## Abstract

As current pain measurement techniques are largely subjective and incomplete, the need exists for a comprehensive and objective system to evaluate pain. This need stems from the general difficulty of self-evaluating pain, as well as cases where patients are untruthful or unable to communicate their pain levels. An objective system, used in parallel with the current subjective methods, may help doctors more effectively manage pain and prescribe appropriate levels of medication. This project aims to determine relationships between a human's physiological biomarkers and reported pain levels, to develop a pain measurement system that is accurate, efficient, and useful in a hospital setting. Biomarkers under consideration include electromyography (EMG), respiration rate, pupil diameter, galvanic skin response (GSR), electromyography (EMG), heart rate, and skin temperature. To collect data, an ice bucket “cold pain” test is administered on healthy subjects in a laboratory setting, with the seven sensors listed above attached to the subject. Preliminary analysis and pilot studies have confirmed each biomarker as a potentially significant indicator of pain. A preliminary binning procedure was also developed to focus on data surrounding reported pain scores only. The final deliverable will be a numeric prediction model that outputs pain scores based on a patient’s physiological activity. Future plans include dimension reduction of biomarkers, model creation, testing, and validation, and preparation for hand-off to be tested in clinical settings.

## Methodology

A lab cold pain test is in progress, with a target sample population of n = 30. Healthy subjects are connected to the seven sensors shown (Fig. 2-4). Baseline data is collected for 30 seconds. The subject then submerges a hand in a bucket of ice water. As physiological data is collected continuously, the subject gives a verbal pain score every 20 seconds, for a total of 30 measurements. Each measurement is given on a scale from 0 to 10.

Because the sampling rates of the physical sensors are high compared to the verbal pain readings of the cold pain experiment, the study requires a binning procedure to eliminate irrelevant data (Fig. 5). Data captured too far away from the pain readings will not be used. Data within ±3 seconds of each reading will be captured and aggregated to reflect measurements of the body’s responses during each pain interval. These aggregated values will be used in the proceeding modeling processes.