DELIVERABLE REPORT

WP2 Disseminaiton, Communication, Exploitation

D2.6

Online Report Publication

Due date

M48 → 52

The Imptox project has received funding from the EU's H2020 framework programme for research and innovation under grant agreement n. 965173. Imptox is part of the European MNP cluster on human health.

PROJECT DETAILS

PROJECT ACRONYM	PROJECT TITLE
Imptox	An innovative analytical platform to investigate the effect and toxicity of micro and nano plastics combined with environmental contaminants on the risk of allergic disease in preclinical and clinical studies

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01/04/2021

WORK PACKAGE DETAILS

WORK PACKAGE ID	WORK PACKAGE TITLE
WP2	Dissemination, Communication, Exploitation

WORK PACKAGE LEADER

Riccardo Brancaleon

DELIVERABLE ID	DELIVERABLE TITLE
D2.6	Online Report Publication

DELIVERABLE DESCRIPTION

This deliverable presents an interactive online platform that visualizes the results of Imptox's clinical data analysis. Designed for selected stakeholders, the platform allows users to explore how environmental and lifestyle factors, including plastic exposure, may be linked to allergic outcomes in children. Built using data and models developed in Deliverable 1.9, it offers interactive graphs, confusion matrices, and subgroup analysis tools to support policy-relevant interpretation. Access is restricted and can be requested via secretariat@imptox.eu.

DUE DATE	ACTUAL SUBMISSION DATE
M52 31/07/2025	DAY/MONTH/YEAR

PERSON RESPONSIBLE FOR THE DELIVERABLE

Riccardo Brancaleon

NATURE

R - Report

DISSEMINATION LEVEL

☒ P - Public

☐ PP - Restricted to other programme participants & EC: (Specify)

☐ RE - Restricted to a group (Specify)

☐ **CO - Confidential, only for members of the consortium**

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REPORT DETAILS

ACTUAL SUBMISSION DATE	NUMBER OF PAGES
DAY/MONTH/YEAR	**11**

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EXECUTIVE SUMMARY

This deliverable presents an interactive online platform, developed by Promoscience, to communicate key findings from the analysis of clinical data gathered during the Imptox project with the help of machine learning techniques. The platform enables selected stakeholders to explore the project's results through data visualizations that illustrate how various environmental and lifestyle factors, including exposure to plastic, may be associated with allergic outcomes in children.

To support this exploration, the platform currently includes **48 interactive graphs** that show how different factors influenced the models' predictions, as well as **16 confusion matrices** that help assess how accurately the models performed across different clinical conditions.

This online platform is directly linked to Deliverable 1.9 - Data Analysis, where the underlying clinical dataset and the application of machine learning techniques are described in detail. Deliverable 1.9 describes how Explainable Artificial Intelligence (XAI) methods were used to uncover patterns between allergic conditions and factors such as plastic exposure, air pollution, diet, and living environment. Three models were developed and tested on clinical data from a large cohort of Croatian school-aged children.

While D1.9 focuses on the development and technical interpretation of these models, Deliverable 2.6 is specifically aimed at translating those findings into accessible, visual, dynamic outputs. **The online platform makes it possible to interact with the data by selecting different clinical conditions, prediction models, outcome types (subgroups) and confusion matrices.** Users can view how various features contributed to model predictions through color-coded bar graphs powered by SHAP values.

Access to the platform is limited to selected stakeholders and is provided via a dedicated link to a password-protected section of the project website. Login credentials can be requested by contacting the Imptox Secretariat at secretariat@imptox.eu.

BACKGROUND AND CONTEXT

Micro- and nanoplastics (MNPs) are emerging environmental contaminants whose potential impact on human health remains insufficiently understood. In particular, their role in the development or exacerbation of allergic diseases is an area of growing scientific and public interest. The Imptox project was established to explore these questions using a multidisciplinary approach that combines analytical chemistry, toxicology, clinical research, and artificial intelligence.

