



One is too many and a thousand not enough: *Substance Use and Abuse*

Substances such as tobacco, alcohol, and narcotics can affect the physical and mental health of users. The consequences of substance abuse, both financial (health care, the criminal justice system, workplace productivity, etc) and non-financial (divorce, domestic abuse, etc), ripple through society and affect more than just the user. The effects of substance abuse on individuals and society have come to the forefront recently as opioid addiction has become prominent¹.

Efforts, such as taxes and regulations on cigarettes and the Drug Abuse Resistance Education program, have been made at the local, state, and national level to educate, control, and/or restrict the consumption of such substances. Such efforts need to start with an understanding of how substance abuse spreads and affects some individuals more than others.

1. **Darth Vapor**—Often containing high doses of nicotine, vaping (inhalation of an aerosol created by vaporizing a liquid) is hooking a new generation that might otherwise have chosen not to use tobacco products. Build a mathematical model that predicts the spread of nicotine use due to vaping over the next 10 years. Analyze how the growth of this new form of nicotine use compares to that of cigarettes.
2. **Above or Under the Influence?**—Like nicotine, the abuse of most substances is correlated with numerous internal and external factors that affect the likelihood of an individual becoming addicted. Create a model that simulates the likelihood that a given individual will use a given substance. Take into account social influence and characteristic traits (e.g., social circles, genetics, health issues, income level, and/or any other relevant factors) as well as characteristics of the drug itself. Demonstrate how your model works by predicting how many students among a class of 300 high school seniors with varying characteristics will use the following substances: nicotine, marijuana, alcohol, and un-prescribed opioids.
3. **Ripples**—Develop a robust metric for the impact of substance use. Take into account both financial and non-financial factors, and use your metric to rank the substances mentioned in question #2.

Your submission should include a one-page executive summary with your findings, followed by your solution paper—for a maximum of 20 pages. If you choose to write code as part of your work to be eligible for the technical computing prize, please include it as an appendix. Cite your sources, including those in the provided data files if you use them. Any code appendix or reference page(s) will not count toward your 20-page limit.

[1] <https://www.npr.org/2019/01/14/684695273/report-americans-are-now-more-likely-to-die-of-an-opioid-overdose-than-on-the-ro>

MORE ON REVERSE

DATA STATEMENT

Various organizations and agencies collect a data on a regular basis. A small amount of data has been compiled and provided. You are not required to use this data; that is, you may choose to use none, some, or all of this data and/or any additional data sources you may identify while working on this problem. Be sure to cite all resources used. The data files (names below) are linked from this page: <https://m3challenge.siam.org/node/439>.

- High_school_vaping_data
- NIH-DrugTrends-Data Sheet
- A figure is also provided for historical context of cigarette consumption

MATLAB Users: If you are trying to use this or any other spreadsheet data in MATLAB, you can import the data by double-clicking the files in MATLAB's "Current Folder" browser or use the [Import Data Button](#) at the top of the Toolstrip. Watch this quick MATLAB [video tutorial](#) about importing spreadsheet data. See how the [MATLAB Import Tool](#) was used in a previous year's problem to import and analyze data.

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