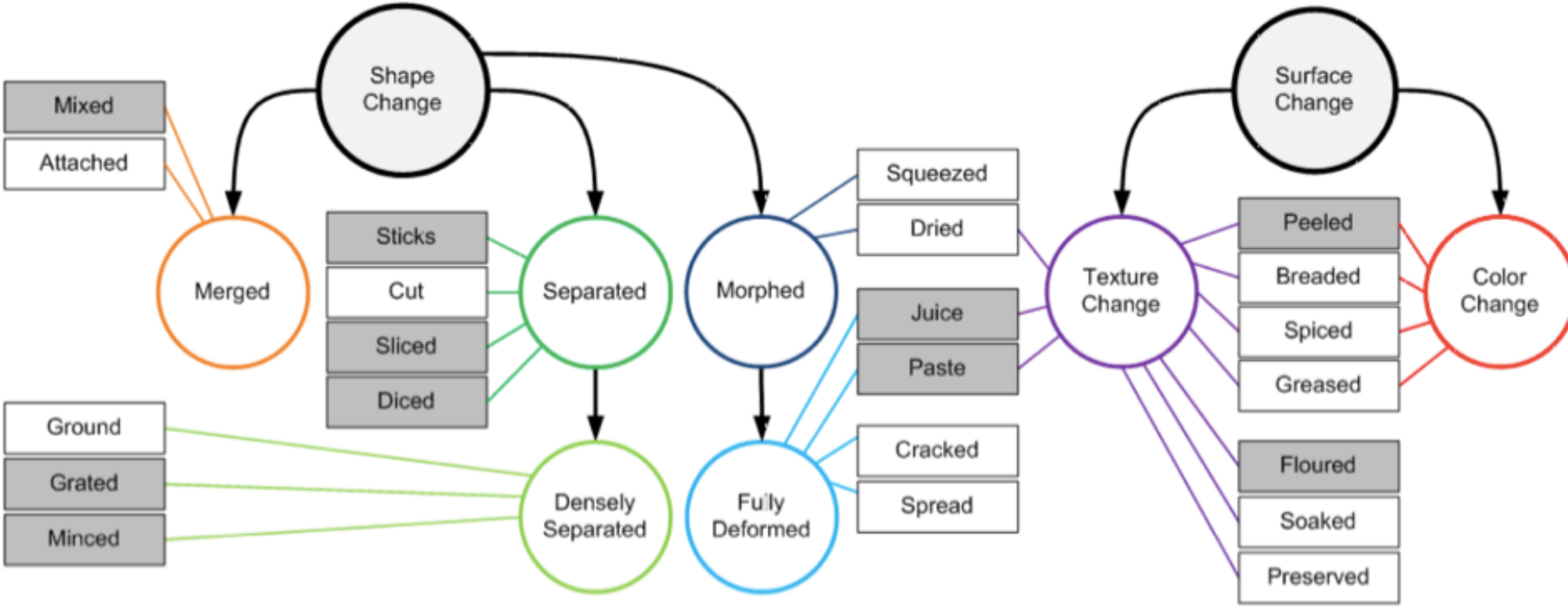
Paulius, D., Jelodar, B., and Sun, Y. (2018) Functional Object-Oriented Network: Construction & Expansion, ICRA 2018, pp 5935-5941.

Paulius, D. Huang, Y., Milton, R., Buchanan, W.D., Sam J., and Sun, Y. (2016) Functional Object-Oriented Network for Manipulation Learning, IROS, 3655-3662.

