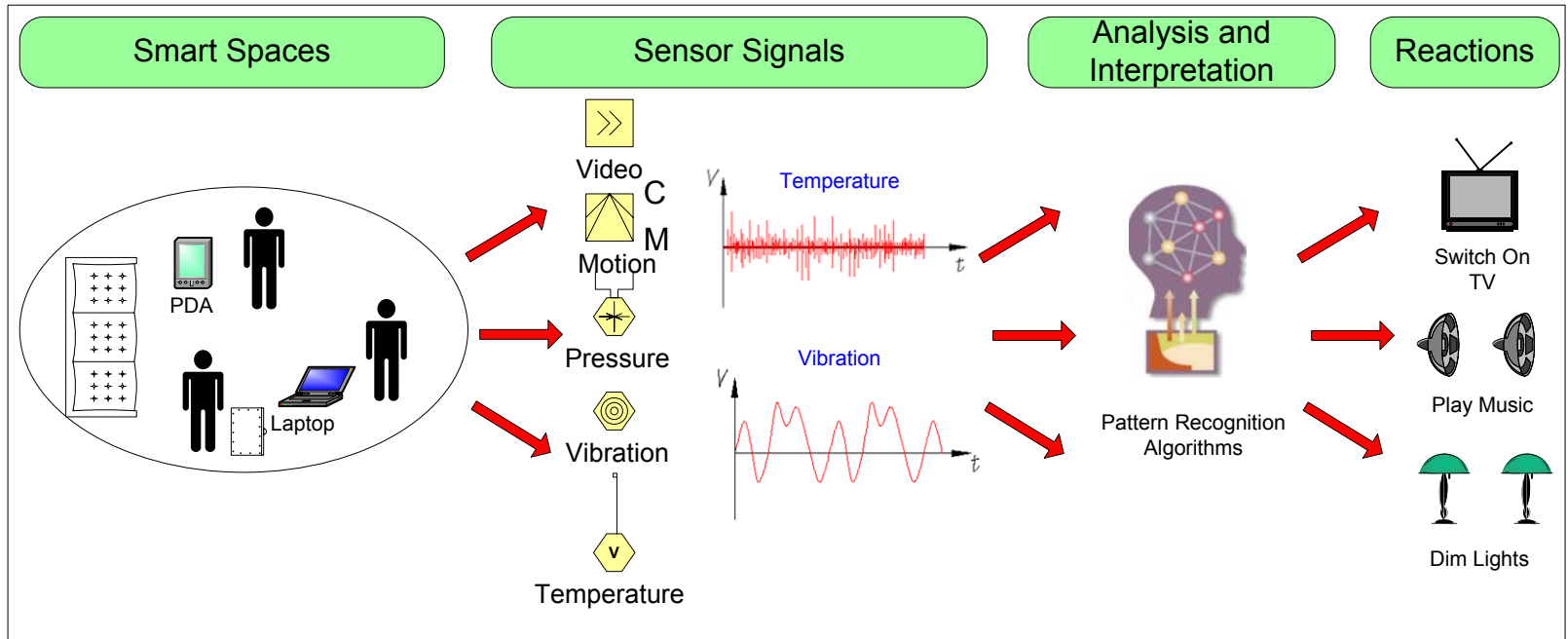

Three Desirable Properties of Activity-Oriented Intelligent Systems

Fahd Al-Bin-Ali and Nigel Davies

The Vision

- The walls have eyes and ears!



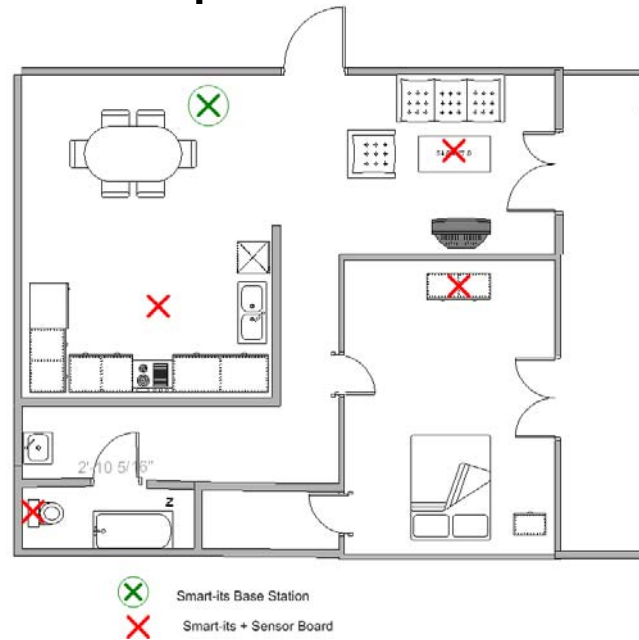
- Calm Technology

Desirable System Properties

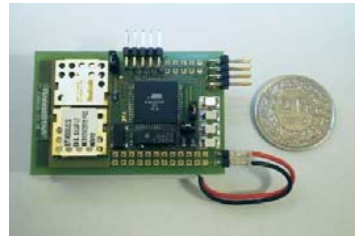
- Accuracy
 - Adaptability
 - Comprehensibility
-

