# A Novel System for Rapidly Identifying Toxic Chemicals During Emergencies

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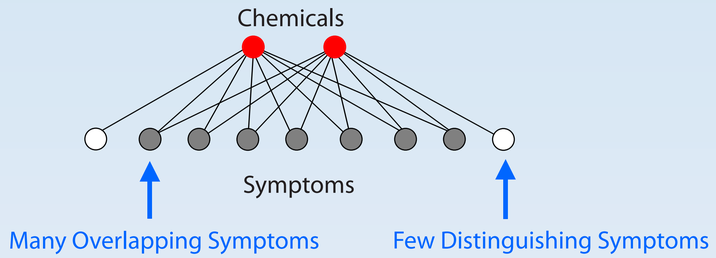
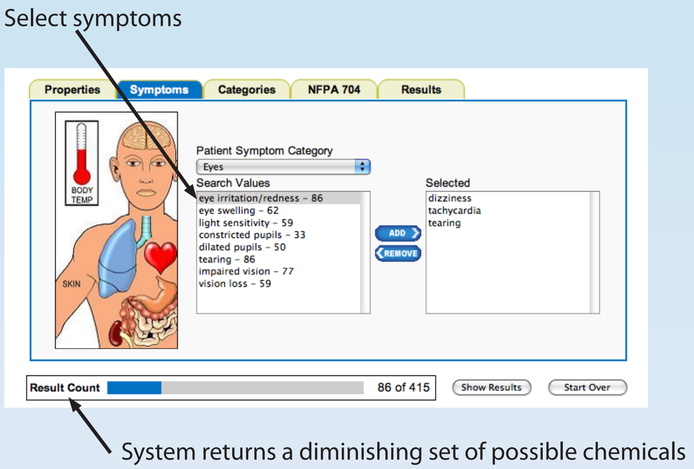
## 1 Motivation

- To save lives during emergencies such as 9/11, there is a critical need for the rapid identification of toxic chemicals
- Unfortunately, current systems such as WISER (developed by the National Library of Medicine) require a large number of symptoms before a chemical can be identified [1].
- This problem is caused by two reasons:
  1. There is a high overlap of symptoms across chemicals making it difficult to distinguish between the chemicals




  2. Current algorithms (e.g., Boolean Search) do not help users select symptoms that are the most discriminating

### WISER: Current System to Diagnose Toxic Chemicals




WISER requires users to select symptoms from an unordered list, which does not help to rapidly distinguish between chemicals

## 2 Hypothesis

- An iterative *Binary Search* algorithm will significantly reduce the number of symptoms required to uniquely identify a chemical

  *(A Binary Search algorithm will rank the symptoms based on their ability to discriminate between chemicals. Each time a symptom is selected, the remaining symptoms will be re-ranked)*

## 3 Method

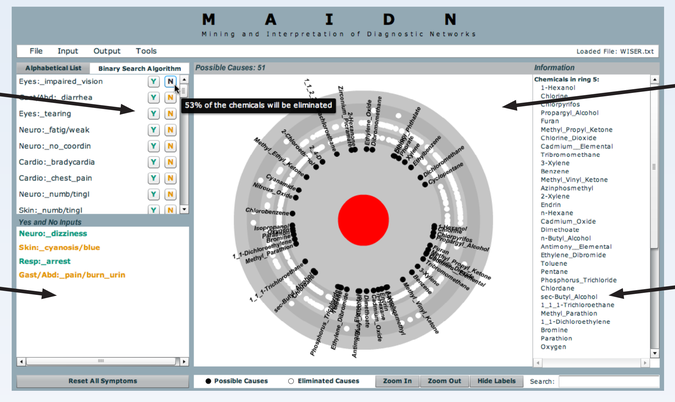
- Method to Design the Algorithm and Interface
  - Collaborated with a first responder to design and implement MAIDN (Mining And Interpretation of Diagnostic Networks) which uses a *Binary Search* algorithm to rank symptoms
  - Used the Heuristic Evaluation [2] method to refine the interface design
- Method to Evaluate the Algorithm
  - Simulated a user diagnosing a chemical in both systems
  - Calculated the smallest number of symptoms to uniquely identify each chemical, and averaged this number across all chemicals
  - Tested whether there was a significant difference in the average number of symptoms to identify a chemical between both systems

## 4 Results

### Design of the Algorithm and Interface

Input Pane: Select from a ranked list of symptoms.

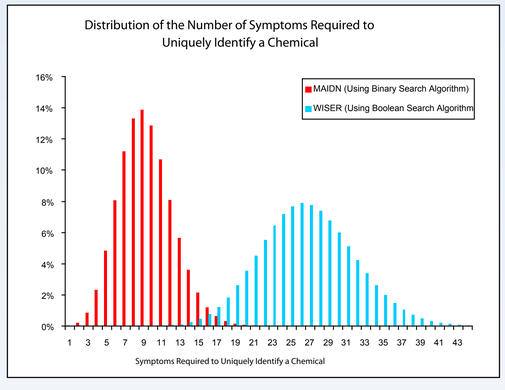
Deselect Pane: Select symptoms, which are then moved back to the Input Pane




Visualization Pane: Each time a symptom is selected, the candidate chemicals move to an inner ring, and the eliminated chemicals become white. Users can click on any node or ring to get more information

Information Pane: Browse the symptoms for the selected chemical

### Evaluation of the Algorithm




Significantly fewer symptoms were needed to uniquely identify a chemical using MAIDN (mean=8.33, SD=0.7) compared to WISER (mean=25.69, SD=12.79, p<.01 two-tailed t-test)

## 5 Summary and Future Research

- The simulation of a user interacting with MAIDN demonstrated that the *Binary Search* algorithm can significantly reduce the number of symptoms required to uniquely identify a chemical
- Future research will test through a user study whether the algorithm and interface helps first responders to rapidly identify chemicals during emergencies

## 6 Acknowledgements

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## 7 References

1. Bhavnani, S.K., et al. Network Analysis of Toxic Chemicals and Symptoms: Implications for Designing First-Responder Systems. *Proc. of AMIA'07* (2007).
2. Nielsen, J. (1994). *Usability Engineering.* San Diego: Academic Press.