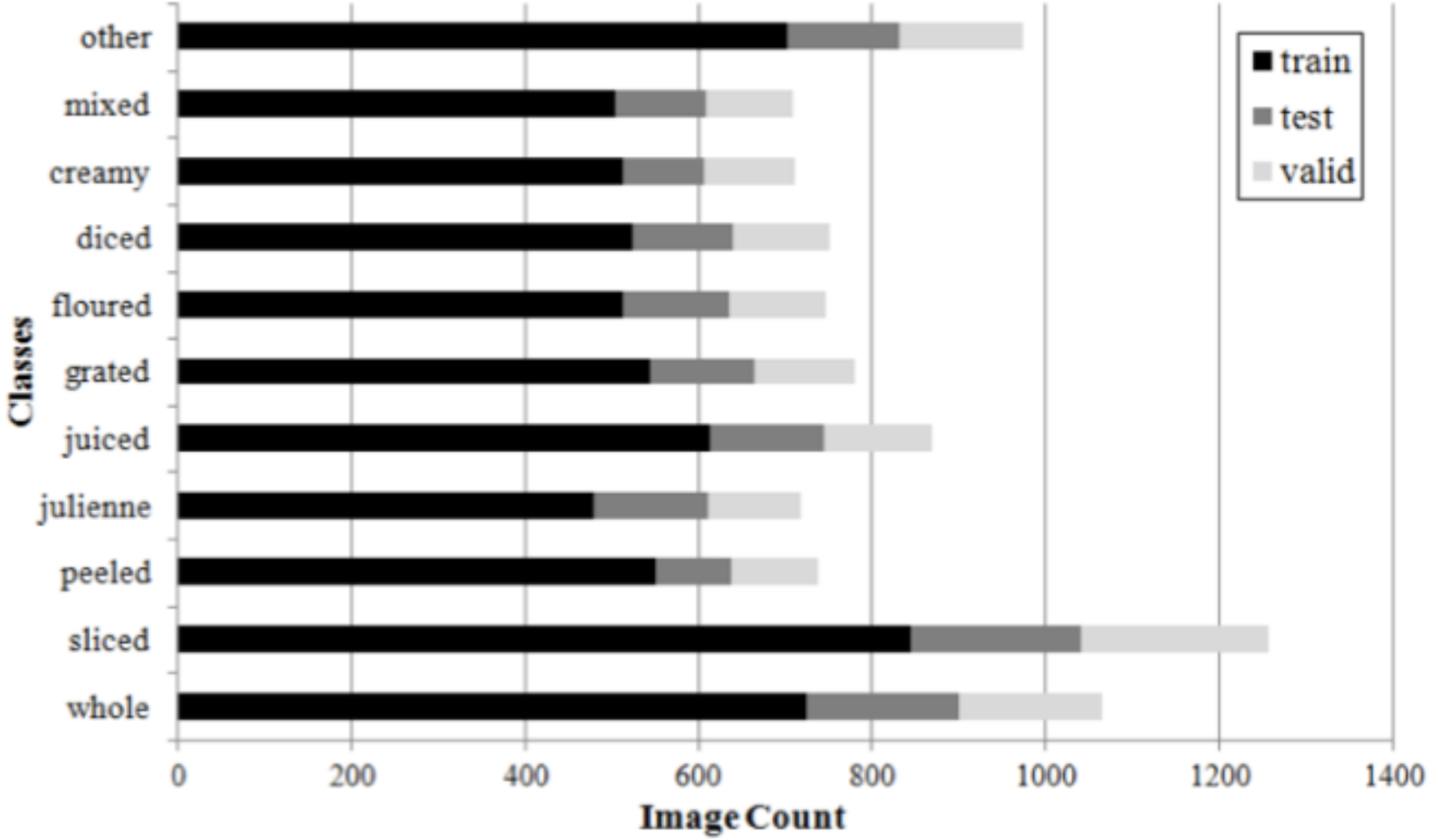
kettle (empty)
faucet (flowing water)
fill
water (in container)
stove (heated)
kettle (ingredients inside) {water}
heat
kettle (boiling water) {water}
water (heated)
pour
tea cup (empty)
water (in tea cup)
tea cup (ingredients inside) {water}
dip
tea bag (in packet)
rip open
tea bag (dry)
tea bag (soaked)
tea cup (unsweetened tea) {tea}
sugar (in bowl)
scoop
spoon (clean)
bowl (ingredients inside) {sugar}
stirrer (clean)
stir
tea cup (sweetened tea) {tea,sugar}
stirrer (dirty)
tea (sweetened)
tea (unsweetened)
tea cup (unsweetened tea) {tea,sugar}
sugar (in tea cup)

Food Ingredient States

Examples


Shape Change
Surface Change
Mixed
Attached
Merged
Sticks
Cut
Sliced
Diced
Separated
Ground
Grated
Minced
Densely Separated
Morphed
Fully Deformed
Squeezed
Dried
Juice
Paste
Cracked
Spread
Texture Change
Peeled
Breaded
Spiced
Greased
Floured
Soaked
Preserved
Color Change

