



**Ubicomp and Health:
Merging Research Agendas**

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Outline

- Ubiquitous Computing (UbiComp)
 - What is it?
 - The role of applications in ubicomp research
- Case studies
 - SMS and asthma
 - Remote diagnosis of autism
 - Quantitative measurement of child-adult behavior
 - Semi-automated food journaling
- What's after ubicomp?
 - If I have time, otherwise ask later...



What is Ubicomp?

Generation 1

40's
main frame
Many P(eople) to 1 C(omputer)

Generation 2

60's
PC
1 P to 1 C

Generation 3

80's
Smartphone, tablets, interactive TV
1 P to many C

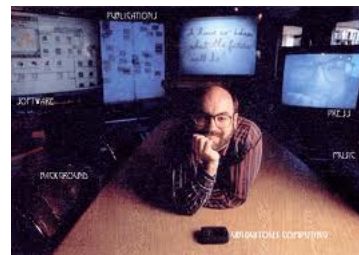


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Ubicomp and applications

“The whole purpose of ubiquitous computing, of course, are the applications.”

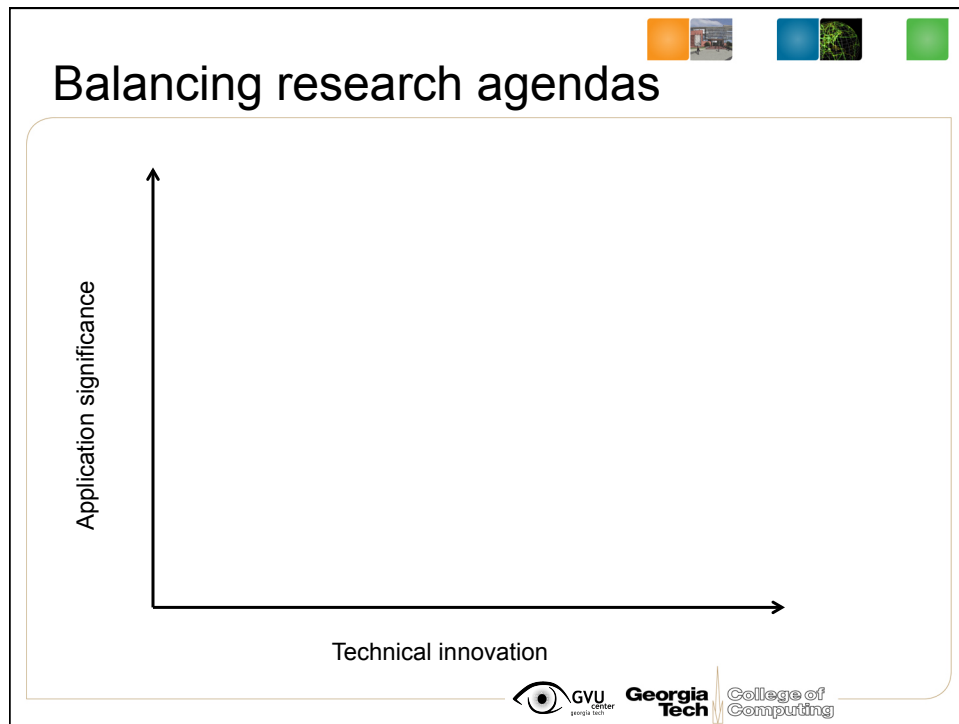


Mark Weiser



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EXPLORING HEALTH







Rosa Arriaga and Tae-Jung Yun

The most common chronic disease among children [WHO, 2008]

- Particular problem in the Southern U.S.
- Severity is not correlated to mortality



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Straightforward Questions

Q: What technology could impact asthma?

