Selected Topics Communications and Mobile Computing
(Smart Health)

TU Graz

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Mental Illnesses

- Mental illness is a term that refers to disorders that are characterized by disturbances in thinking, mood, or behavior, or a combination thereof, associated with distress or impaired functioning

- Mental illness can be caused by physical illnesses, biochemical abnormalities in the brain function, stress and other environment factors; often a combination of these factors contributes to causing a mental illness

Signs and Symptoms

- **Symptoms** are subjective feelings and sensations that the person is aware of
    - A person may say: "I feel low, sad, and depressed"
- **Signs** are objective observable behaviors that the person demonstrates
    - A person may look very sad, and move and speak very slowly
- The more symptoms and signs a person has, the more likely it is that she/he has a mental illness

Common Signs

- **Agitation:** Because the symptoms of mental illness can be very distressing, a person may become very agitated, upset, and restless

- **Anxiety:** Very common symptom and sign of many serious mental illnesses, including depression and psychotic illnesses; the person may show signs of excessive fear such as sweating, breathing very fast, and being agitated

- **Abnormal mood:** In acute phases of mental illness, there are unusual or extreme qualities to the person's mood; moods can also change very quickly from a reduced emotional response (indifference, apathy) to an extreme of emotions (ecstasy)

- **Confusion:** This is a general term and could mean that the person is disoriented or incoherent (unable to conduct an understandable conversation)

Common Signs

- **Incoherent speech:** Persons with mental illness may not be able to conduct a coherent conversation; their speech may ramble from one unrelated topic to another, they may not be able to answer questions, and they may also talk about things that are strange or unrealistic or not speak at all

- **Changes in eating and sleeping:** A marked change can also indicate a problem

- **Unusual beliefs or delusions:** A person with a mental illness may have strange beliefs and ideas, such as someone trying to destroy them or that they have special powers, or that they are being persecuted or threatened in some way (being poisoned, followed, under threat of assassination)

Common Signs

- **Hallucinations:** Sometimes persons with mental illness experience disturbances in sensory perception (of sight, hearing, smell, taste, or touch); they may say that they are hearing voices or that they are feeling things in their body

- **Aggression or violent behavior:** Although most people with a mental illness do not become aggressive, some may do so, and such persons can display any type of aggression (verbal, physical)

Common Signs

- **Appearance**: In an advanced stage a person with mental disorder may look neglected, unwashed, or may not have changed their clothes for sometime, or may be dressed strangely

- **Other unusual behavior:** The person may be wandering in the streets, appear to be homeless, may also walk into direct traffic, shout in the street, and become verbally abusive or aggressive to bystanders

Types of Mental Illnesses

- Adjustment Disorders (stress, sad, hopeless)
- Anxiety Disorders (fear, worry, panic)
- Dissociative Disorders (memory, identity, sense of self)
- Eating Disorders (anorexia, bulimia)
- Impulse-Control Disorders (temptation, urge, impulse)
- Mood Disorders (depression, bipolar)
- Personality Disorders (paranoia)
- Psychotic Disorders (schizophrenia)
- Sleep Disorders (apnea, narcolepsy)
- Somatoform Disorders (hypochondriasis)
- Substance Disorders (alcohol, drugs)

Identifying Psychological Disorders

- Deciding what behaviors, thoughts, or feelings are "normal" or "abnormal" can be difficult
- Normal is average for the majority of people. Using this definition of normality, deviation from the majority becomes the primary criteria for abnormality
- Socially Unacceptable Behavior
  - Laughing is a healthy outlet for most people
  - Laughing all the time and especially in inappropriate situations, might be considered abnormal
  - Behavior that violates a society's accepted norms
    - Unwritten rules
    - Culture-bound syndrome
    - Norms change over time

Maladaptivity

- Behavior that impairs an individual's ability to function adequately in everyday life

- Example would be behavior that causes misery and distress rather than happiness and fulfillment

- Example: Alcohol abuse is a behavior; alcohol abuse often has strong negative effects on the drinker's health, work, and family life

Anxiety Disorder

- Phobic disorder (irrational fear)

- Panic disorder (panic attacks)

- Generalized anxiety disorder (excessive, ongoing anxiety about many different things)

- Obsessive-compulsive disorder (uncontrollable, reoccurring thoughts and behaviors)

- Stress disorders (physical, mental, or emotional stress)

Generalized Anxiety Disorder (GAD)

- Excessive or unrealistic worry about life circumstances that lasts for more then 6 months

- Most common anxiety disorder

- Often people with GAD have other anxiety disorders too

Psychological Views on Anxiety Disorders

- Based on learning theorists ideas- if child picks up spiders and adult freaks out then child learns to be phobic

Biological Views

- Born with disorders
  - Example: if one identical twin shows disorder, the other has a 45% chance of developing the same
  - Passed down through the gene pool; ancestors more likely to survive and reproduce if they had fears of real dangers, such as heights, snakes, etc.

Obsessive-Compulsive Disorder (OCD)

- Obsessions- unwanted thoughts or ideas that occur over and over again (fear of somebody breaking into the house)

- Compulsive- repetitive ritual behaviors, often involving checking and/or cleaning something over and over again (rechecking the locks on windows and doors of the house a dozen times or more before can relax)

Post-traumatic Stress Disorder (PTSD)

- Occurs after severe trauma: war, rape, child abuse, natural disaster, etc.
  - Not everyone who experiences a trauma will develop this
  - Symptoms can start up to 6 months after trauma and last for years
  - Acute stress disorder- similar to PTSD, but coming on sooner and not lasting as long

  - Flashbacks
  - Nightmares
  - Numbness of feeling
  - Avoidance of situations related to trauma
  - Difficulty sleeping and relaxing

Dissociative Disorder

- Do you sometimes space out during class?

