Datafication for [MindTrack: Platform for Detecting ADHD in Children]

Motivation and Functionality

Consider this scenario: A middle school teacher trying to teach her class is bothered by a restless, talkative, impatient student who constantly disrupts the learning environment. After many efforts to maintain order, the teacher reports this behavior to the school administration. The principal, instead of summoning the child's parents for disciplinary action, simply asks: "Could they have ADHD?"

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder associated with hyperactivity, inattention, and impulsivity (*Data and Statistics About ADHD*, 2022). As of 2016, 9.4% of children (approximately 6 million) ages 3-17 in the United States were diagnosed with ADHD (Danielson et al., 2022) – and this number has since been on the rise, with more than 10% of children reported to have ADHD in 2018 (Bluth, 2018).

While ADHD can also manifest in adults, it is an especial concern for parents of young children and schools because of the lasting impact that ADHD can have on a young learner's academic performance. Children with ADHD have a difficult time controlling their impulses, resulting in classroom disruptions and hindering the learning process (*Teaching Students With ADHD*, 2023). An essential component of treating ADHD in children is early detection because it allows for

timely intervention, such as behavioral therapy and educational accommodations, from parents and teachers.

For health systems, diagnosing patients with ADHD has become difficult due to the growing waiting lines and specialist clinician shortages (Chen et al., 2023). For school systems, large class sizes make it challenging for already overworked teachers to provide individual and prolonged attention for a child showing ADHD symptoms, that is, if the teachers have even had training on recognizing ADHD.

However, the process can be streamlined by designing an AI tool - MindTrack - that helps mental health professionals and educators diagnose children with ADHD. The tool would be a platform that runs several assessments designed by experts on the patient to determine the risk score of having ADHD and triage patients accordingly. MindTrack aims to achieve two objectives: reduce the burden on therapists, teachers, and parents as well as provide support for children with ADHD. MindTrack targets children aged 6 to 12, as the American Academy of Pediatrics (AAP) recommends those ages in children for evaluation (Adesman, 2001).

Assessments for the platform require patients' demographics and medical history, schoolwork, teacher and parent report forms, and behavioral tasks. Then, a mental health professional would hold a clinical visitation for the patient and determine the risk of having ADHD.

Strategy for Building MindTrack:

The algorithm for detecting ADHD solves an automation prediction problem: It is fed with input data about the child's condition. Then, after a visitation, a health provider determines a risk score label for the case.

1. Datafication:

The input data includes the child's (aged 6 to 12) electronic medical records (EMRs), which consist of demographics, any diagnosed health conditions, any medication the patient is taking (if any), teacher report form, and parent report form. The forms entail the child's attention span, grades, organization skills, ability to remain seated, and talkativeness in school and at home. The

American Academy of Pediatrics (AAP) recommends asking parents and teachers about the child's behavior in different settings since children with ADHD will demonstrate a consistent pattern of inattention and hyperactivity. The forms' criteria are the usual parameters used by healthcare providers for diagnosis, as they correlate with how ADHD manifests in children (*Symptoms and Diagnosis of ADHD*, 2022).

After submitting this data, the child undergoes an interview process at school done by the school counselor in a virtual reality setting. Virtual reality is used to simulate a real-life setting and identify impulsive behaviors. (*Virtual Reality Game Can Assess Children's ADHD Symptoms*, 2022) The child uses a head-mounted display and hand controller to perform a series of tasks:

Task	Behavior Anomaly Tracked
Complete an age-appropriate puzzle with the TV on	Abnormal eye movements
Watch a video	High number of clicks on controller
Dictation writing	Poor margin alignment, spelling mistakes, inconsistent letter shapes and sizes
Waiting in a line to buy food	Excessive fidgeting

Testing the child's behavior in a controlled simulated environment allows us to determine abnormalities in an objective manner (*Virtual Reality Game to Objectively Detect ADHD*, 2022). In addition to tracking specific behaviors, the efficiency of the task completion is recorded. A combination of behavioral anomalies will likely lead to a diagnosis.

2. Building the training dataset:

To build the training dataset, MindTrack will work with schools and hospitals to retrieve information about students' electronic medical records, academic performance, and impulsive behaviors. We will provide an incentive for hospitals and schools - better triage protocols and better learning environments - to share this data with us during the early stages of our algorithm development. They will also benefit from a discount on the MindTrack platform once the algorithm is deployed.

3. Labeling, Training, and Validation:

The dataset will be split into a training subset and a testing (holdout) subset according to an 80:20 ratio. For the training subset, the mental health professional assigns a label for the risk score of the child having ADHD after conducting a clinical visitation. We then deploy the algorithm on the holdout subset to validate the algorithm. This allows us to measure the accuracy of the predictor algorithm.

