Concept Paper: Identification of Mental Health Symptoms for Veterans

Technical Summary

Technical Approach The identification of possible mental health symptoms for veterans is hampered by the lack of an automated decision support systems. Consequently, rates of suicide are unacceptable and behavior patterns for many cause harm and trauma to family members. Extensive data and variables must be factored into an identification routine. An obvious, but difficult solution is to automate as much of the evaluation process as possible while still retaining the expertise of human judgment. Steady improvements in data access rates and formatting have been realized with data warehouse technology. Data mining has similarly enhanced decision support systems. Still lacking are the capabilities to effectively fuse diverse sources of information, to incorporate the essence of tell-tale signs, and to propagate the belief of evidence in the context of probabilities and identification rules.

NBS Enterprises (NBS) proposes an approach that when implemented provides an automated "sense and respond" decision support system (DSS). While not addressing issues of treatment, it produces accuracy and reduced time lines for identifications.

To expedite the conduct of system operations, processing times for data must be reduced. The keys to success for decision makers are the association of disparate sources of data and the derivation of courses of action in minutes, as opposed to hours for thought and testing. NBS proposes the development of a prototype that encapsulates:

1. An automated decision support tool to manage data and develop alternative courses of action (COA)
2. Integrated databases
3. Machine learning with disparate data
4. Predictions of patient susceptibility to mental health instability

A concept of operations for an automated decision support system which improves the identification of high-risk patients is outlined in Exhibit 1. Business rules are recorded for an identification program. Many facets might be included in the rules such as subject habits and family background, as well as combat experience and current behavior. A data extractor transitions disparate data to structured databases while domain specific metadata (data about data) interface with each database. Given that a new set of data is obtained, which represents patient information, associations are formed using semantic nets and mapped to the business rules. An analytical model, which encapsulates the rules, is exercised to assess patient susceptibility to mental health disorders.

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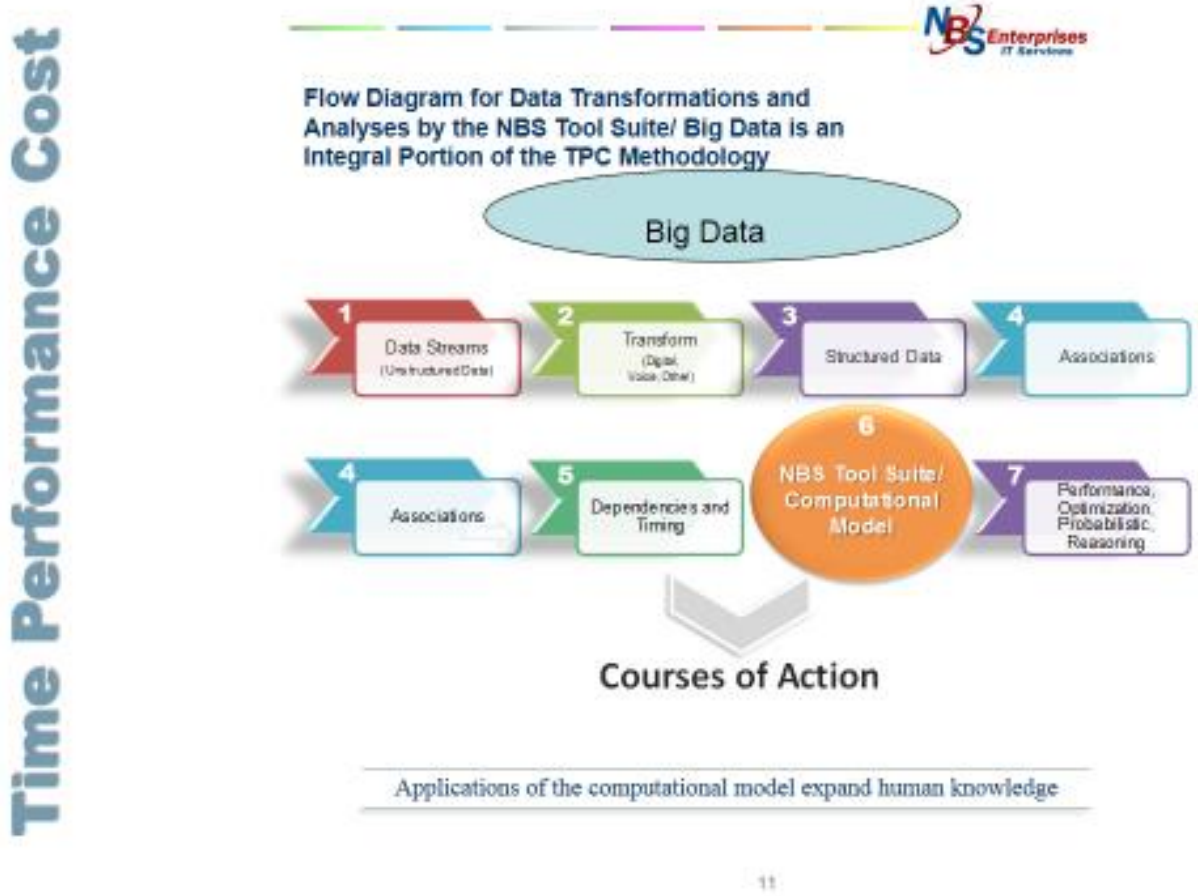