- Do you sometimes miss a turn/exit because you were thinking of something else?

- Do you get so involved in a book or show that you don't hear your name?

- If you answered "yes" to any or all of the questions you have **dissociated**

Dissociative Disorder

- People will remove themselves mentally from a stressful/traumatic situation to reduce the anxiety

- Sometimes people will lose their memory or identity: dissociative amnesia:

  – Forget the events surrounding a stressful/traumatic event

  – Can last a few days to years

  – Not associated with head injury

  – Common during war time or natural disasters

Dissociative Disorder

- Dissociative Identity Disorder
  - Multiple personality disorder
  - Two or more personalities within the same person
  - Each personality has different voice, personality, facial expression
  - Personalities control the individual when they are in that state
  - Common in children who have experienced severe abuse

Depersonalization Disorder

- Feelings of being outside body watching events going on around you

- Again most often happens after traumatic or stressful event

Mood Disorders

- Extreme emotions that are not connected to "real" event or situatation

  – Depression- feelings of helplessness, hopelessness, worthlessness, guilt, sadness

  – Bipolar disorder- cycle of moods from depression to manic (elated, hyper-active, etc.)

  – Major depression is one of the most common mental illnesses, affecting 6.7% (more than 16 million) of American adults each year

Depression Signs

- Persistent depressed mood for most of day
- Loss of interest or pleasure in all activities
- Significant weight loss or gain due to changes
- Sleeping more or less than usual
- Speeding up or slowing down of physical and emotional reactions
- Fatigue or loss of energy
- Feelings of worthlessness or unfounded guilt
- Reduced ability to concentrate or make meaningful decisions
- Recurrent thoughts of death or suicide

Potential Digital Biomarkers

- "Easier":
  - Avoiding social exposure, seclusion
    - Mobility and social exposure sensors
  - Sadness
    - Activity levels and types; entertainment choices
  - Repetitive behaviors & memory problems
    - Activity sensors
  - Sleep problems
    - Sleep quality & sleep pattern sensors
  - Substance
    - Gait, balance, sweating, heart rate, …
- Tougher:
  - Personality, psychotic, eating, somatoform, …

Example: MoodScope

- Turn smartphone into "sensor"

- Focus on daily mood assessment

- Use only available low-power information
  - No audio/video sensing
  - No bio instrumentation
  - Non-invasive
  - Application-independent
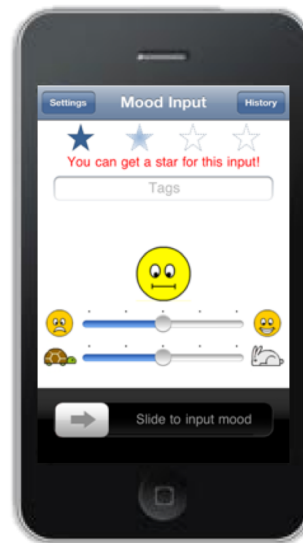
Mood is …

- … a persistent long-lasting state
  - Lasts hours or days
  - Emotion lasts seconds or minutes

