Verifying Product Carbon Footprints

Project Report

WiSe 2023/2024

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Submitted on Munich, 06.12.2023

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Introduction

In an age marked by escalating environmental concerns and a growing commitment to sustainable practices, the need for businesses to assess and mitigate their carbon footprints has become of vital importance. But as industries grapple with the complexity of carbon footprint calculations and diverse data models, the issue of data accuracy and credibility becomes increasingly relevant.

SINE Foundation, a non-profit organization dedicated to decarbonizing the economy, is building an open-source library of software and governance tools for higher data quality in sustainability initiatives. Additionally, SINE leads the tech workstream in the Partnership for Carbon Transparency (PACT) and works with the world's leading corporations for more emission transparency. One of their solutions – Tandem, is an open-source cryptographic engine that allows companies to collaborate and securely exchange their data, for example to calculate carbon footprints in supply chains, without revealing their inputs.

In response to the problem of data accuracy, SINE Foundation has identified the potential of artificial intelligence (AI) to play a role in tackling this issue. The focus of this project is a concept leveraging AI to solve the posed challenge of Product Carbon Footprint (PCF) verification.

Problems

The project's complexity is partly due to the many problems that need to be tackled to deliver an effective solution. Firstly, companies use different data models to calculate carbon footprints, many of which remain proprietary. This complicates the standardization of PCF calculation and consequently of data verification. Secondly, Product Carbon Footprints are a complex subject with a multitude of variables and industry-specific considerations, requiring deep domain expertise. Additionally, the datasets involved in PCF calculations are massive and interconnected, particularly when considering supply chains. Inaccuracies in one part of the chain can lead to even bigger inaccuracies down the line and increase the risk of additional errors. The scale of the datasets poses challenges in processing and analysing the data and recognizing inconsistencies to verify it.

Finally, the central problem, which is directly tied to the challenge "verifying carbon footprints," is the issue of emission data being misreported, manipulated or otherwise inconsistent. This can happen intentionally, due to companies wanting to present a more positive environmental image but can just as well be due to user error or initial lack of appropriate and correct data.

In either case, misrepresented data can undermine the effectiveness of regulatory measures, industry benchmarks and other sustainability initiatives. It also risks collaborative efforts aimed at combating climate change by eroding public and private trust.

Solution

The problems outlined above prompt the question of whether AI can assist in verifying the available data models and establish heuristics for smaller firms and farmers. The advantage of AI lies in its ability to process extensive data, identifying anomalies that might be challenging for humans to even notice, especially when considering the complexity involved in the PCF calculations of just one single product or company.

The AI model for this solution must compare the PCF against industry standards or similar products and rank it based on this information, helping the users to make informed decisions. That is why after doing research we decided to use a Comparative Analysis Algorithm, which would be capable of benchmarking and ranking the products.

First, various data models (mostly open-source ones) would be analysed, which can help establish benchmarks and industry norms, providing a basis for comparison and potentially helping to standardize PCF calculations in the future.

Then, weighted scores would be assigned to different factors contributing to the carbon footprint. These factors may include raw material sourcing, manufacturing processes, transportation, and end-of-life considerations. The weighted scoring system reflects the relative importance based on industry-specific considerations. For example, emissions from transportation may be weighed differently than those from manufacturing processes. This allows for an industry-tailored approach to ranking, accounting for the diverse nature of products and industries. It also enables easy comparisons and identification of outliers, which is crucial for decision-making in data accuracy and sustainability assessments.

Therefore, the key elements that need to be considered by the Comparative Analysis Algorithm are factor selection, weighting, scoring, ranking and normalization. It's important to note that the effectiveness of a Comparative Analysis Algorithm depends on the quality and accuracy of the data collected, the relevance of the factors considered, and the accuracy of the weighting assigned to each factor.

In our case, we also integrate various certifications to further improve the accuracy of sustainability assessments. Certifications provide crucial evidence of whether a product was manufactured sustainably and serve as an additional layer of verification. This allows the algorithm to consider not only quantitative data but also qualitative aspects, which are otherwise not accounted for in PCF calculations.

```python
def calculate_carbon_footprint_score(product_data, weights):

    total_score = 0

    for factor, value in product_data.items():
        if factor in weights:
            total_score += value * weights[factor]

    return total_score


def rank_products(products_data, weights):


    product_scores = []

    for product_data in products_data:
        score = calculate_carbon_footprint_score(product_data, weights)
        product_scores.append((product_data['product_name'], score))

    # Sort products based on their scores in descending order
    ranked_products = sorted(product_scores, key=lambda x: x[1], reverse=True)

    return ranked_products
```

Figure 1: Example structure of the code

User Interface

On top of delivering the AI concept, we wanted to design a user-friendly interface, that would allow our stakeholders, in particular regulatory bodies, and sustainability analysts, to gain insight into the AI system's assessment of PCF data accuracy and to be able to act on it.

