MoodScope: Sensing mood from smartphone usage patterns

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Mood-Enhanced Apps

- Personal analytics
- Media recommendation
- Social ecosystems
Affective Computing
(Mood and Emotion)

Biometric-based
(Skin conductivity, Temperature, Pulse rate)
Highly temporal
High cost of deployment
Hassle

Audio/Video-based
(AffectAura, EmotionSense)
Captures expressions
Power hungry
Slightly invasive
Can your mobile phone infer your mood?

From already-available, low-power information?*

* No audio/video sensing, no body-instrumentation
MoodScope ∈ Affective Computing

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
Mood is...

• ... a persistent long-lasting state
  o Lasts hours or days
  o Emotion lasts seconds or minutes

• ... a strong social signal
  o Drives communications
  o Drives interactions
  o Drives activity patterns
Circumplex model (Russell 1980)
How is the user communicating?
What apps is the user using?
\[ f(\text{usage}) = \text{mood} \]
iPhone Livelab Logger

- Web history
- Phone call history
- Sms history
- Email history
- Location history
- App usage

Mood Journaling App

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

• Detect a mood pattern
• Validate with only 60 days of data
• Wide range of candidate usage data
• Low computational resources
Daily Mood Averages

- Separate pleasure, activeness dimension
- Take the average over a day
Exploring Features

• Communication
  o SMS
  o Email
  o Phone Calls

• To whom?
  o # messages
  o Length/Duration

Consider “Top 10” Histograms

? How many phone calls were made to #1? #2? ... #10?

? How much time was spent on calls to #1? #2? ... #10?
Exploring Features

- Communication
  - SMS
  - Email
  - Phone Calls

- To whom?
  - # messages
  - Length/Duration

- Usage Activity
  - Applications
  - Websites visited
  - Location History

- Which (app/site/location)?
  - # instances
Previous Mood

- Use previous 2 pairs of mood labels
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<th>Dimensions</th>
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Model Design

- Multi-Linear Regression
  - Minimize Mean Squared Error
- Leave-One-Out Cross-Validation
- Sequential Forward Feature Selection during training
Sequential Feature Selection

Improvement of model as SFS adds more features

(Each line is a different user)
Sample Prediction
Error distributions

- Error^2 of > 0.25 will misclassify a mood label

93% < 0.25 error^2
vs. Strawman Models

Models using full-knowledge of a user’s data with LOOCV

Model A: Assume User’s Average Mood
73% Accuracy

Model B: Assume User’s Previous Mood
61% Accuracy

MoodScope Training: 93% Accuracy.
Personalized Training

Model Accuracy

Training Days

Incremental personalized model

All-user model accuracy
Personalized/All-user Hybrid Training

- Incremental personalized model
- Hybrid mood model

Model Accuracy vs. Training Days
Resource-friendly Implementation

Phone

- Inferred Mood
- Mood Model
- Current Usage
- Mood Inputs/Usage Logs

Cloud

- Mood Model
- Model Training
- Mood and Usage History
Inferred Mood
MoodScope:

Sensing mood from smartphone usage patterns

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

• Validate with 32 users x 2 months worth of data

• Simple resource-friendly implementation