- … a strong social signal
  - Drives communications
  - Drives interactions
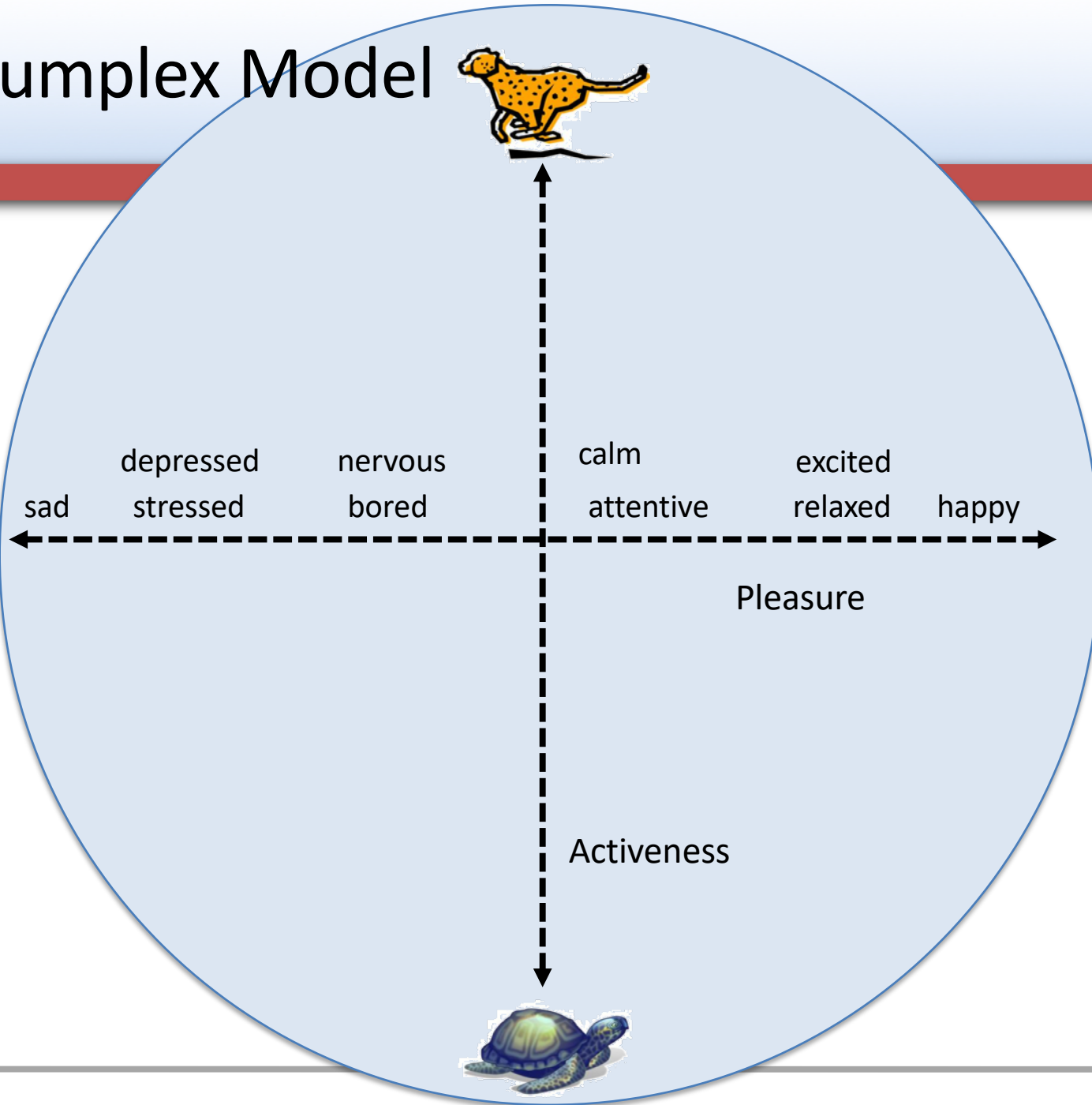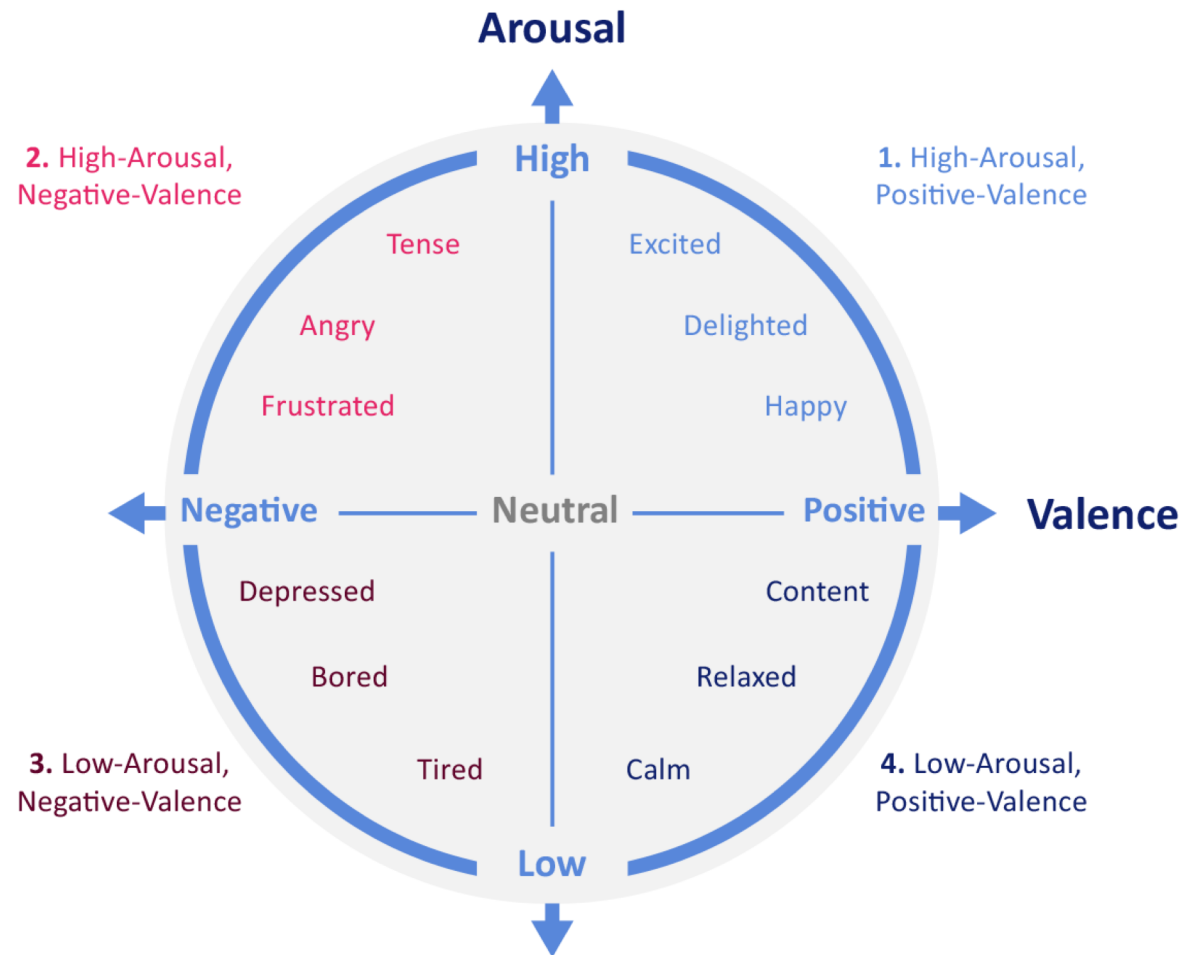 - Drives activity patterns

Mood Sensing

Affective Computing

Biometric-based

(Skin conductivity, Temperature, Pulse rate)

Time series data

High cost of deployment
Requires skin contact

Audio/Video-based

(AffectAura, EmotionSense)

Captures expressions

Power hungry
Slightly invasive

Mood Sensing

Usage trace-based
(MoodScope)

Passive; continuous

How to model mood?