The System

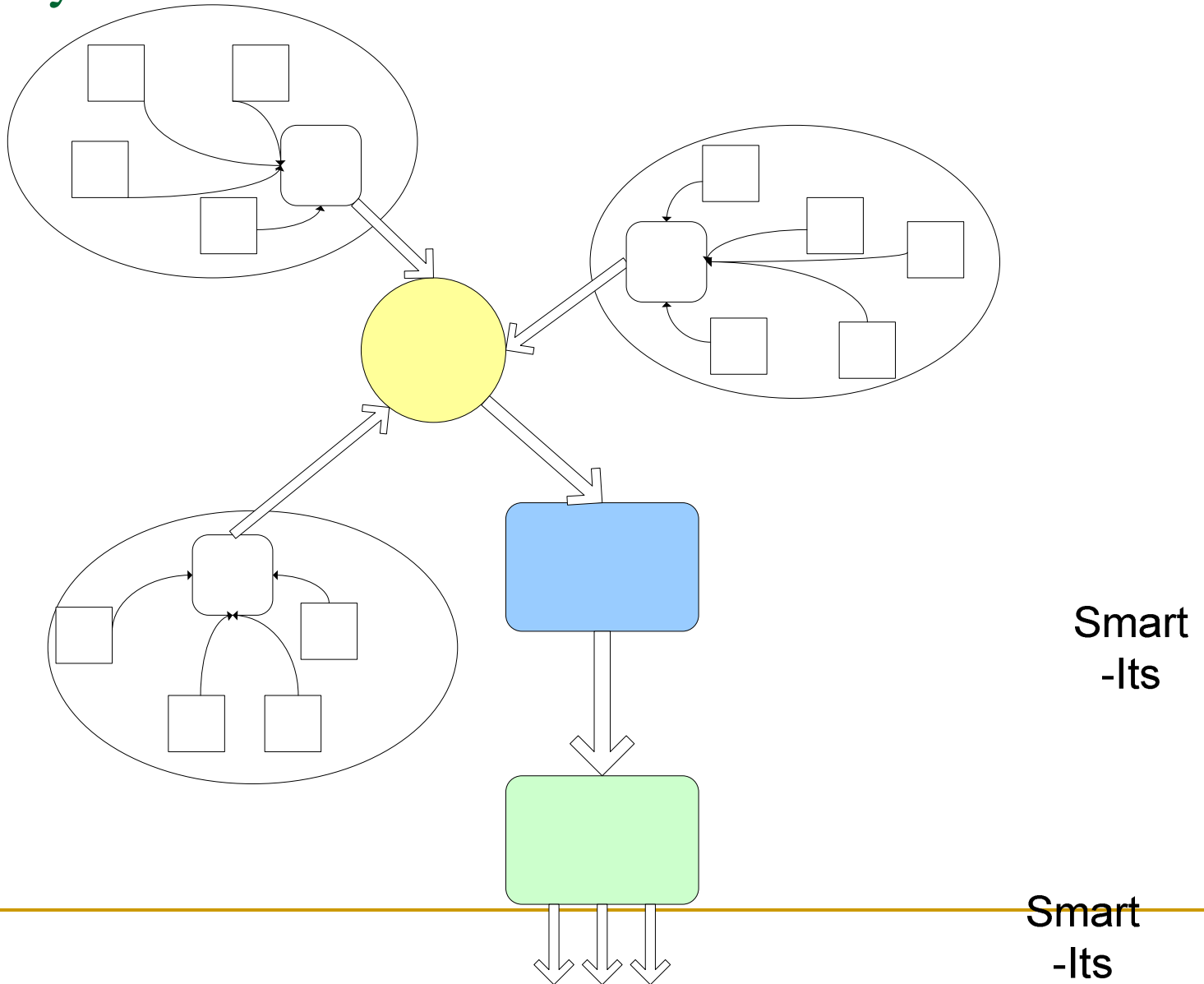
- Domestic Space Setup



- Hardware and Software Sensors



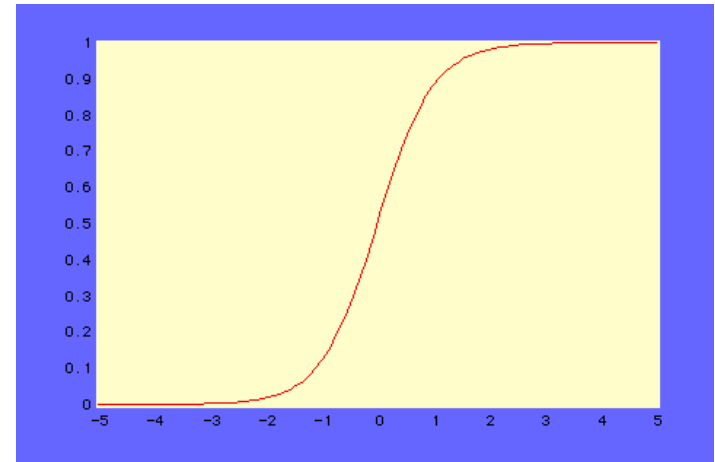
The System



The Model

- Data Preprocessing
 - Variable Selection
 - Principle Components
- Multinomial Logistic Modeling

$$\pi_{ij} = \frac{e^{x_i^T \beta_j}}{1 + \sum_{k \neq j^*} e^{x_i^T \beta_k}}$$



The Model

- Why Logistic Regression?
 1. Suitable for Modeling Probabilities
 2. Deals with both quantitative and qualitative variables
 3. Potentially Comprehensible
 - Explicit and Simple Functional Form
 - Odds Ratio
 - Model Assumptions
 - Responses follow a multinomial distribution