A: Cell phones
(Lenhart, 2010)

- 75% of 12~17 year-olds possess cell phones
- 88% of teen cell phone users are text-messagers
- More than half of teens (54%) are daily texters



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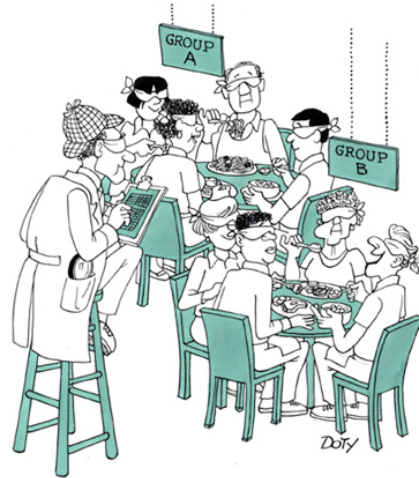
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Straightforward Questions

Q: How do we ascertain that our technology is causing improved outcomes?

A: Conduct a randomized control trial (RCT).

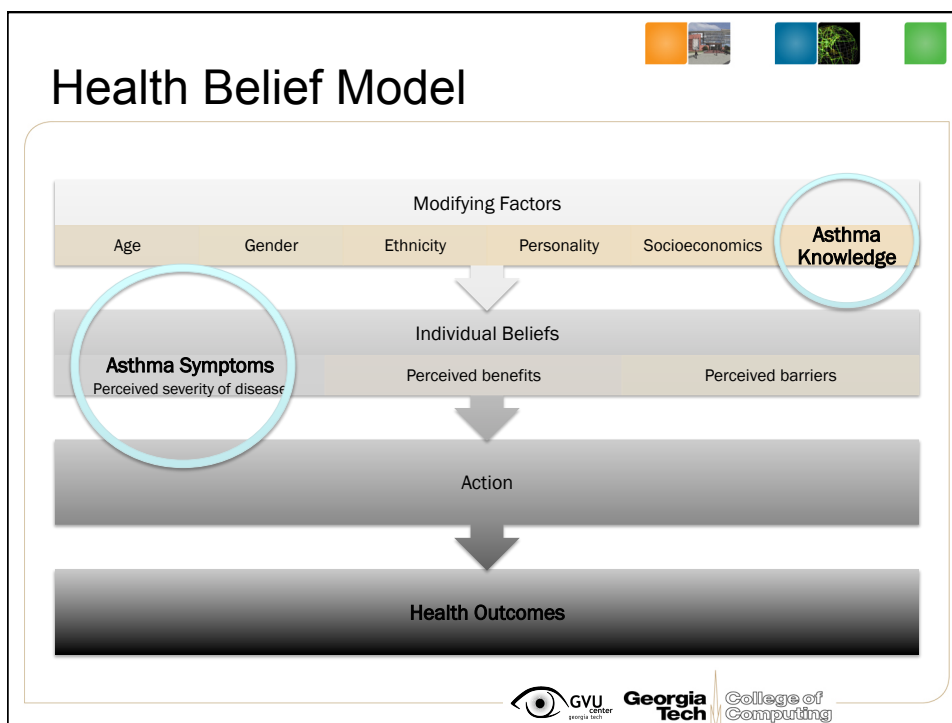
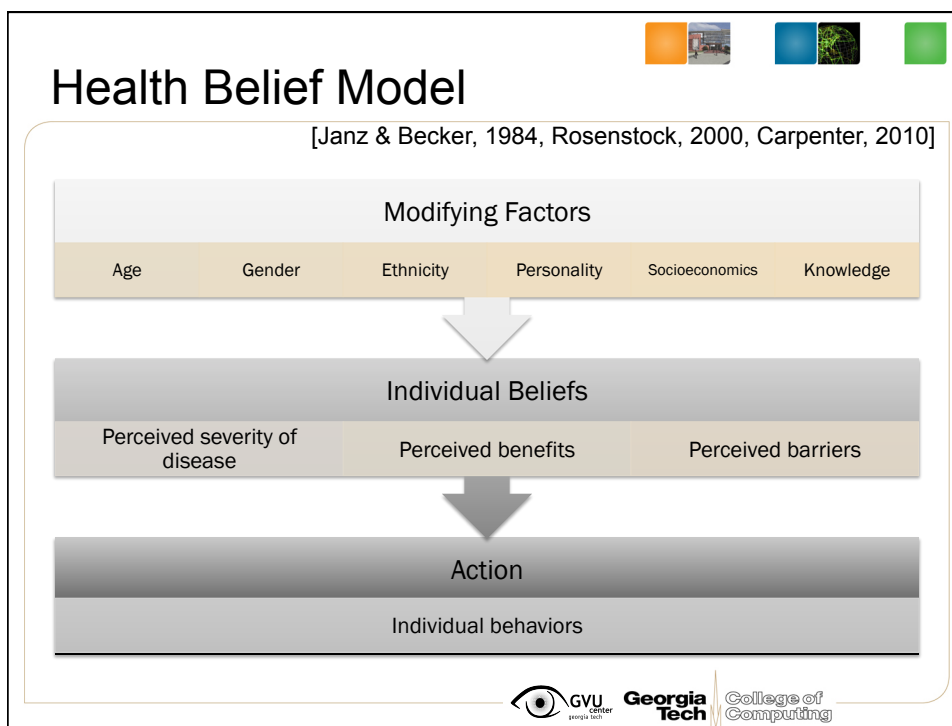