Audio/Video-based

Captures expressions
Power hungry
Slightly invasive

Biometric-based
Very direct; fine-grained
High cost of deployment

MoodScope

$$f (\ usage\ ) = mood$$

Circumplex Model

Valence-Arousal Model

MoodScope

- How is the user communicating?
  - Maybe people text more when they're happy and call more when they are angry
  - Call mom when sad
  - Longer text messages
- What apps is the user using?
  - Social applications
  - Games
  - Web Browser
  - Music player

iPhone Livelab Logger

- Web history

- Phone call history

- SMS history

- Email history

- Location history

- App usage
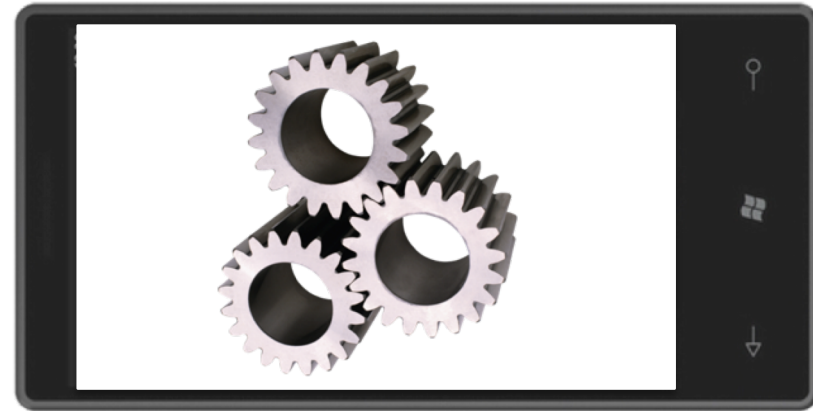
Adapted From C. Shepard, A. Rahmati, C. Tossel, L. Zhong, And P. Kortum, "Livelab: Measuring Wireless Networks And Smartphone Users In The Field," In *Hotmetrics*, 2010.