 - Responses are accompanied with a monotonic change in the observed variables
 - Samples are independent
 - Models are dependent
-

Fitting the Model

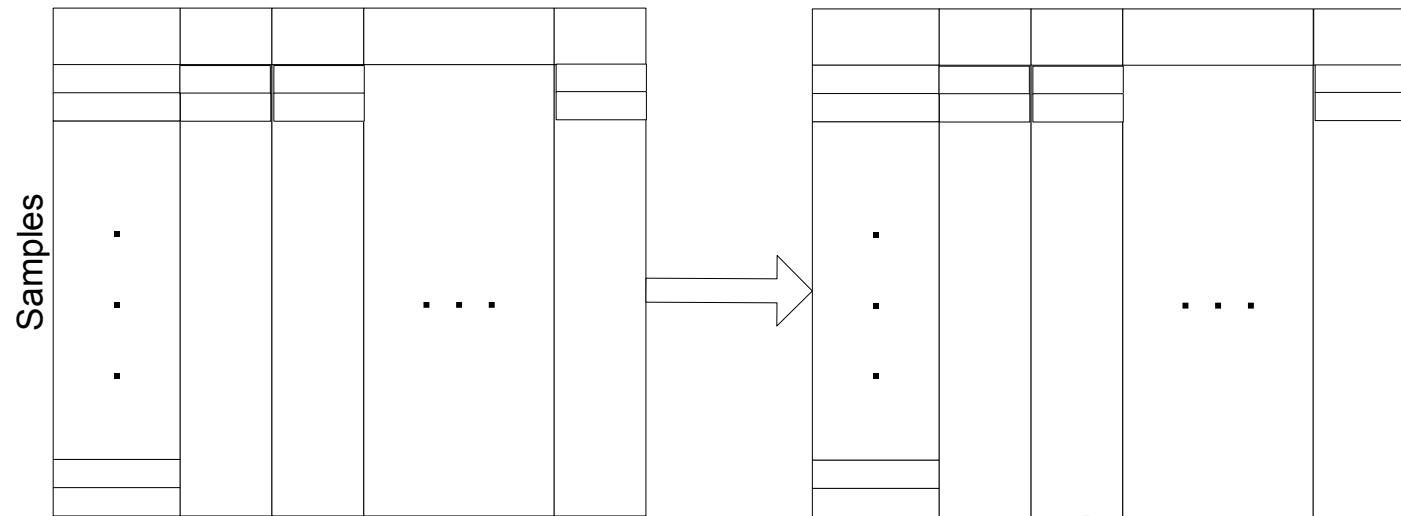
- Consider each sample as a Bernoulli experiment with outcomes 1 indicating that the sample belongs to category j and 0 indicating some other category and probability:

$$\pi_{ij} = \frac{e^{x_i^T \beta_j}}{1 + \sum_{k \neq j^*} e^{x_i^T \beta_k}}$$

- For r activities, fit $(r-1)$ logistic formulae that compute $r-1$ probabilities for every sample. Trivially, compute the r^{th} probability
- Estimate the Coefficients using MLE, using the multinomial likelihood