"Anyone for a game of Blind Man's Bluff after dinner?"

A harder question

Q: How do we pick the right variables to manipulate?

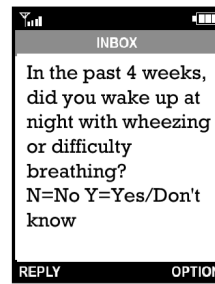




Symptom Texts

15 Yes/No questions

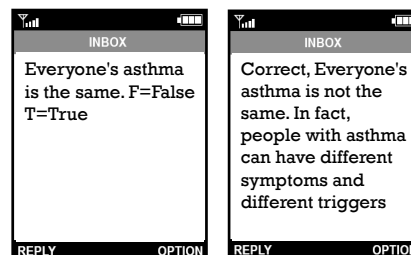
- Adapted from Asthma Therapy Assessment Questionnaire [Skinner 2004]



Knowledge Texts

15 true/false questions

- Adapted from Asthma Myths [MedicineNet.com]



Study Design

- Participants
 - Physicians
 - Children with Asthma (10 ~ 17 years old)
 - Caregivers
- 3 Groups (total participants n = 30)

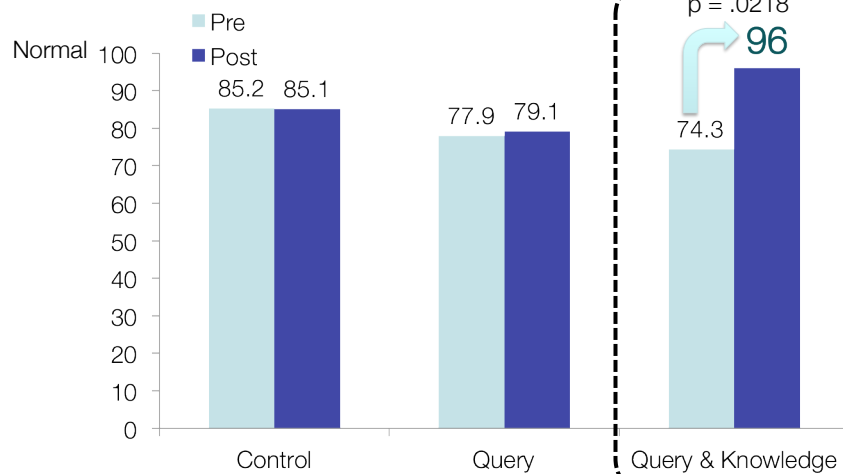
Control	Symptom	Symptom & Knowledge
N = 10	N = 10	N = 10