Mood Journaling App
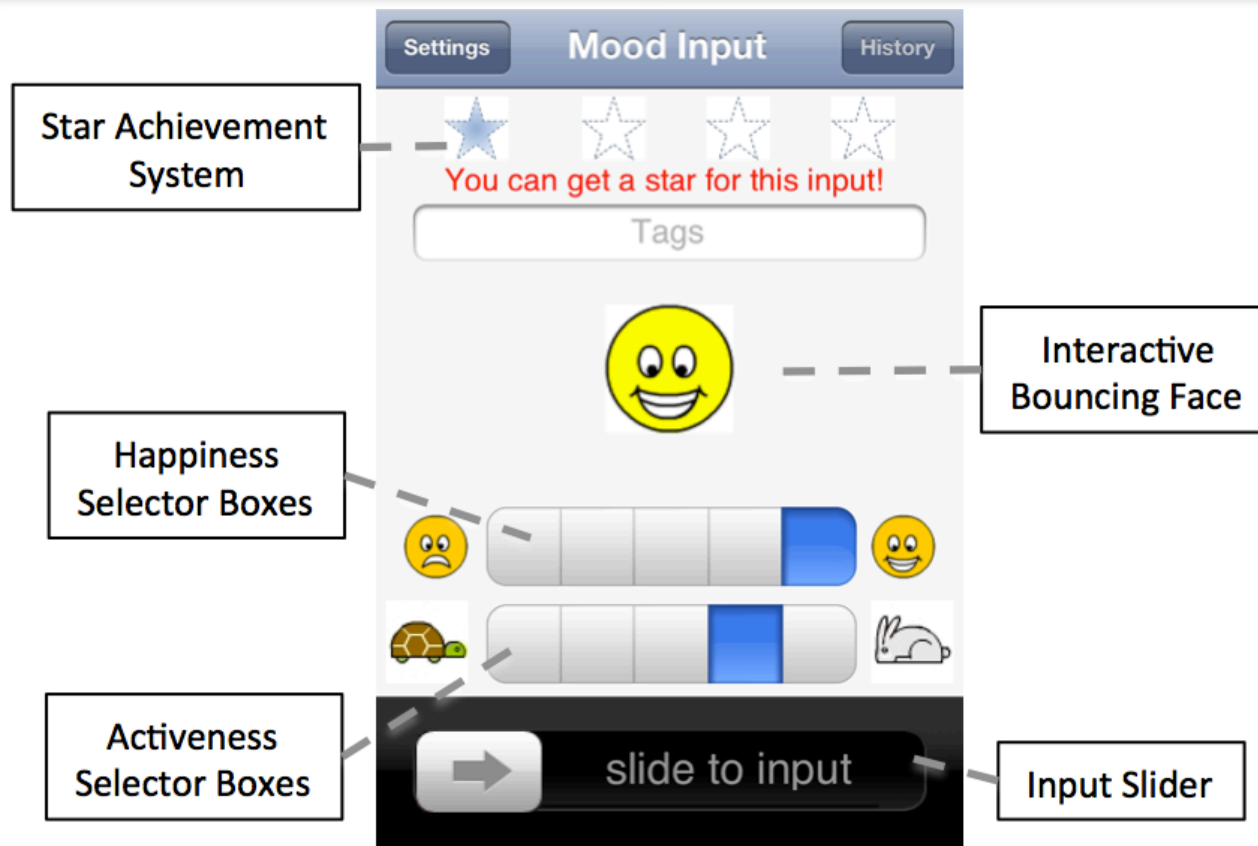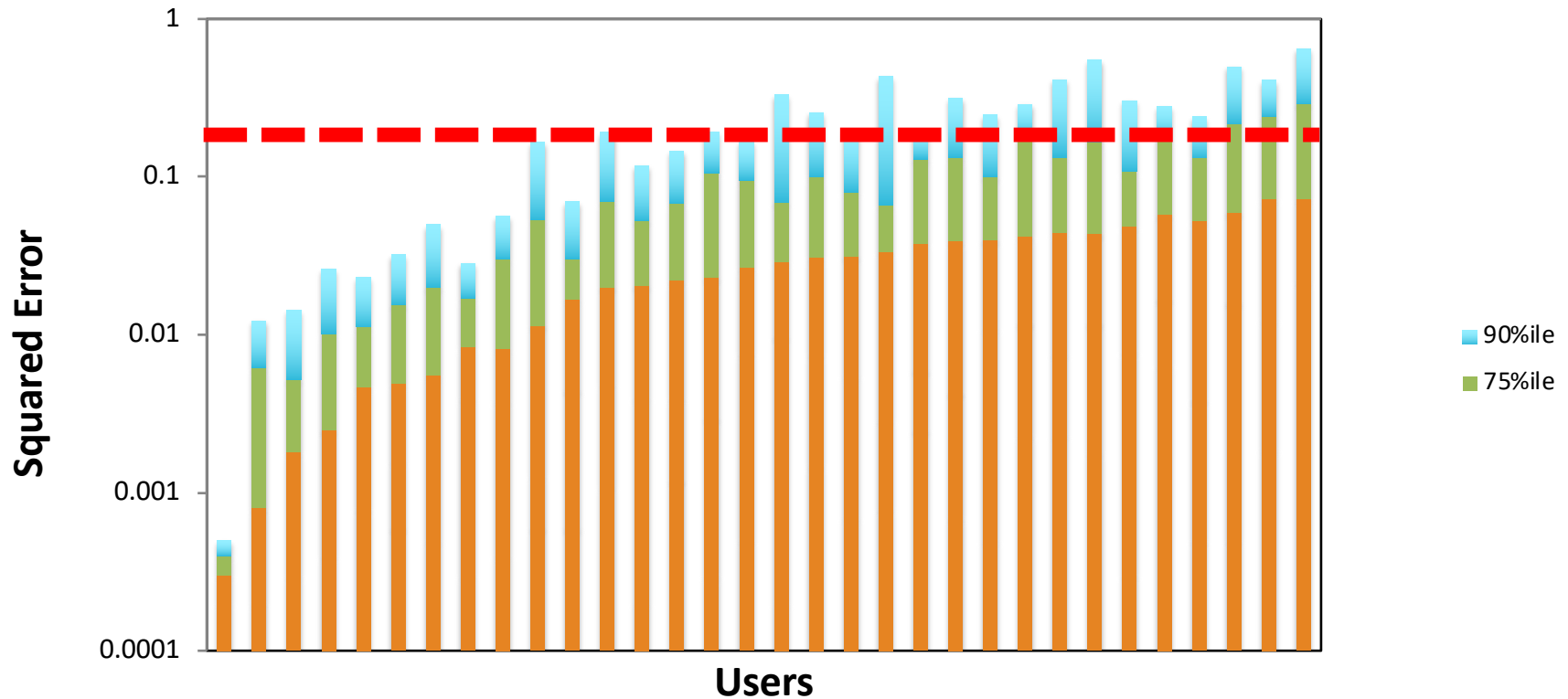

