Research Proposal

Title:	identify functionality in black box systems using neural networks.
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Background

distances - DTW, pearson

clustering algorithms - k means, dbscan, gmm

other - hmm, autoencoders

Useful in many areas.

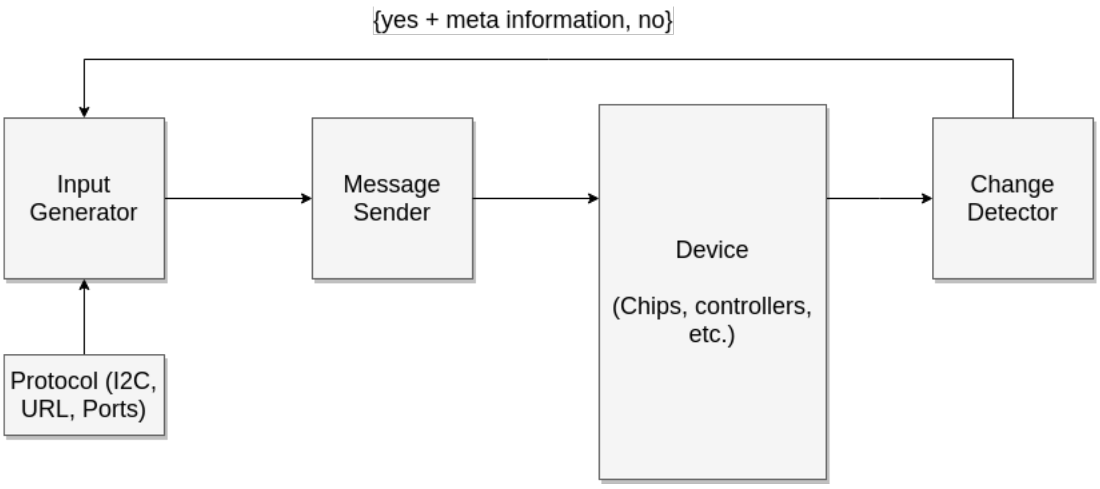
identify the acceptable input grammar. A novel approach to model learning using machine learning. by sending I2C messages and analyzing the power trace with neural networks. Uses: black box HIL testing by manufacturers, finding undocumented functionality for security purposes, input grammar for fuzz tests, inputs for polygraph

Problem Statement

1. **Change Detector**: Given a black box system, determine internal state changes in response to inputs in order to learn the system's behaviour.
2. **Input Generator**: Given inputs and knowledge of previous state changes, what should be the next query to the system?

Method

System


{yes + meta information, no}
Input Generator
Message Sender
Device

(Chips, controllers, etc.)
Change Detector
Protocol (I2C, URL, Ports)

Change Detector

distance based: measure of how much the signal moved dtw: define a threshold. larger difference = more confident.

clustering algorithms: do they require us to input no. of states? online learning? confidence? options: dbscan, k means DBSCAN is good, no states required, identifies noise. BUT we have to recalculate with all data points, every time (BUT only do DTW once, ie. receive batch of responses, cluster, return yes + msg that triggered it, or no or maybe or more than one + msgs.

Bayesian approach: DETERMINE WHICH CLUSTER OR MAKE A NEW ONE. can eliminate noise manually or just accept it. for each state, build an expected signal. that way we save out on memory. if the expected signal has an extremely high standard deviation ... it might be time to make a new cluster but we need some way of matching up signals (apparently you can align them using cross correlation, or custom change detection ie. significant change) compute dtw distance to each expected state signal. (or cluster) return (current state) or (new state, msg that triggered it)

parameters: eps, min samples, const * standard deviation of expected signals for each state

Input Generator

L star algorithm: can't because we don't have an oracle that can give us a counterexample, unless we search and depend on our clustering algorithm? randomization

step 1: determine active msgs. step 2: try to change the state: send a bunch of messages while modifying one bit at a time depending on protocol (character for

URL, bit for NMAP packets). step 3: receive response from change detector (yes + msg that triggered it, no, maybe, more than one + msgs)

parameters: protocol specification (json?)

Additional Modules or Functionality

method to convert states and transitions to mealy machine. message sender (already implemented for I2C) focus will be on I2C since system is already in place.