Child Digital Twin (C-DT)
Protecting Vulnerable Individuals Against Abuse

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WHAT IS THE C-DT APP?

The Child Digital Twin (C-DT) is an AI-based, smartphone application that enables parents, teachers, and social workers to create a protective digital network for their children to safeguard them against abuse.

PROTECTING CHILDREN

The C-DT app is installed and connected on both the caregiver's and the child's phones. Based on the child's device sensors, information from other apps, and, if accessible, body-sensors data, the C-DT learns the child's social interactions and routines. The C-DT assigns risk levels to the child's social interactions based on a centrally define Reference Risk Model that reflects abuse risk profiles. The C-DT then tracks the child's daily activities, anticipates potentially high-risk events, and alerts the child to change their location or contact a trusted adult as needed. Furthermore, the C-DT alerts caregivers to potential risk events that a kid may face allowing them to intervene and mitigate the risk of abuse. As a result, the solution aids a community in better mitigating and reducing abusive situations and improving children's safety. The solution updates the abuse risk profiles in real-time based on feedback from numerous users, caregiver assessments, and community-observed abuse events. The software may connect a child to numerous caregivers at the same time, giving them a digital safety network that spans their social circle. The app's notifications should help the child develop better awareness and intuition over time, allowing them to avoid potential abuse events on their own.

CHILD DIGITAL SAFETY NETWORK

According to the World Health Organization "Child maltreatment is a global problem with serious life-long consequences" (who.int/news-room/fact-sheets/detail/child-maltreatment). Child abuse is a complicated phenomenon and difficult to detect, as its characteristics vary significantly across cultures and countries. A critical issue in safeguarding children is that abuse is often inflicted by individuals close to the child, such as parents, relatives, or caregivers. What makes the subject more challenging to approach is identifying abuse events. In many cases, children will deny it out of fear, shame, or a lack of understanding. Our proposed solution provides a child with a underlined digital safety network. In addition to digitally predicting potential risk events, adults' awareness of the availability of such a digital network and the fact that all interactions with the child leave a digital trail should raise the
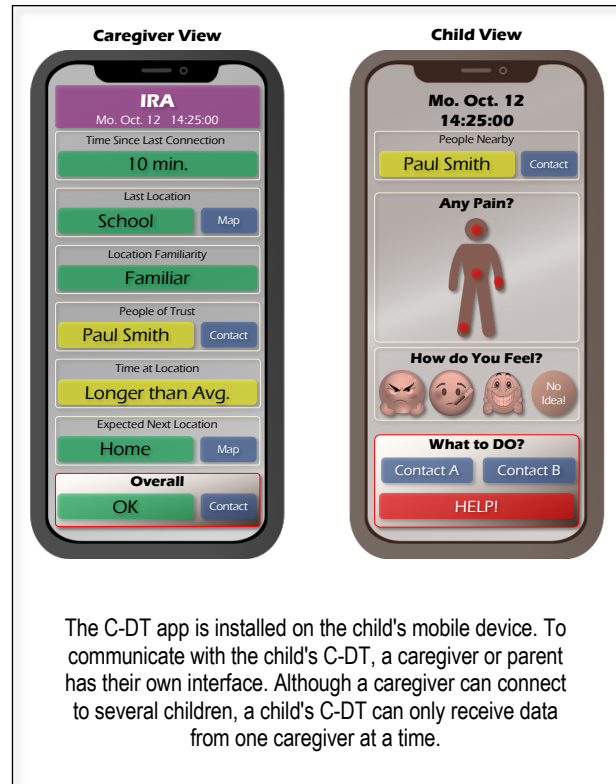
The C-DT app is installed on the child's mobile device. To communicate with the child's C-DT, a caregiver or parent has their own interface. Although a caregiver can connect to several children, a child's C-DT can only receive data from one caregiver at a time.

bar for an adult to abuse the child. Children are usually immersed in the moment, with little awareness of the big picture of their actions and their consequences. Having the C-DT "nudging" a child to adjust their actions to avoid possible risky situations would compensate for their lack of the big picture of their actions. Additionally, the child's awareness of being "somehow connected" to other people they trust may help them develop confidence in themselves and trigger them to break an unpleasant encounter. Ultimately, the solution will provide social organizations with more accurate indicators to steer their social interventions towards preventing child abuse. Due to their extensive experience and understanding of abuse dynamics and specifics, these organizations would be invaluable partners in scaling up the solution across communities or countries.