The interface includes the ability to search for products and manufacturers and gain access to detailed reports highlighting whether potential inconsistencies or data manipulation have been detected. Displayed data is broken up into easily digestible chunks, based on steps in the supply chain, for example "manufacturing" or "transportation," with additional details then providing information on what makes the data inconsistent or how it differs from industry averages. Additionally, users can view graphs illustrating their data of choice and view company certifications which back up sustainability claims. Every company's or product's final "data accuracy score" is always visible and colour coded from red to green, to ensure that every user can easily and intuitively understand the detected level of data accuracy.

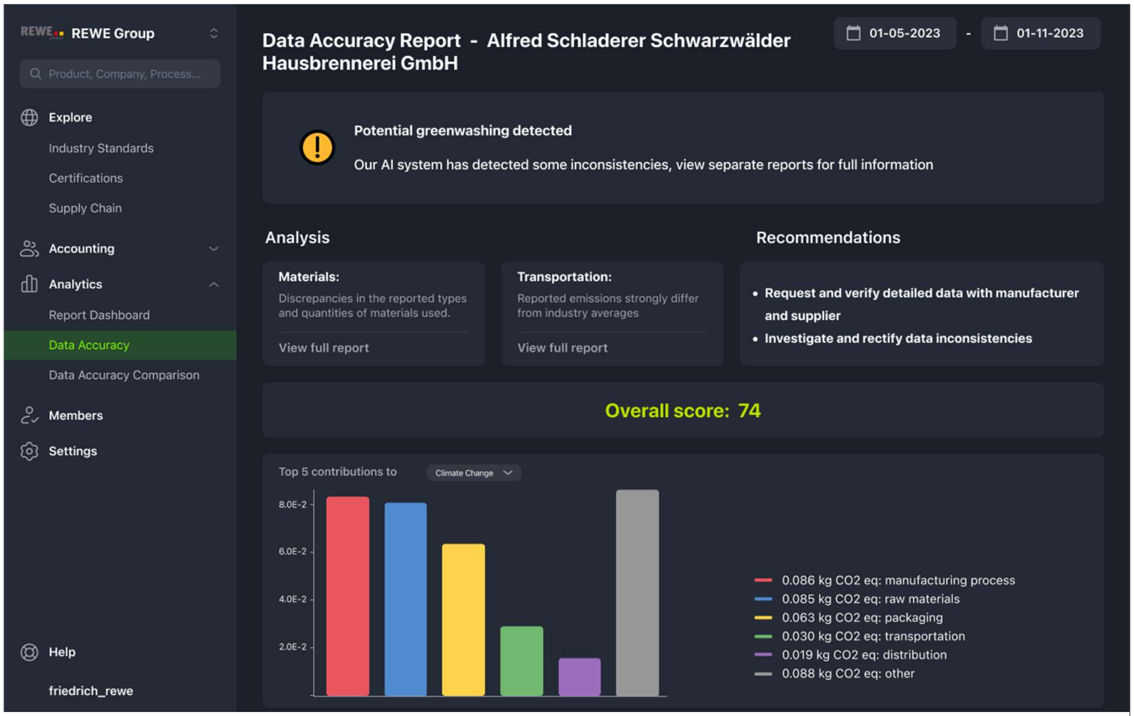

Figure 2: Data accuracy report mock-up screen

Finally, a comparison screen enables users to view two companies or products side by side, enabling a direct comparison of their Product Carbon Footprint data and AI system's insights into its' accuracy and consistency, and aiding decision-making processes.

