INTRODUCTION

According to the World Health Organization (WHO), it is estimated that 800,000 people worldwide die by suicide each year with at least as many suicide attempts [1]. The grief felt in the aftermath of such an event is compounded by the fact that a suicide may be prevented. This reality of suicide has motivated WHO member states to commit themselves to reducing the rate of suicide by a significant percent by 2020 [2].

In an effort to educate the public, the American Foundation for Suicide Prevention (AFSP) [3] has identified characteristics or conditions that may increase an individual’s risk. The three major risk factors are: 1) health factors (e.g., mental health, chronic pain), 2) environmental factors (e.g., harassment, and stressful life events), and 3) historical factors (e.g., previous suicide attempts and family history). Additionally, the time period preceding a suicide can hold clues to an individual’s struggle. The AFSP categorizes these warning signs as follows: 1) talk (e.g., mentioning being a burden or having no reason to live), 2) behavior (e.g., withdrawing from activities or sleeping too much or too little), and 3) mood (e.g., depression or rage).

Identifying these risk factors is the first step in suicide prevention. However, the social stigma surrounding mental illnesses means that at-risk individuals may avoid professional assistance [4]. In fact, they may be more willing to turn to less formal resources for support [5]. Recently, online social media networks have become one such informal resource. Research has shown that at-risk individuals are turning to contemporary technologies (forums or micro-blogs) to express their deepest struggles without having to face someone directly [6, 7]. As a result, suicide risk factors and warning signs have been seen in a new arena. There are even instances of suicide victims writing their final thoughts on Twitter, Facebook, and other online communities [8, 9].

We believe that this large amount of data on people’s feelings and behaviors can be used successfully for early

detection of behavioral changes in at-risk individuals and may even help prevent deaths. Social computing research has focused on this topic in recent years [6, 9, 10]. However, few initiatives have been concerned with the real time detection of suicidal ideation on Twitter. Previously proposed detection methods rely heavily on manually annotated speech, which can limit their effectiveness due in part to the varying forms of suicide warning signs in at-risk individuals [6, 11, 12 ]. Many of these methods also focus on the messages published by individuals at a specific time, independent of the whole context, which may be represented by the sequence of publications over time.