$$L(\beta) = \prod_{i=1}^n \prod_{j=1}^r \pi_{ij}^{y_i^j}$$

Activity Prediction



Activity k such that
 $\forall m, \pi_{ik}(s) > \pi_{im}(s) \ \& \ m \neq k$

Activities

Sens

1

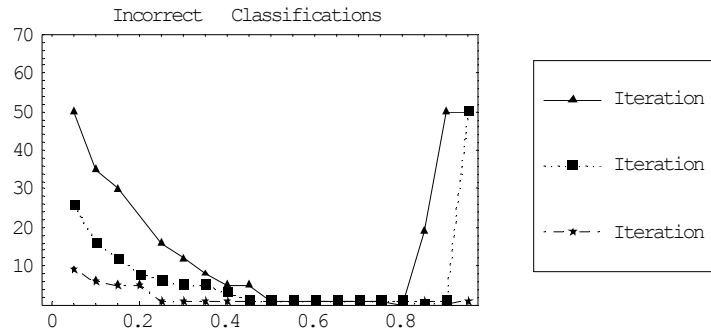
1

123

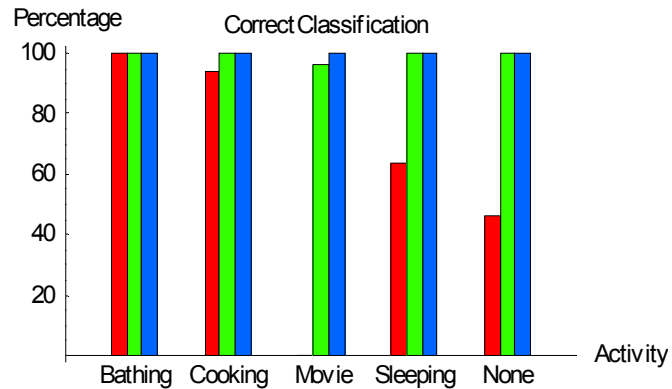
2

232

Experimental Results (Variable Selection)

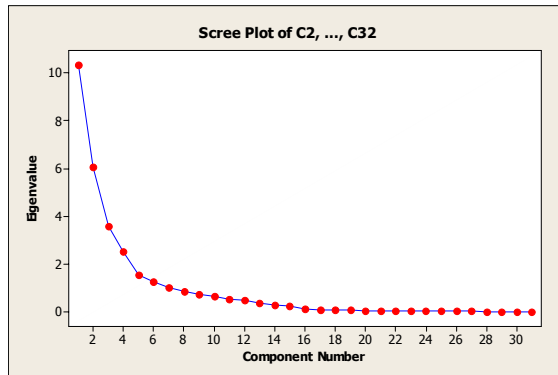


Binomial Logistic Regression

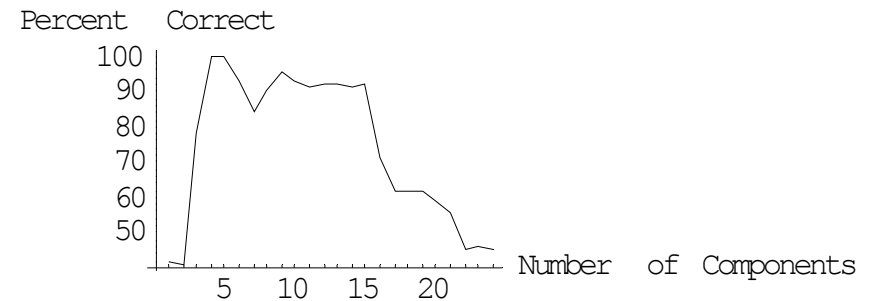


Multinomial Logistic Regression

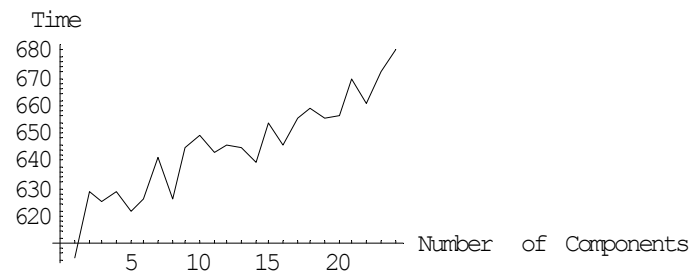
Experimental Results (Principle Components)



Eigen Variability



Classification Performance



Classification Time

Future Work

- Spatial and Temporal Modeling
 - Experimenting with end-user initialization
 - Relaying explanations to end-users
-

More Information

- Source Code at <http://www.fahd.albinali.name>
 - IPAQ User Applications
 - Multinomial and Binomial Logistic Demo
 - Sensor Code (Lancaster + C# Stubs code)
 - C# Stubs for Event Heap.
 - Email: albinali@cs.arizona.edu
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