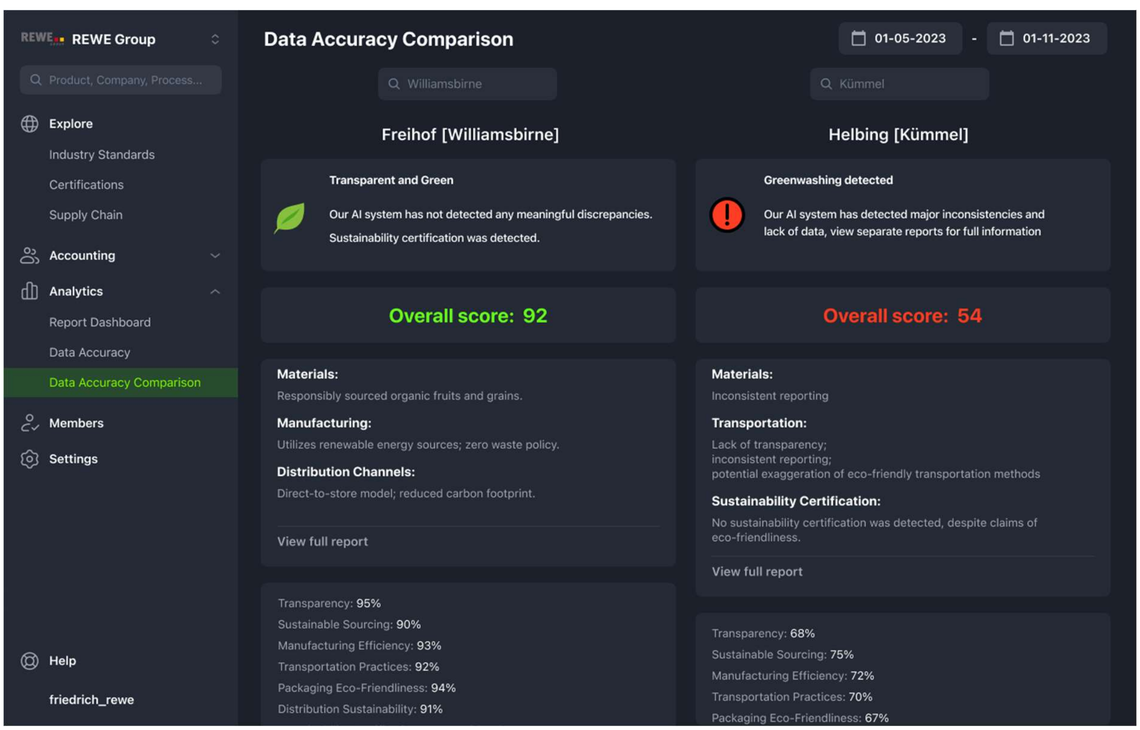

Figure 3: Data accuracy comparison mock-up screen

Work Process

The project's initial phase involved understanding the challenge verifying Product Carbon Footprints (PCF) and breaking it down into smaller problems that needed to be tackled, to then analyse them in depth.

The team conducted research to understand what some existing data models for PCF calculations look like, what emission factors are, what challenges the experts in this field currently deal with, and how AI could potentially play a role in addressing data accuracy concerns. We also gathered background information on SINE Foundation, its initiatives, and their collaboration with the Partnership for Carbon Transparency (PACT). The complexity of the challenge led to increasingly in-depth research and analysis into the existing data models.

Subsequently, the team encountered a bit of a roadblock due to the multitude of identified problems and challenges. An interim presentation allowed the team to show their progress to Prof. Stefan Wurster and Prof. Gudrun Socher, who provided constructive and helpful feedback. At this point, it became apparent that a different and more focused approach was needed, as solving every issue was impossible and impractical, leading to unclear and vague solutions.

Seeking guidance, the team actively engaged with the supervisors Helene v. Schwichow and Charlotte Böhm. Their insights provided valuable direction, helping the team reframe problems and focus on a feasible solution. Additionally, Aurel Stenzel, the Co-Founder of SINE Foundation and the challenge giver, played a crucial role in providing support and context.

With the guidance received and a clearer perspective on the core challenges, the team reframed the problems and started developing a conceptual framework using Comparative Analysis Algorithms. Following that, the team started working on the user interface, creating a mock-up that encapsulated the functionalities of the proposed solution.

AI Footprint

As with any technological solution, it's important to evaluate the potential environmental impact. The carbon footprint of the AI solution needs to be considered in comparison to the benefits derived from mitigating PCF calculation inaccuracies and misrepresentations. While AI processing can demand substantial energy, the efficiency gains achieved through streamlined and standardized PCF calculations, coupled with the long-term positive impact on sustainability initiatives, should outweigh the environmental costs associated with the AI's energy consumption. For the sake of a comparison - large language models like GPT-3 have a considerable carbon footprint, exceeding 500 tonnes of CO2eq, while in 2020, the French multinational oil and gas company "Total" greatly exaggerated the reduction of their Scope 3 emissions, failing to disclose at least 10 million tonnes of CO2. This illustrates the scale of environmental consequences when data inaccuracies go unchecked. Striking a balance between leveraging AI for sustainability and managing its own carbon footprint is paramount for ensuring a net positive impact on the environment.

Conclusion

In a landscape where environmental responsibility is paramount, the challenges surrounding Product Carbon Footprint (PCF) verification demand innovative solutions. The proposed AI-driven framework, utilizing Comparative Analysis Algorithms with a focus on benchmarking and ranking, could address the intricacies of diverse data models and industry-specific considerations. By leveraging the AI's capacity to process vast datasets and identify anomalies, we can enhance the accuracy and credibility of PCF calculations, promoting increased data quality in sustainability initiatives.

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