THE C-DT IN ACTION

Ira, is an eight-year-old girl from the outskirts of a middle-sized town. Ira's mother has a part-time job at a downtown clothing store. Ira goes to school with her sisters, but she is frequently required to stay at home for a few hours to care for her old,

dependent grandmother while her mother is at work. Ira's mother began to notice a change in Ira's mood and appetite, particularly when she attends to her grandma. The mother couldn't figure out what was causing the change and talking to Ira wasn't much help. After a few weeks, Ira became agitated whenever her mother asked her to help with her grandmother's care; nevertheless, she simply refused to attend school in the afternoon on such days. The mother then explored using the C-DT to ensure that Ira could always connect with her mother. After two weeks of using the app, Ira's mother began to receive C-DT notifications indicating that on days after Ira attends to her grandmother, and on her way to school, she occasionally deviates from the home-school normal route and from the time it takes her to get there. When Ira follows the same route with her sisters on typical days, there is never such a deviation. Talking about the issue with Ira didn't help much, and only led to further agitation. The mother doubted that the reason behind Ira's delays and attitude is due to some type of unpleasant encounters on her way to school. The mother then told Ira, from now on, and when Ira is alone, she needs to take a longer, but busier, route to school. Ira's mother asked a store owner on the new route, whom she trusts, if it is okay to connect him to Ira's phone so that every time Ira passes by the store, the C-DT alerts Ira that a person of trust is within Bluetooth range. The mother also set up the C-DT to alert her on days when Ira leaves to school off the usual time, and when she gets there. The mother tries—unsuccessfully—to pinpoint the exact location of the delays—and prospective encounters—on Ira's trip to school. She then phoned a local social group, which the C-DT had advised, and told them about her concerns, as well as the location and dates of the delays. The social organization relies on caregivers' feedback (actual abuse incidents, probable incidents, relevant locations, and times, and if agreed by care givers, high-risk events notifications to identify potential abuse risks in the community and update the C-DT risk profiles to reduce overall community incidents. Ira was now less irritated when she had to stay behind to care for her grandmother. Ira became calmer a few weeks into the new changes, and gradually returned to her former self.

How is the C-DT Different?

The C-DT Platform is enabled by the proprietary Bayesian-based algorithm, called the Semantic Algorithm. Using abuse historical data, the Semantic Algorithm computes, assigns, tracks, and updates probabilities for hundreds of abuse-related parameters and events in near real-time. However, the Reference Risk Model, which reflects the abuse risk probabilities associated with all children who have ever used the C-DT, is the unique feature of the C-DT Platform. The Semantic Algorithm enables the abuse Reference Risk Model to maintain what might be called the "abuse risk-DNA" in a specific population in the form of probability values for various

abuse risk parameters. Accordingly, the risk assessment by a C-DT at one side of a town can automatically help improve the risk assessment of another child's C-DT on the other side of the town, as long as both C-DTs are relying on the same abuse Reference Risk Model. That is, the C-DT Platform enables adaptive crowd intelligence, where (if desired by the user) critical events experienced by one member of a population can be used to help other members update their events' risk assessment and following decisions. Additionally, social organizations can incorporate new knowledge and assumptions directly into the abuse reference model and reflect them to all relevant C-DTs, enhancing the abuse risk forecasting accuracy in the entire population.

Long Term Vision

Managing abuse risk is one aspect of a child's life. With access to more data in the child's environment and increased trust in the solution, the C-DT can apport caregivers with the management of other dimensions of a child's life such as health risks, educational goals for disadvantaged kids, substance abuse, or addiction in general. The approach in these cases is identical: identifying reference profiles for each objective and monitoring the actual progress against the profile to predict deviations and find required interventions.

Data Privacy Approach

All solutions that involve personal data must explicitly address data privacy concerns. This is even more crucial when dealing with data about children. The C-DT solution architecture ensures that sensitive personnel information is accessible only to the users, i.e., the child and their parents or guardians. All data transmitted between the C-DT (frontend), and the Reference Risk Model are **anonymized and probabilistic.**

Our Role

We are information and solution architects. Our role is to define the architecture of the C-DT Platform, ensure the various risk models are designed according to the C-DT data structures, and provide the algorithms and—if required—the infrastructure necessary to implement the solution. We have pending patents for the concepts and algorithms underlying the C-DT solution: the Human Digital Twin (HDT), which is also describen in various research papers (Orcid.org/0000-0002-2775-6946).

Contributions
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