# Concept and development of an expert system to identify optimal locations for kitesurfing using Python language

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## Abstract

The aim of this study was to develop an expert system to facilitate the selection of suitable locations for kitesurfing in Europe. The developed system was implemented in Python. This system allows for the assessment of whether a given location is sui table for kitesurfing based on meteorological data and expert knowledge. The meteorological data necessary for the system's operation was obtained from the *OpenWeatherMap* service using a dedicated API. The study provided a brief overview of the development of kitesurfing as a sport discipline and described the necessary conditions for practicing this sport, which enabled the formalization of rules necessary for the development of the expert system. The algorithm was developed based on data from southern Spain, tested for two locations: Sicily and Switzerland, and then for multiple points located along the European coastlines. After testing the data, an analysis and presentation of the algorithm's results were conducted in both tabular and cartographic form.

***Keywords:*** expert systems, Python, pandas, kitesurfing, spatial analysis, QGIS

## 1 Introduction

Kitesurfing has been a popular water sport, attracting enthusiasts across Europe. However, finding suitable locations with optimal weather conditions for safe and enjoyable kitesurfing has been a challenge. To address this need, the aim of this study was to develop and implement an expert system algorithm using Python, pandas library, and binary logic. The algorithm analyzed meteorological data to determine the suitability of a given location and day for kitesurfing.

## 2 Study Area

The study area for this research covered various regions along the European coastlines, including southern Spain, Sicily and multiple other points. These locations were selected to represent diverse weather patterns and potential kitesurfing hotspots in Europe.

## 3 Methodology

The core of this study involved the development of a Python-based algorithm. Binary logic was employed to assess pivotal atmospheric variables – wind speed, wind direction, and temperature. The algorithm's formulation incorporated predefined criteria, facilitating the categorization of each variable as conducive or non-conducive to optimal kitesurfing conditions.

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The algorithm's refinement was achieved through the integration of insights from proficient kitesurfers. Expert knowledge served to calibrate the criteria, ensuring congruence with real-world kitesurfing intricacies. This amalgamation enriched the algorithm's precision and practical applicability.

Validation encompassed rigorous testing of the prototype algorithm across diverse datasets, including geographical locations spanning Tarifa (Spain), Trapani (Sicily), Basel (Switzerland), and other coastal points across Europe. Comparative analyses against actual weather data and expert evaluations validated the algorithm's efficacy.

Algorithmic outcomes were communicated through tabular representation and cartographic visualization, elucidating its competence in identifying suitable kitesurfing locations. Comparative analyses enabled the algorithm's performance assessment across different geographic contexts.

### 3.1 Sub-section of methodology

Central to this study was the intricate development of the algorithm, underpinned by binary logic. This systematic approach facilitated the evaluation of pivotal atmospheric variables – wind speed, wind direction, and temperature. Each variable was subjected to meticulous scrutiny against predetermined thresholds, resulting in binary classification indicating its suitability for kitesurfing conditions.

Expert insights garnered from seasoned kitesurfers played a pivotal role. The infusion of expert perspectives ensured the algorithm's harmonization with practical kitesurfing dynamics. The calibration of optimal condition criteria by experts augmented the algorithm's accuracy and relevance.

The prototype algorithm's validation was grounded in meticulous testing using authentic meteorological datasets. Comparative analysis with genuine weather conditions and expert evaluations substantiated the algorithm's precision, solidifying its dependable recommendations for kitesurfing enthusiasts.

## 4 Results

The systematic analytical approach and rigorous validation deployed in this investigation yield significant insights into optimal kitesurfing sites. This synthesis involves merging meteorological data with a refined algorithm. Validation involves meticulous real-world meteorological testing and consultation with experts, confirming the algorithm's effectiveness. Notably, the algorithm adeptly identifies prime kitesurfing days in Tarifa, as documented in Table 1, showcasing its ability to discern nuanced conditions.

Figure 1 visually encapsulates the range of algorithmic outcomes across the North-West European region. Remarkably, among the 214 days considered (spanning June 1st to December 31st, 2022), a notable 71 days emerge as highly favorable for kitesurfing in the west France region. This visual representation equips enthusiasts with insightful data when planning their next kitesurfing excursion.

Figure 2, in a parallel manner, delves into the algorithm's evaluation of South European regions, revealing a sparser distribution of points, indicating less ideal kitesurfing conditions.

