

# Using Participatory Sensing to Monitor and Self-Manage Chronic Illnesses

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# Chronic Illnesses

- ❑ An illness lasting longer than three months
- ❑ Treatment can become expensive
- ❑ Doctors attempt to treat the symptoms
- ❑ Patients want to live a normal life



# Too Many Chronically-ill Patients

- ❑ Increasing at a high rate
- ❑ Not enough doctors to compensate
- ❑ Patients need a way to help themselves



# Overview

- ❖ Participatory Sensing
- ❖ Sensor Networks
- ❖ Goals and challenges of using participatory sensing
- ❖ A look into a method to monitor coughs
- ❖ Conclusion

# What is Participatory Sensing?

- ❑ Uses sensors to collect data
- ❑ The data is then converted into meaningful information
- ❑ The user decides when the sensing happens
- ❑ Handheld devices are commonly used with participatory sensing
  - ❑ Smart phones have many sensors
- ❑ The sensors are part of a sensor network

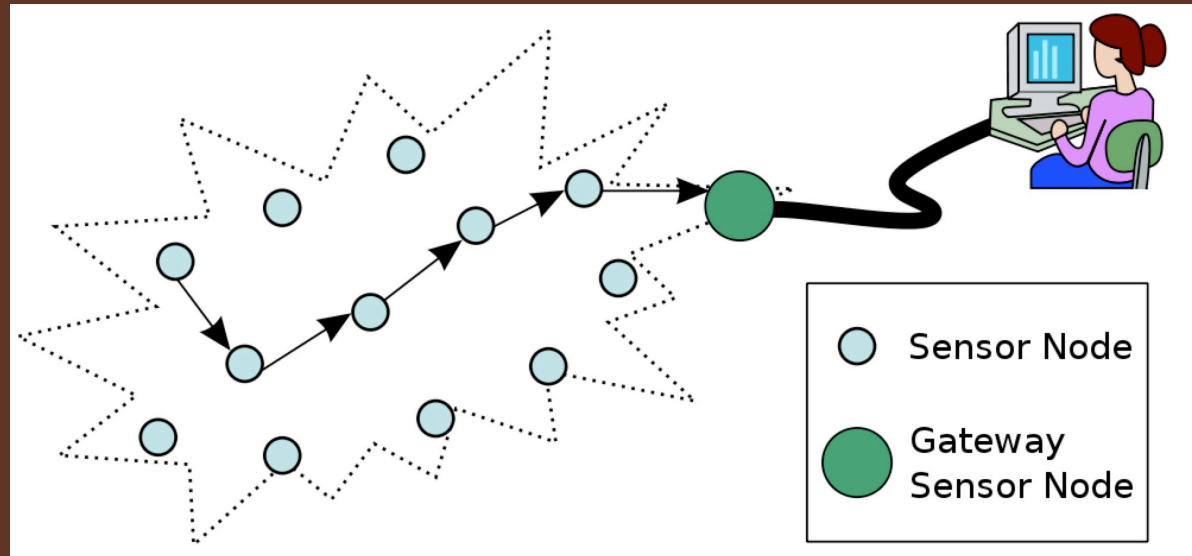
# Example of Participatory Sensing



A heart rate monitor

# Sensor Networks

- ❑ Most are now wireless sensor networks (WSN)
- ❑ Many nodes and each node has a sensor
- ❑ A distributed architecture
- ❑ Sensors for physical and environmental conditions



# Helping Chronically-ill Patients

- ❑ Participatory sensing can assist in the self-management process
- ❑ The goals and challenges of using participatory sensing in healthcare:
  - ❑ Provide affordable and user-friendly devices
  - ❑ Meaningful data that is accurate
  - ❑ Protect the privacy of the patient
- ❑ Participatory sensing needs to be appealing



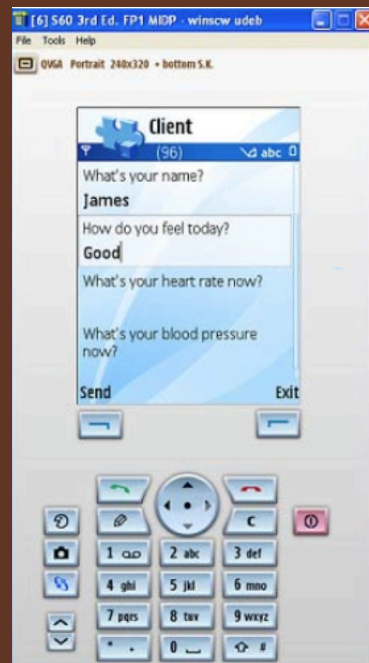
# Accessible and Usable Devices

- ❑ Devices need to be affordable

- ❑ Integration with commonly used devices

  - ❑ 85% of Americans own a cell phone

- ❑ User-friendly software



# Relevant and Accurate Data

- ❑ Data collection needs to be specific based on the illness
  - ❑ Chronic Illnesses can have many symptoms
- ❑ Accurate data allows for better care
  - ❑ Symptoms and frequency of symptoms can determine what medication is needed
- ❑ Helps patients who easily forget how often symptoms occurred

# Preserving the Patient's Privacy

- ❑ Relevant and accurate data is the result of more sensing
- ❑ More sensing means more risk to the patient's privacy
- ❑ Security of the data in the network