Measures

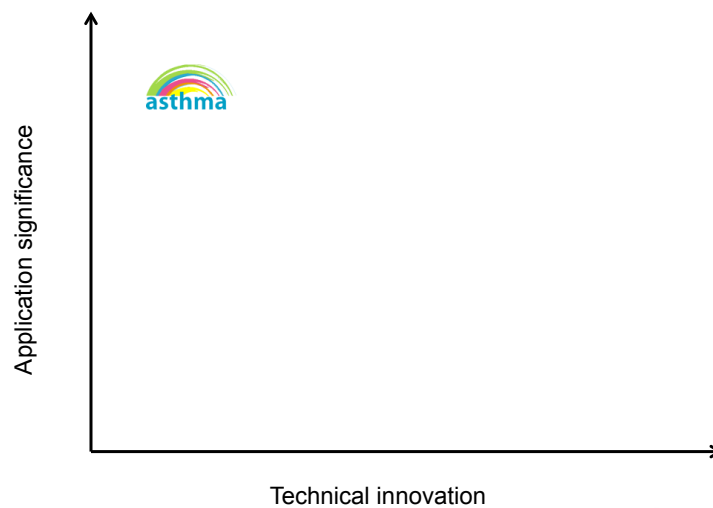
3-5 months			
	1 st Doctor's visit	Between the visits	Follow up visit
Children	Demographics, Knowledge, Quality of Life, Physiological test	SMS log	Knowledge, Quality of Life, Physiological test , Perception of Intervention Effectiveness
Caregiver	Quality of Life		Quality of Life
Physician	Technology usage	Dashboard log	Perception of Intervention Effectiveness

FEF25~75% Predicted

Yun et al. 2012

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Agata Rozga, Rosa Arriaga, Nazneen
Chris Smith (SARRC)
Behavior Imaging Solutions, Inc.

1 in 88 children in U.S. affected (CDC, 2012).

But it is more than a statistic for me.



Gregory Abowd is Chief Research Officer of BIS



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Autism diagnosis challenge



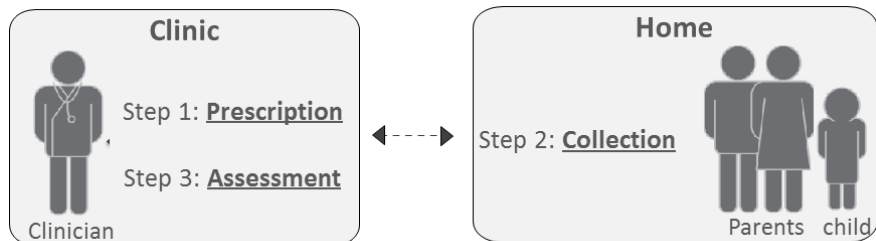
12 to 18 Months or More



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Inspiration: Analogy to standard lab test



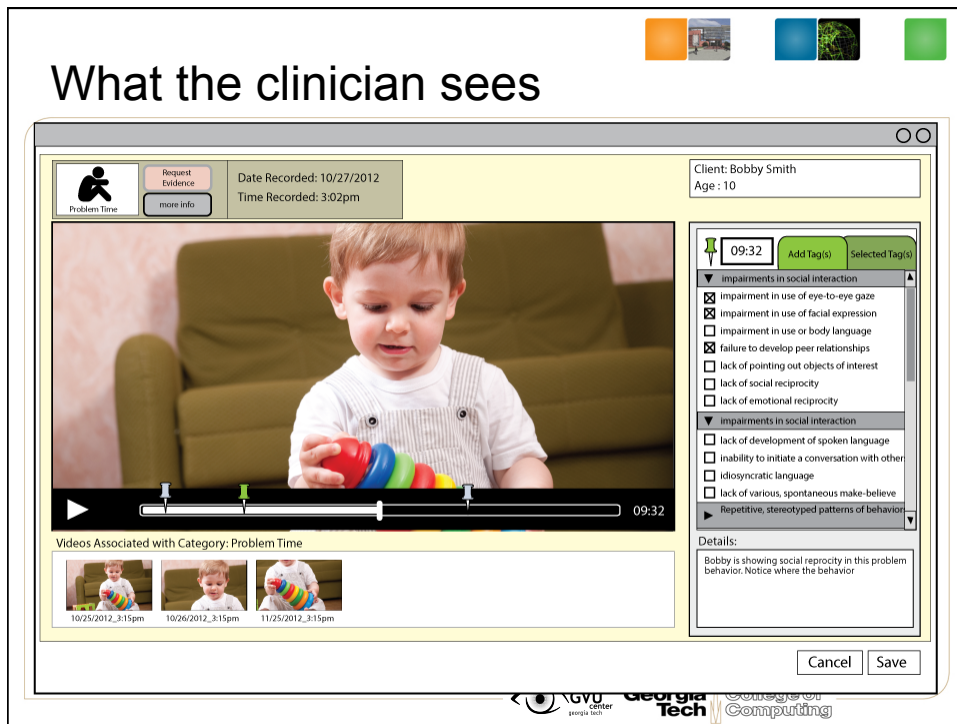
Goal: Collect "behavior specimens" suitable for autism diagnosis