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Table 1: Number of days in Tarifa, when doing kitesurf was possible

| Tarifa 2022 | | |
|---|---|---|
| **Month** | **Number of days** | **Percentage ratio** |
| January | 16 | 52% |
| February | 14 | 50% |
| March | 8 | 26% |
| April | 7 | 23% |
| May | 10 | 32% |
| June | 4 | 13% |
| July | 13 | 42% |
| August | 3 | 10% |
| September | 2 | 7% |
| October | 10 | 32% |
| November | 3 | 10% |
| December | 2 | 6% |
| | **92** | **43%** |

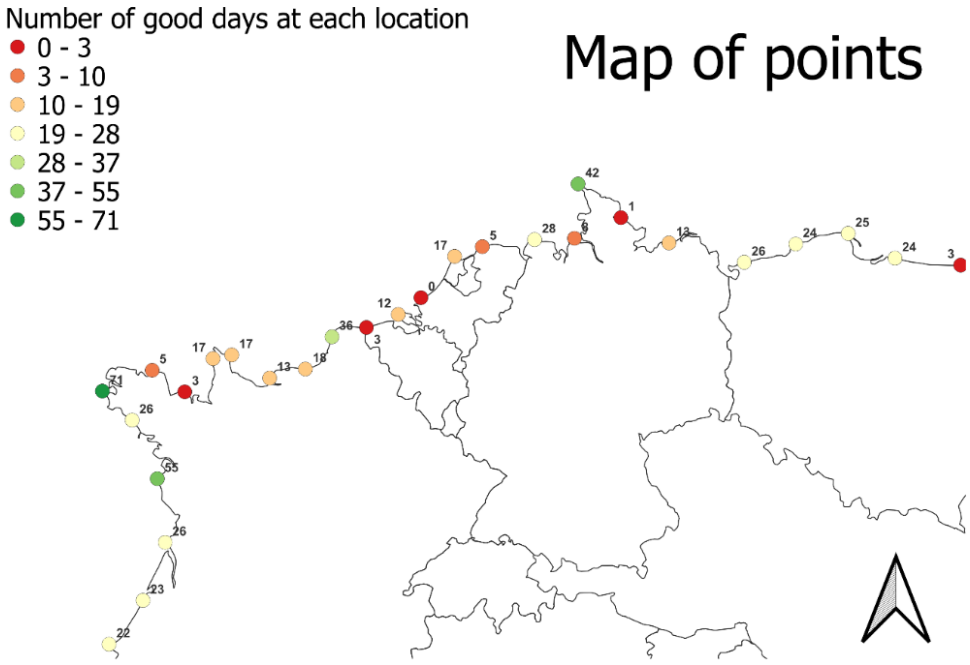


Figure 1: Map of points in North-West Europe

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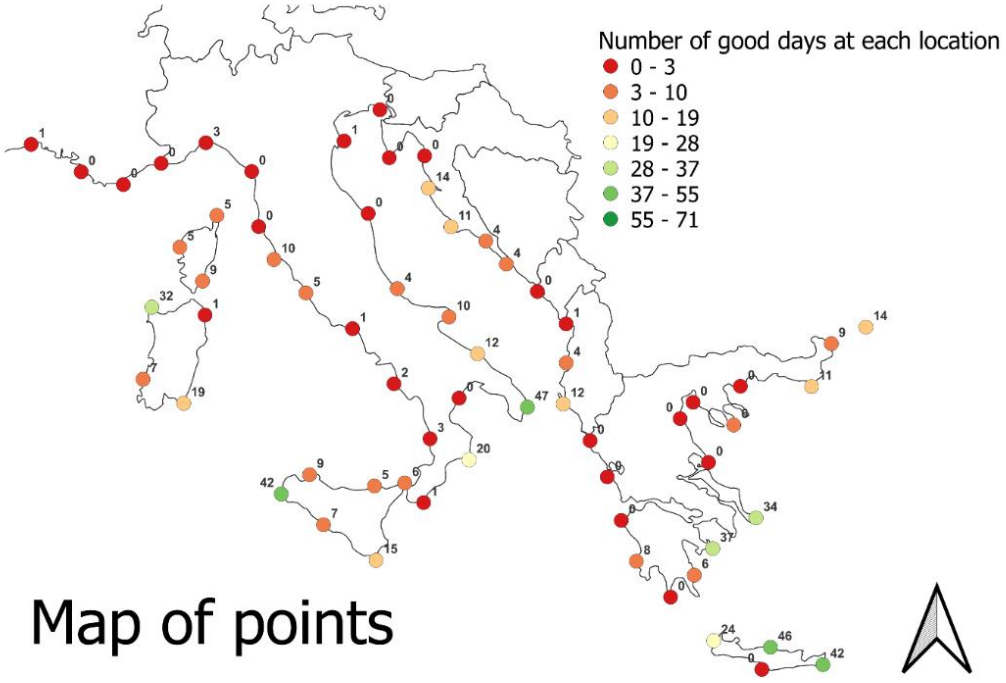


Figure 2: Map of points in South Europe

## 5 Discussion

The algorithm's accuracy in identifying optimal kitesurfing conditions, validated against real-world meteorological data and expert insights, underscores its resilience. Its adaptability across varied geographies renders it a versatile tool. The potential integration of probabilistic meteorological forecasts enhances its real-time utility, catering to all levels of kitesurfing expertise.

## 6 Conclusion

In summary, this study presents a formidable algorithmic expert system for identifying optimal kitesurfing spots. The fusion of meteorological data and expert insights ensures dependable recommendations. This research equips kitesurfing enthusiasts with a valuable resource for locating ideal destinations. As the algorithm evolves, its potential to incorporate real-time forecasts adds a promising dimension to kitesurfing decision-making.

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