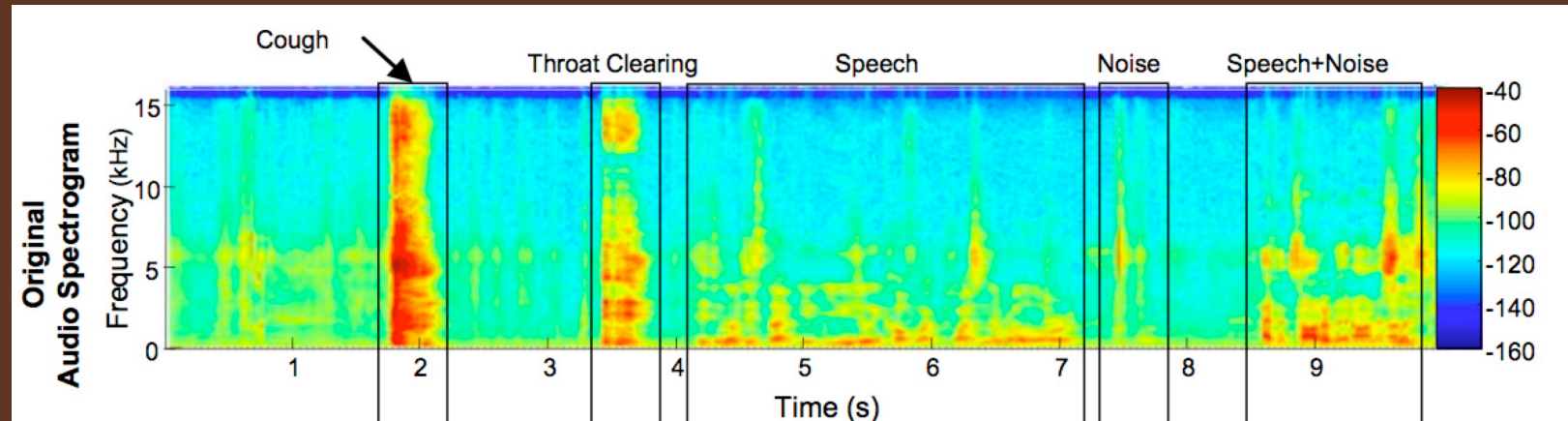
# Respiratory Diseases

- ❑ Diseases, like cystic fibrosis, cause patients to cough frequently throughout the day
- ❑ Patients have a difficult time keeping track of the number of coughs
- ❑ Study done with microphones recording coughs
  - ❑ Average number of coughs recorded per hour was 33
  - ❑ Patients reported 22.8 fewer coughs per hour

# Monitoring Coughs Effectively

- ❑ Recording coughs helps keep track of the exact number
- ❑ Difficult to record only coughs
- ❑ Methods have attempted to record coughs and not private conversations

# Using a Spectrogram



- The decibel level of a cough is much greater than other sounds
- The intensity (decibel level) stretches over a wide range of frequencies of both high and low
- Helps assign values to cough sounds and non-cough sounds

# Principal Component Analysis

- ❑ Using the spectrogram, analysis of components that distinguish a cough from non-cough sounds
- ❑ 10 components
- ❑ Components carry weights
- ❑ Components are used as inputs to a random forest

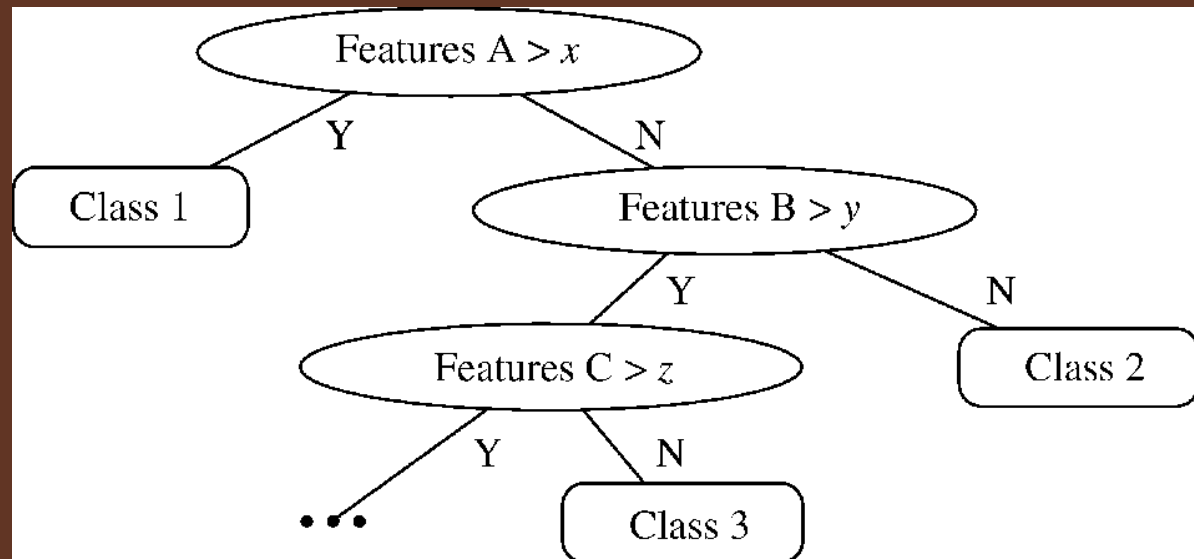
# Random Forests

- ❑ Cough and non-cough events construct the random forest

- ❑ Made up of many decision trees

- ❑ Input passed to forest goes through decision trees

- ❑ The mode classification is the result of the tree





# Results

- ❑ Speech was unintelligible
- ❑ False positives can be removed
- ❑ Used microphone on a cell phone
- ❑ 92% mean true positive rate

# Conclusion

- ❑ Participatory sensing can help manage the growing number of chronically ill patients
- ❑ Must be appealing to patients
  - ❑ Accessible and user-friendly
  - ❑ Helpful when used
  - ❑ Patient feels their privacy is safe

# Acknowledgments

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# References

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