Dataset

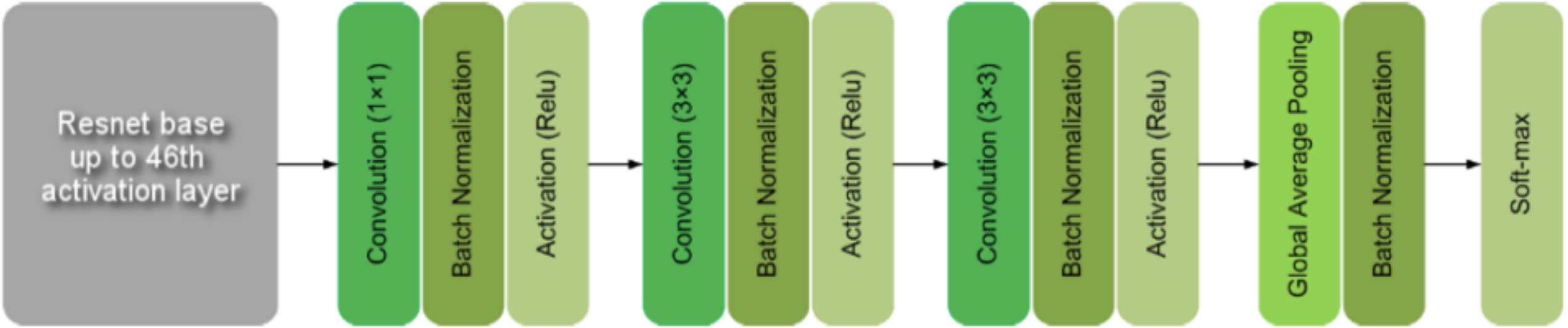


Dataset Download: http://rpal.cse.usf.edu/datasets_cooking_state_recognition.html

Dataset

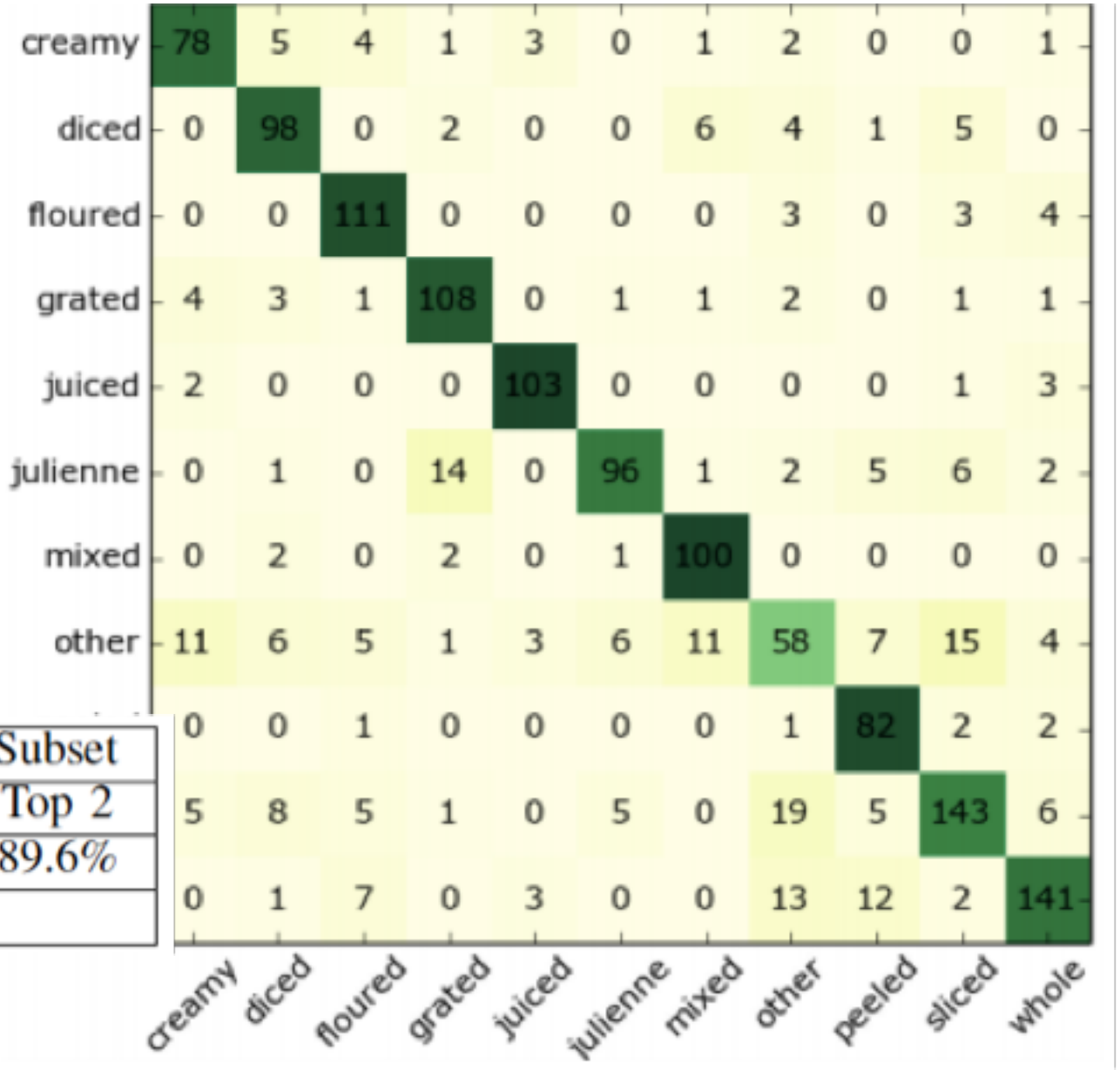
- 11 classes of states : whole, peeled, floured, sliced, diced, grated, julienne, juice, creamy, mixed, other
- 17 main cooking objects: tomato, onion, garlic, green pepper, potato, carrot, strawberry, egg, mushroom, bread, beef/pork, chicken/turkey,
- cheese, butter, dough and milk
- Total number of images: 9309