Solution: Naturalistic Observational Diagnostic Assessment (NODA)

What the parents use



What the clinician sees



Evaluation

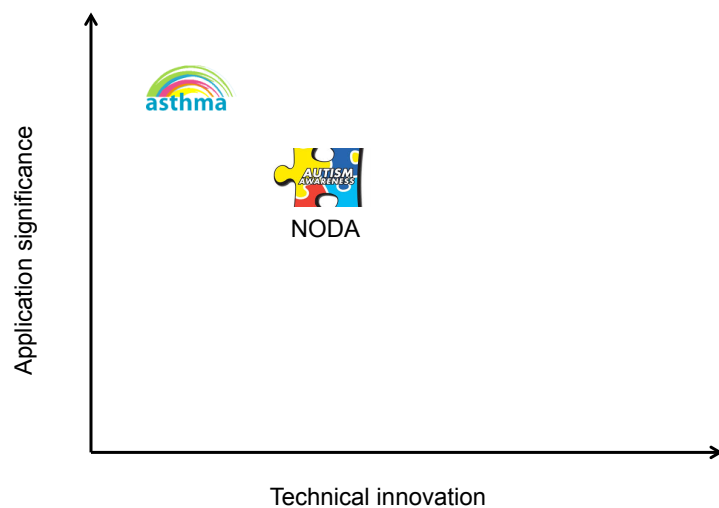
2013

formative studies
iterative design of capture and assessment interfaces
pre-clinical trial @ GT

2014

clinical trial @ SARRC
hypothesis: this will work for triage

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Agata Rozga, Irfan Essa, Jon Bidwell

How can we develop more objective and quantitative measures of child development?



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Behavior Imaging: An analogy



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Response to Name (RTN) Protocol

