

# Warmer Days or Sour Grapes ?

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The high quality of wines produced in the Finger Lakes Region of upstate New York is widely known. Proximity to lakes tempers the climate and makes it more suitable for growing several varieties of premium grapes: Riesling, Gewürztraminer, Chardonnay, Merlot, Pinot Noir, and Cabernet Franc. (There are many more, but we will restrict the discussion to these six to simplify the modeling.) Each variety has its own preferred “average temperature” range but is also different in its susceptibility to diseases and ability to withstand short periods of unusually cold temperature.

As our local climate changes, the relative suitability of these varieties will be changing as well. A forward-looking winery has hired your team to help with the long-term planning. You will need to recommend

- a) the proportion of the total vineyard to be used for growing each of the above six varieties;
- b) and when should these changes be implemented (based on observed temperatures and/or current market prices for each type of wine).

Naturally, the winery is interested in maximizing its annual profit. But since the latter is weather-dependent, it might vary a lot year-to-year. You are also asked to evaluate the trade-offs between optimizing the expected/average case versus the worst(-realistic-)scenario.

Things to keep in mind:

- Climate modeling is complicated and predicting the rate of “global warming” is a hotly debated area. For the purposes of this problem, assume that the annual average temperature in Ithaca, NY will increase by no more than 4°C by the end of this century.
- It is not all about the *average* temperature – a short snap of sub-zero temperature in late February or early March (after the vines already started getting used to warmer weather) is far more damaging than the same low temperature would be in the middle of the winter.
- It takes at least 3 years for a newly planted vine to start producing grapes suitable for winemaking.