User-base
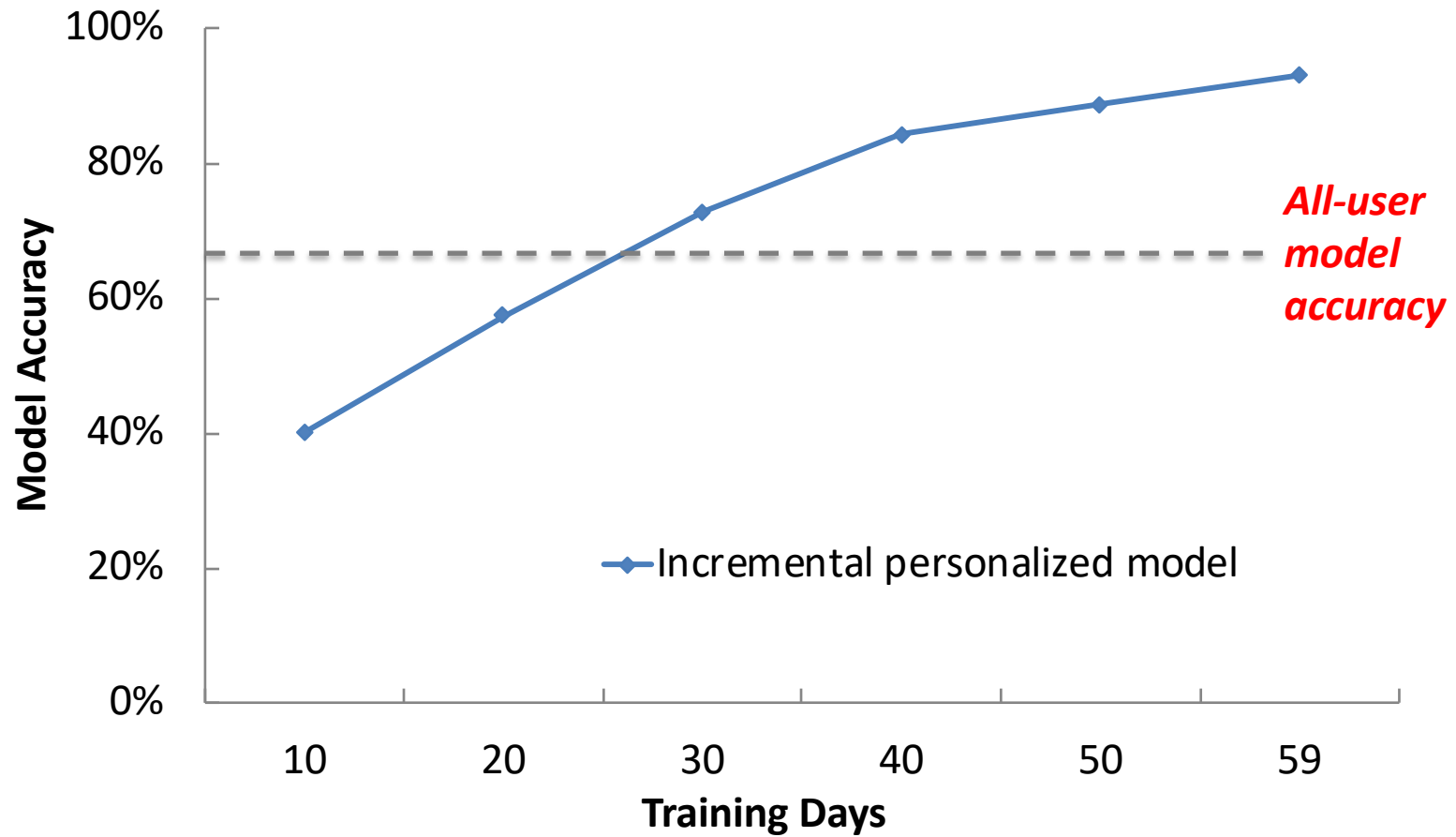32 users aged between 18 and 29
11 females