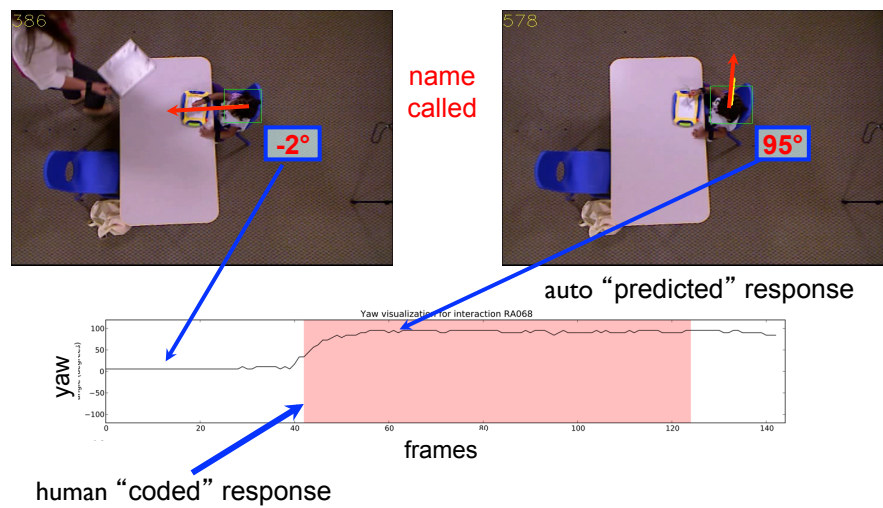


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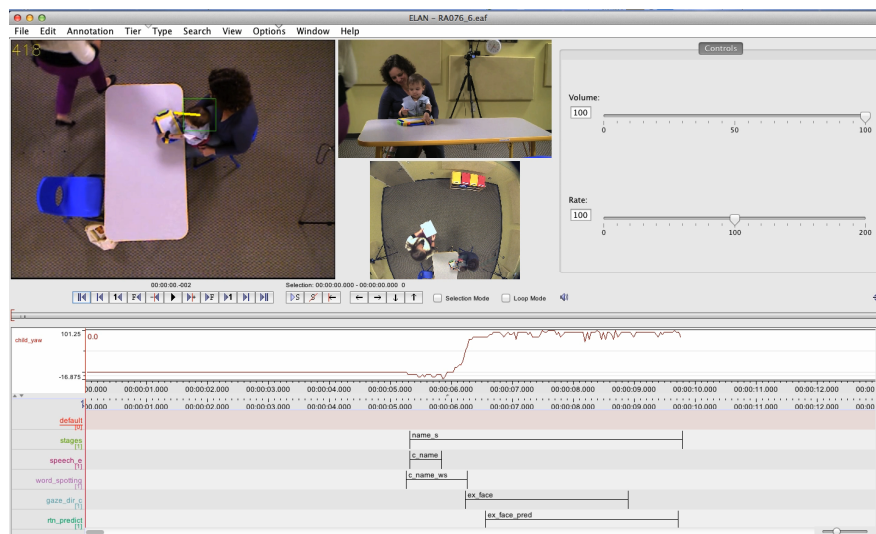
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Predicting response to name



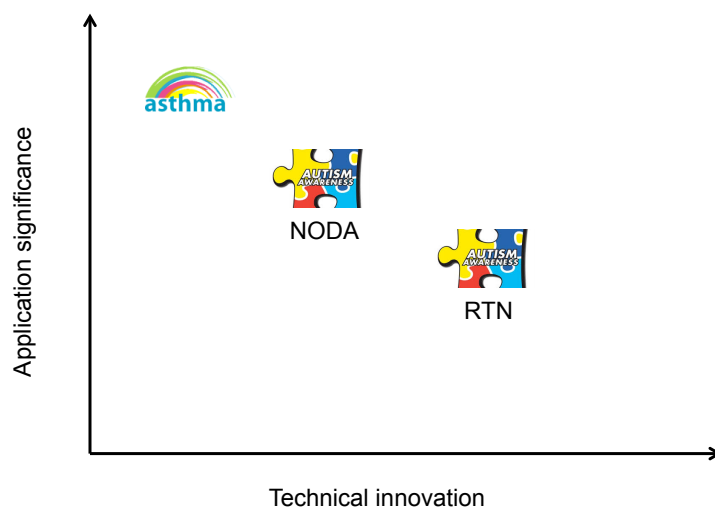
Pulling it all together



Preliminary results

		Actual		Predicted	13 TD children (avg. 20 mos) 19 name calls Precision = 1.00 Recall = 0.83
		Response	No Response		
Response	Response	10	0		
	No Response	2	7		

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Irfan Essa, Edison Thomaz, Vinay Bettadapura
Intel

Semi-automated food journaling

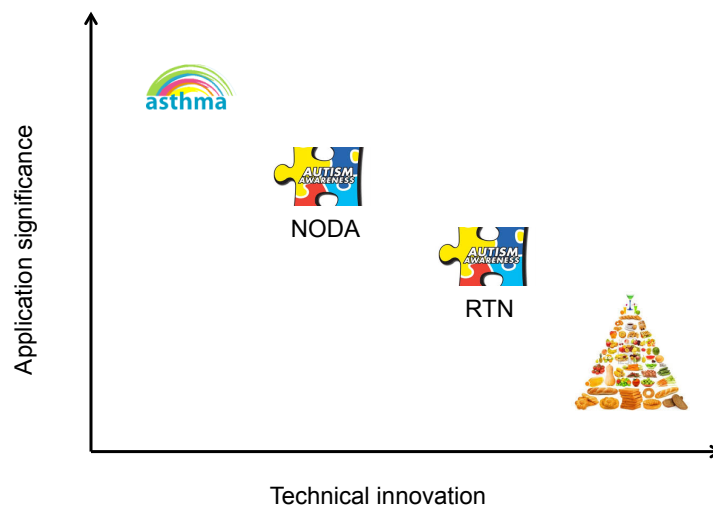
- This will not soon be automated, and perhaps never should be
- Very challenging multimodal activity recognition problem
 - POV, sound, accelerometry, location
 - Privacy-Saliency challenges