Deployment:

When deployed, MindTrack will encourage hospital systems and middle schools to collaborate with the purpose of detecting ADHD in children. Hospitals have an incentive to buy our ADHD detection tool because it would improve their triage protocols by reducing waiting times and compensating for their specialist shortages.

We will also partner with NGOs in order to identify private and public schools who would be willing to use our product. We will incentivize them by showing them the promise of early detection and intervention of ADHD in a child's academic life. When teachers are aware of a student with ADHD, they are able to make certain changes in their classroom to minimize the disruptions and distractions caused by ADHD. These adjustments foster a positive and constructive learning environment for everyone.

Since the VR screening will be done at school by the counselor and affording the virtual reality equipment for certain schools can be difficult, we will partner with philanthropic organizations to raise funds for the equipment. Owning that equipment is beneficial for schools since virtual reality can also be used for miscellaneous educational purposes.

Risks:

It is crucial to consider potential risks in building and deploying MindTrack as it will be used to make high stakes decisions about children's mental health:

1. Labeling Errors: As MindTrack solves an automation problem, mental health professionals could misdiagnose and thus mislabel (overestimate or underestimate) the child's risk score after the visitation. The more dangerous case would be underestimating the risk score because of the impact ADHD has on a child's academic and social life if undetected. This risk could be mitigated by offering the professionals specialized training on ADHD and its diagnosis to avoid mislabeling.
2. Sampling Errors: Sampling a limited number of schools could lead to the systemic exclusion of certain populations (e.g: children from low socioeconomic backgrounds). If subpopulations of children attending different schools have not been sampled, the dataset will not contain relevant ADHD diagnoses for them. This marginalization can lead to racial, gender, and wealth-based biases.
3. Confounding Variables:
    a. Technological inclination and computer literacy might skew our results since some children find it difficult and daunting to experiment with virtual reality.
    b. Several mental health disorders share symptoms with ADHD, which could lead to misdiagnosis. For example, children suffering from depression are not able to concentrate, and the inability to concentrate is a symptom of ADHD (*5 Common Problems That Can Mimic ADHD*, 2018). We will mitigate this risk by ensuring that an ADHD diagnosis is given when the child shows a combination of the behavior anomalies we test.
4. Privacy: Due to the sensitive nature of the dataset needed for training and the stigma around mental health, parents and schools might not be willing to share the data with us. Therefore, we need to ensure the anonymity of patients. Users should be informed that their data will remain anonymous and confidential and that their participation is voluntary. Once they agree, they will have to sign participant consent forms.

In conclusion, MindTrack holds immense potential to revolutionize early detection and intervention for ADHD in children. This tool empowers schools, teachers, parents, and healthcare providers to collaborate more effectively in identifying potential ADHD cases in children. By detecting ADHD early, we can provide timely support, leading to improved academic performance and social interaction for affected children and providing a brighter future for them and their families.

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<table>
<tr><td colspan="2">Problem Statement: Assisting mental health professionals with identifying child patients who are likely to have ADHD</td></tr>
<tr><td colspan="2">User: Children ages 6 to 12</td></tr>
<tr><td>Functionality: The algorithm identifies child patients with high likelihood and risk of having ADHD. These patients are then triaged to mental health professionals who conduct advanced examinations and give a diagnosis.</td><td>How Input → Output creates functionality:
The predictor algorithm receives as inputs the patient's medical history and the results of the assessments done on the platform. Then, the patient sees a mental health professional who gives the diagnosis and its risk score. The algorithm would predict that risk of having ADHD.</td></tr>
<tr><td>Input (conceptual):
Data from the patient's demographics, medical history, school life, and results of the virtual reality tasks completed.</td><td>Inputs X (must be in your data):
<u>Demographics:</u> age, sex, and ethnicity.

<u>Medical History:</u> Any diagnosed health conditions, any medication the patient is taking (if any).

<u>Teacher Report Form:</u> attention span in class, grades, organization skills, ability to remain seated, excessive talking.

<u>Parent Report Form:</u> questions about the child's impulsive behaviors</td></tr>
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	Virtual Reality tasks for child: The child completes a series of tasks in a virtual reality setting at school in order to identify any impulsive behaviors.
Output *(conceptual)*: Mental health professionals label the visitation they had with the patient.	**Label Y *(must be in your data)*:** The diagnosis of the doctor with a risk score label of the case.
Dataset construction (how are the labels collected?) The labels are collected by partnering with hospitals to collect electronic medical records of the patients. Incentivize them to provide the data by suggesting reduced waiting lines. We will partner as well with schools to provide us data about children's school life.	