Sample Prediction
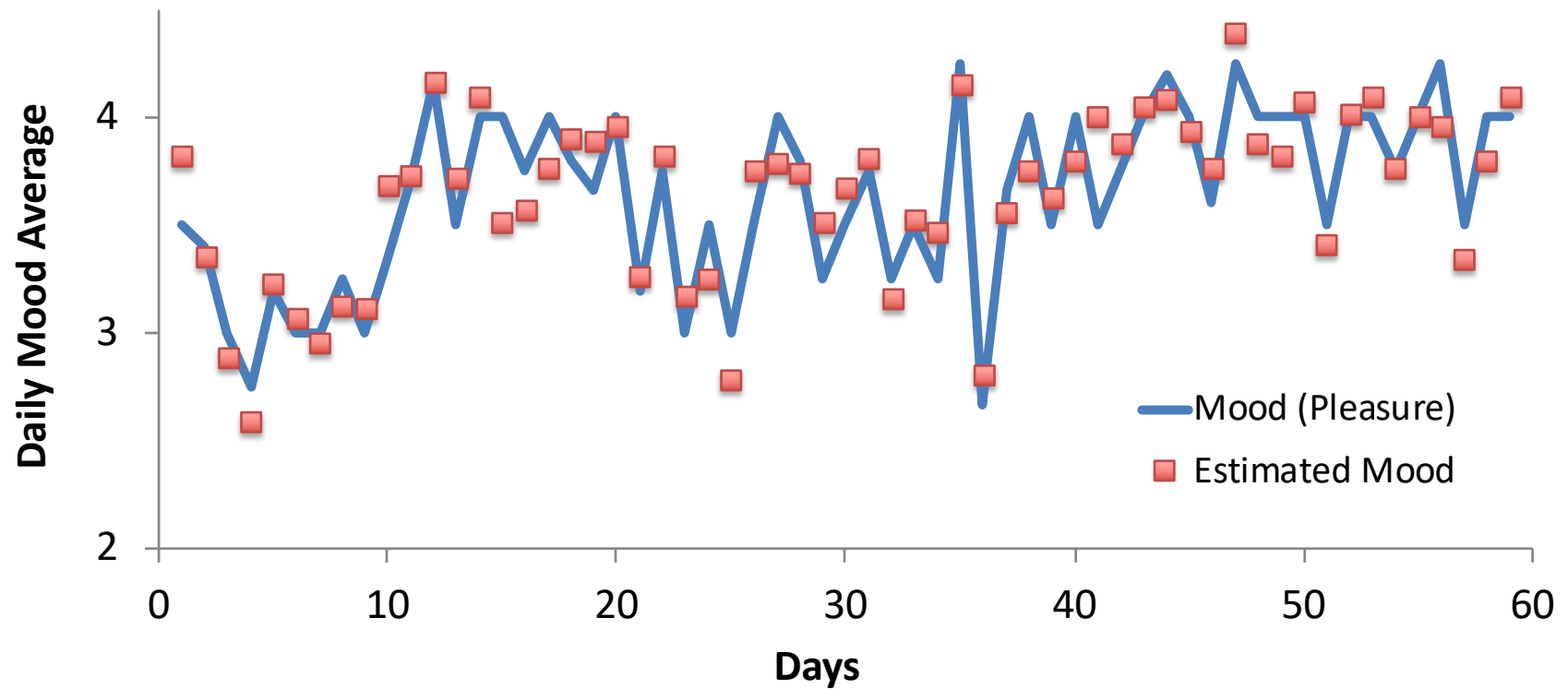
Error Distributions
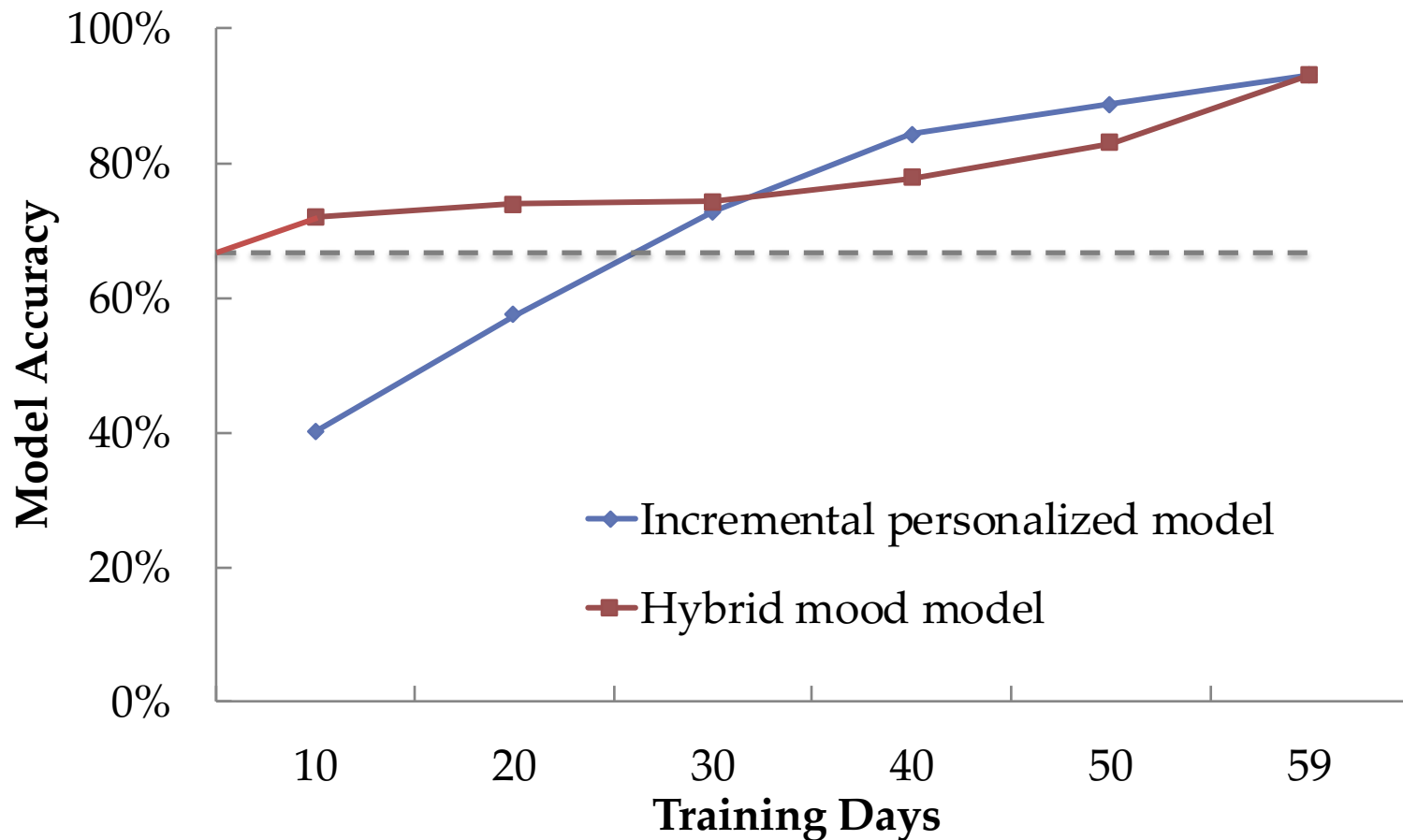
- Error^2 of > 0.25 will misclassify a mood label
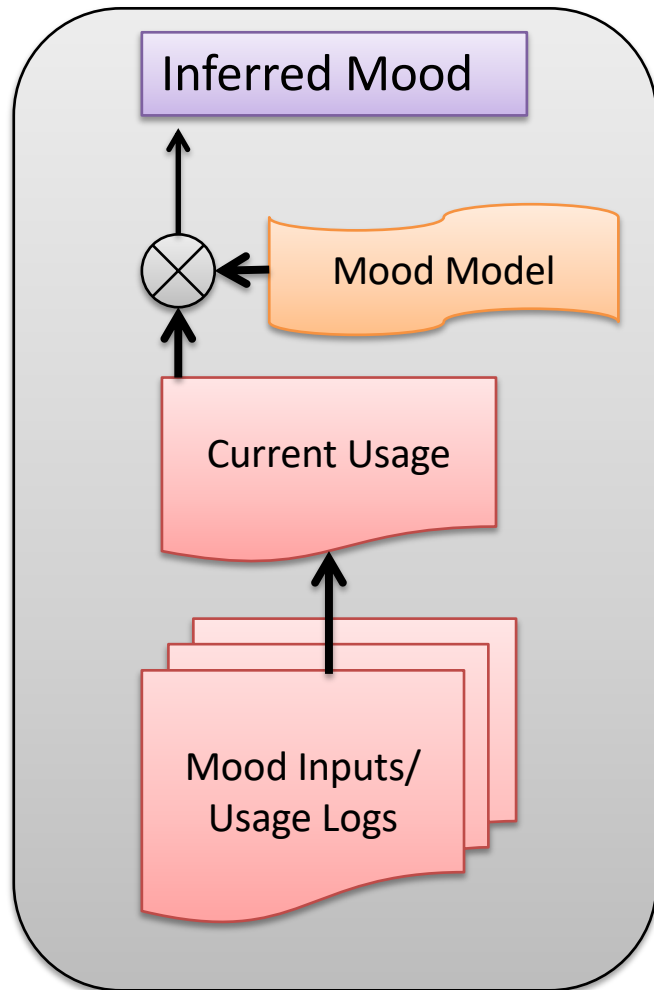
93% < 0.25 error^2