Food State Identification



Preliminary Results

- 6498(70%) training,
  1413(15%) testing, and
  1398(15%) validation



Model	State Dataset		Imagenet Subset	
	Top 1	Top 2	Top 1	Top 2
Resnet-based Model	80.4%	91.5%	78.5%	89.6%
Voting	82%	92%	-	

Refer to [3].

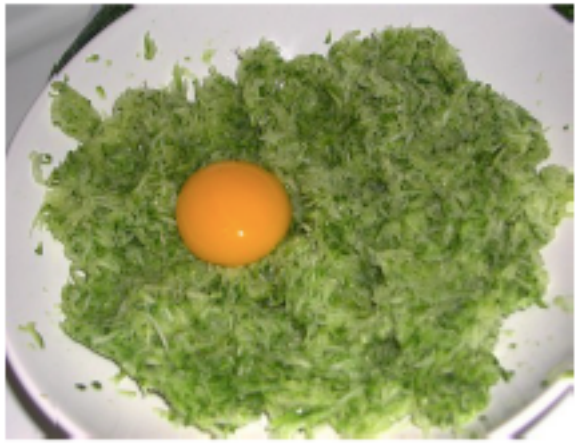
Failure Cases

(a) Crumbs as floured

(b) Sliced as creamy

(c) Melted as juice

(d) Grated as Julienne



Summary

- FOON: object+motion
- FOON dataset: objects, states, motions, time
- Motion sequence generation using FOON
- Food ingredient state recognition

Support

This material is based upon work supported by the National Science Foundation under Grants No. 1421418 and No. 1560761.

Thank You!

Contact: yusun@usf.edu

References:

[1] Jelodar, AB., Paulius, D. and Sun, Y. (2018) Long Activity Video Understanding using Functional Object-Oriented Network, IEEE Transactions on Multimedia, pp. 1-12

[2] Paulius, D., Jelodar, B., and Sun, Y. (2018) Functional Object-Oriented Network: Construction & Expansion, ICRA 2018, pp 5935-5941.

[3] Jelodar, A.B., Salekin, M.S. and Sun, Y., 2018. Identifying Object States in Cooking-Related Images. *arXiv preprint arXiv:1805.06956*.

[4] Paulius, D. Huang, Y., Milton, R., Buchanan, W.D., Sam J., and Sun, Y. (2016) Functional Object-Oriented Network for Manipulation Learning, IROS, 3655-3662.

[5] Sun, Y., Ren, S., Lin, Y., (2014) Object-Object Interaction Affordance Learning, Robotics and Autonomous Systems, 62(4): 487-496.

[6] Ren S., Sun Y. (2013) Human-Object-Object-Interaction Affordance, IEEE Workshop in Robot Vision (WoRV)/Winter Vision Meeting (WVM), pp. 1-6.