Exhibit 1

Architecture: The architecture for the proposed DSS is outlined in the summary template shown previously. Disparate data are accessed and associated and structured with metadata before transition to a quantitative model. Metadata serve as formal, machine representations of data. Typically focused on specific problems or domains, they can also act as integration and data fusion models. Metadata are developed to represent relationships to additional data that specify a priori knowledge (e.g., one or more structured databases). Semantic relationships interconnect the a priori knowledge, fusing existing knowledge to historical data and accelerating discovery and exploitation of new associations. The integrated metadata and event mapping engine provide a data fusion foundation for the machine learning tool suite.

The machine learning portion of the proposed solution is noted in Exhibit 2. The machine learning paradigm is initiated with familiar hospital care. Patients arrive and experience triage and initial reviews by the hospital staff. If necessary, doctors and specialists continue with patient care recommending tests and procedures. All data collected during these reviews are

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made available for later quantitative assessments. Data acquired from interviews are stored in the patient records. Historical data acquired from previous patient interviews are associated with the current patient data using metadata techniques. The associated data are fed to the machine learning tool suite where quantitative analysis and recommendations are provided to experts for their review. The machine learning processor accepts associated data and adapts them to appropriate algorithms. Typically, decision trees are structured from the associations and are annotated with probabilities, distribution functions, and supplementary information.
The machine learning results do not generate decisions. Rather, they provide rapid computations and act as a guide for specialists who do make decisions.

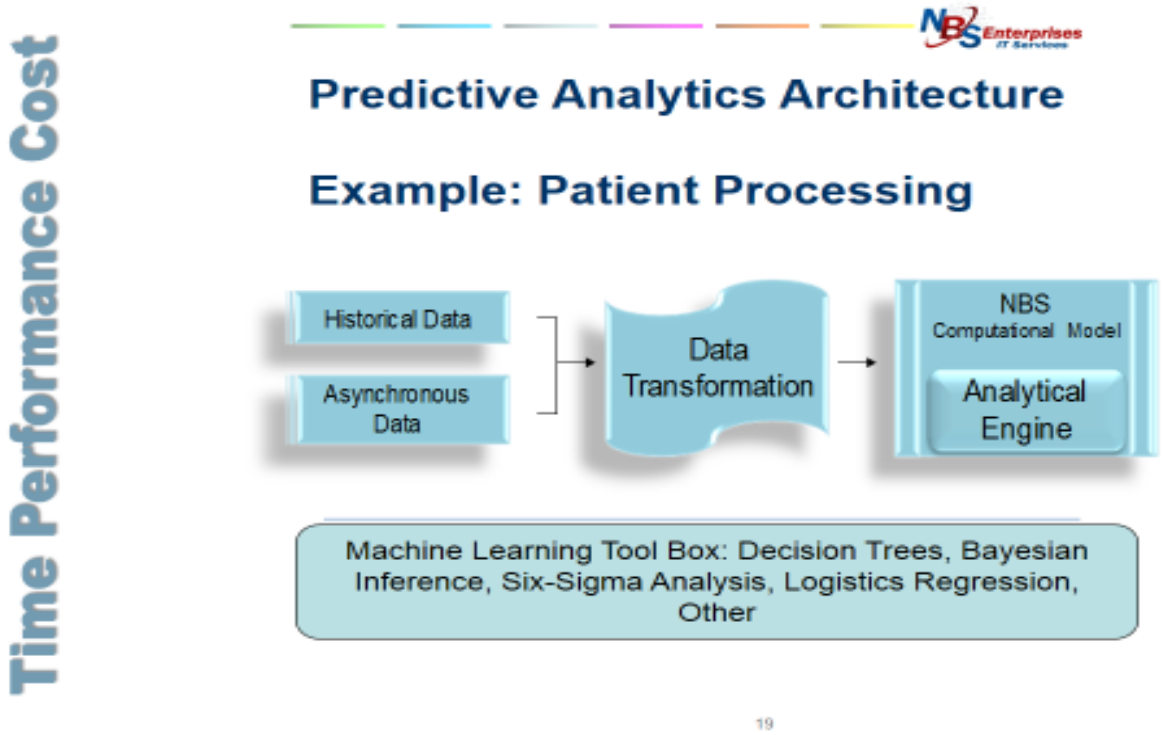

Exhibit 2

Implementation Plan: The implementation of an automated planning tool comprises three phases:

1. Phase 1: Assess current scheduling procedures, define transitions necessary for automation, and develop a rapid prototype for demonstration and proof-of concept purposes.
2. Phase 2: Incorporate VA desires and enhancements into the prototype and provide a Beta site for the prediction tool.
3. Phase 3: Implement and insert the "to-be" automated prediction tool into all evaluation centers.

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An implementation plan is initiated with the development of a prototype, which is the objective of this proposal. The prototype acts as a precursor to a sophisticated decision support system that associates disparate data and assists with the identification of veterans who are susceptible to suicidal tendencies and other mental health disorders.

Benefits and Rationale of a Decision Support System (DSS): The primary benefits of the NBS solution to untimely identification procedures are the dramatic reductions in decision maker think times, rapid development of courses of action, and expanded guidance for patient care.

The NBS machine learning paradigm associates disparate data sources, transitions data to models and operates on data with analytical algorithms, bounds the probabilities of positive identifications and defines the avenues of additional investigations.

Technical Challenges: The primary challenges of developing effective decision support for positive identifications of mental health anomalies are:

1. The development of criteria for the initiation of screening procedures,
2. The digestion and fusion of historical data with patient specifics, and
3. The automated development of courses of action.

Supporting Technical Analysis: The proposed prototype and future system associates historical data with patient records and the diagnostics of specialists. The data are structured and transitioned to a quantitative model. The model comprises a set of machine learning algorithms which when exercised provide decision support and guidance for courses of action. The rapidity of the computations reduces assessment times dramatically and permits specialist to service the backlog of patient needs for mental health evaluations. As an example, consider a data presentation where three dashboards indicate the probabilities of suicide relative to a suffered event.

The intent is to identify veterans susceptible to suicide.

1. First dashboard: Troubled home life, e.g., promiscuous wife during veteran's absence-probability of suicide is 0.03-no problem.
2. Second dashboard: Severe wounds, e.g., loss of leg or arm-probability of suicide is 0.04-no problem.
3. Third dashboard: Fellow soldiers killed in an ambush, some mutilated-probability of suicide is 0.05-minor problem.

Next, an association is made of the three maladies: When a veteran experiences all three of the events, probability of suicide escalates to 0.40-big problem that must be addressed.
Further, analysis shows that if the trauma of ambush is mitigated, probability of suicide is reduced to about 0.15.

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Thus, a recommended course of action for a soldier suffering from all three dashboard maladies is to provide therapy that will reduce the impact of the ambush trauma.
The data analysts are not health care specialists, so they do not provide advice on the methods of therapy. This is up to mental health specialists.

But, data analysis has uncovered the cause of a suicidal tendency and the prediction is supported by derived probabilities.

In addition to singular representations, associations of dashboards are imperative while therapy remains in the hands of specialists.

Data analysts do not have to be skilled in mental health treatment in order to identify suicidal tendencies.

Anticipated Requirements for VA Resources: NBS requests that patient data and historical data are made available by the VA, as well as specialist descriptions of current "as-is" procedures for mental health evaluations. If data are not available, NBS will, based upon previous and similar efforts, devise pseudo data to test the prototype under development.

Team Expertise: Gary S. Schebella has participated in the management, analysis and development of several DoD systems. These include information systems for the US Air Force and the FBI, Navy/ Marine Corps logistics distribution for the Office of Naval Research (ONR), Future Combat System (FCS) assessments for sensor management and sensor exploitation, and nuclear/bio-chemical threat evaluations for the Defense Threat Reduction Agency (DTRA). He has directed research teams, simulated and modeled enterprises in order to compute performance, to derive requirements and to assist with the transition of 'as-is' to 'to-be' system architectures. He has developed numerous decision support systems (DSS) for logistics, sensor management and persistent surveillance. Encapsulated in the DSS are metadata which transition big data to structured formats applicable for input to assessment and forecasting software.

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