Personalized Training

Personalized/All-user Hybrid Training

Resource-Friendly Implementation

Phone

Cloud

Inferred Mood

Mood Model

Current Usage

Mood Inputs/
Usage Logs

Mood Model

Model Training

Mood and Usage
History
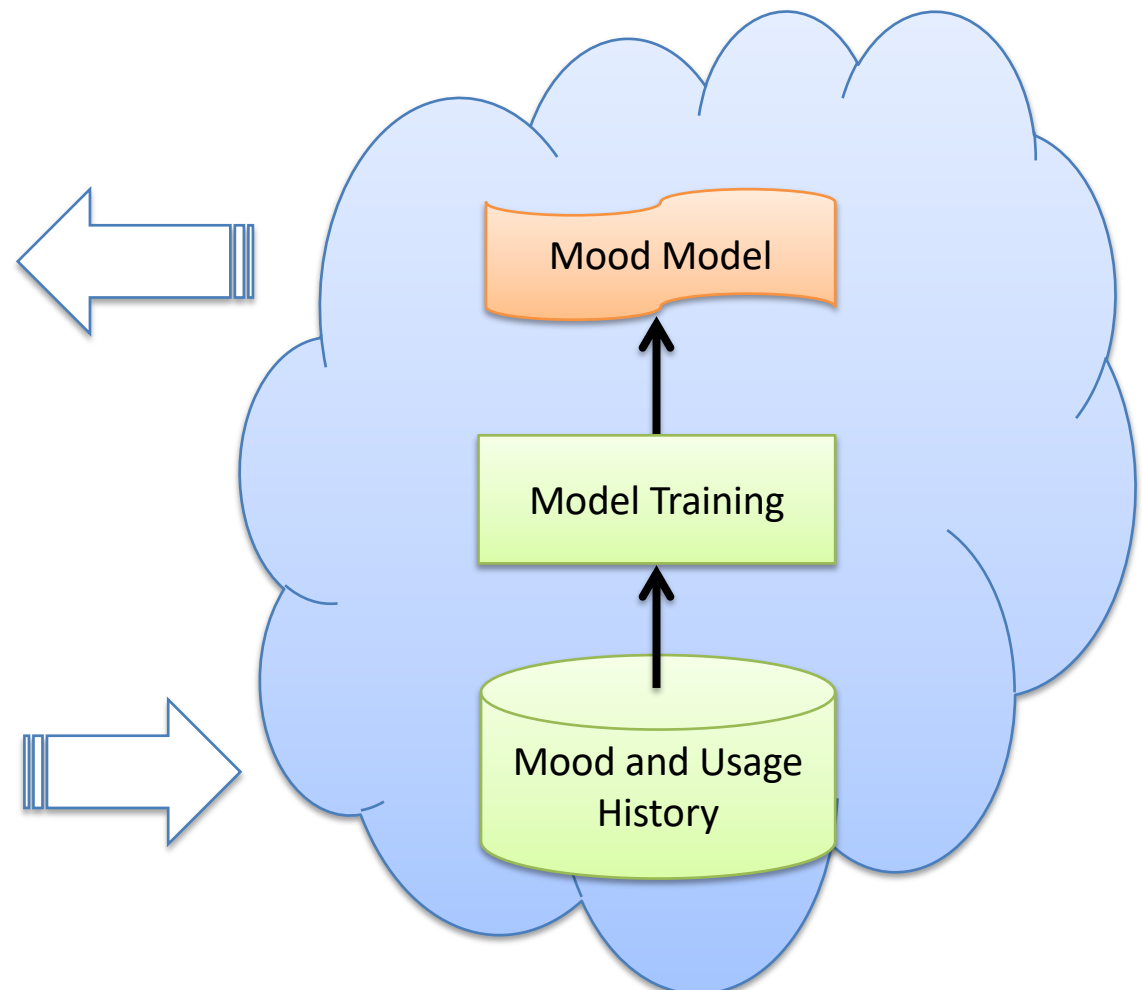
MoodScope

- Robustly (93%) detect each dimension of daily mood
  - On personalized models
  - Starts out with 66% on generalized models

- Validate with 32 users x 2 months worth of data

- Simple resource-friendly implementation

Discriminative Features