Goal: Detecting the moment of eating

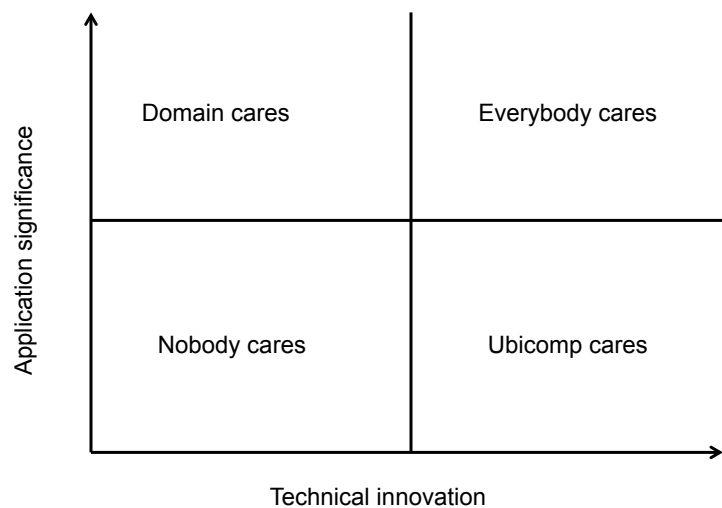
- Why? Journaling is best diet intervention
- Detecting urges
- Just in time info (e.g., CHF and salt)



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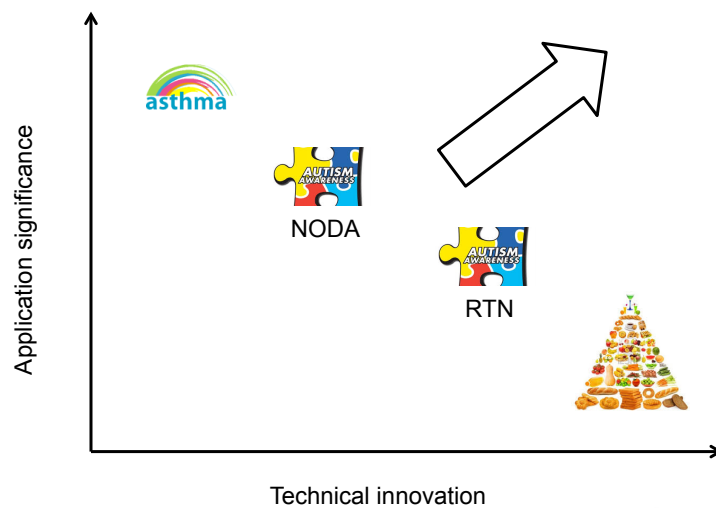
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Where should we aim?



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Reflecting on RTN

- In the lab, it's very controlled, and humans can do this easily
 - Or can they?
 - Automated measurements can reveal finer detail
- What about doing this “in the wild”?
 - Using Point of View (POV) imagery
 - Circle time in a daycare setting with multiple children
- Exploiting other sensing modalities
 - Currently: vision + audio
 - Soon: physiology (EDA, heart rate)



What is after Ubicomp?

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40's
main frame
Many P to 1 C

Generation 2

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Generation 4

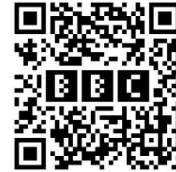
2000's (?!?!)
Crowd/cloud + social + wearables
many P to many C



Another defining characteristic

UbiComp

- Blurring the distinction between digital and physical worlds



Gen 4

- Blurring the distinction between what is human and what is computing



amazon mechanical turk™
Artificial Artificial Intelligence



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What does this mean for health?

(Bold) predictions

- In < 5 years, the majority of clinically relevant data will be collected outside of clinical settings.
- Health will be more consumer driven and you will get real, actionable advice from more than your network of health professionals.
- Health research will be more “n of 1” versus RCT.

Gen 4 computing will be essential.



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Thank you!



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- ACM