As part of this effort, a rich clinical dataset was collected from more than 1.000 school-aged children in Croatia by Imptox partner the *Srebrenjak Children's Hospital.* This dataset includes a broad range of exposure categories, such as dietary habits, exposure to airborne pollutants, household and living conditions, family medical history, and plastic-related exposure. The goal was to examine whether any patterns could be observed between these factors and the occurrence of allergic conditions, such as sensitization to specific allergens or reported allergy symptoms.

To analyze this complex data, Imptox partner *Haute Ecole Spécialisée de Suisse Occidentale* adopted state-of-the-art machine learning techniques capable of identifying non-linear patterns and interactions between variables. As documented in *Deliverable 1.9 Data Analysis*, several models

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were developed and tested, with a particular focus on integrating Explainable Artificial Intelligence (XAI) to ensure transparency and interpretability of the results.

Deliverable 2.6 builds upon that analytical foundation by translating the output into an interactive online platform. The aim is to make the findings accessible and usable for selected stakeholders, including policymakers and public health experts, who may use this information to support evidence-based risk assessment and inform future research or regulation related to MNPs and allergic disease.

PLATFORM DESIGN

Accessibility and Data Security

To ensure responsible use and targeted dissemination, the platform is hosted in a restricted-access section of the Imptox website accessible via this link. Access is granted by invitation or upon request, subject to relevance and intended use. Once access has been greented, users receive the login credentials via email. Requests can be submitted by contacting the Imptox Secretariat at secretariat@imptox.eu.

Access is granted to selected **stakeholders** such as:

- Public health agencies
- Regulatory bodies
- Research institutions
- European Commission services and affiliated experts

These stakeholders are expected to use the platform to support interpretation of results in the context of policy-making and risk assessment related to MNPs and allergy. All data shown on the platform is aggregated, and measures have been taken to ensure privacy and data protection. No personal data is displayed or accessible, and the platform is not publicly searchable or shareable without prior authorization.

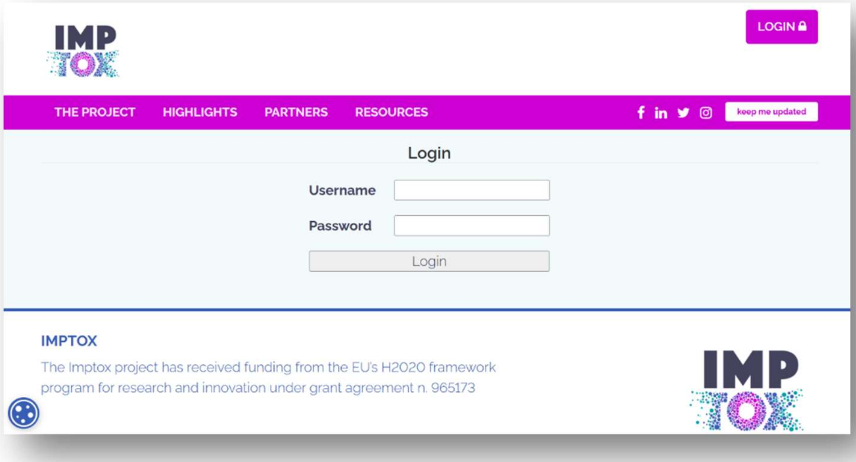

Figure 1: Login Page to Access the Imptox Data Visualization Platform

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Technical Implementation

To ensure that the visual representations on the platform are fully interactive and can respond dynamically to user input (e.g. model type, clinical condition, prediction subgroup), the web development team at Promoscience reimplemented the visualizations originally produced in deliverable 1.9, using the same dataset that had supported the initial analysis. While the SHAP-based graphs had already been generated during the data analysis phase, adapting them to an online environment required rebuilding the visualizations in a more flexible and interactive format suitable for web deployment. This involved structuring the data to fit the needs of the visualization library and creating an interface that allows users to select different combinations of factors and view the results directly in the browser. To achieve this, Promoscience adopted modern web technologies: JavaScript was used to ensure a dynamic user experience with real-time updates and no page reloads; Plotly.js enabled the generation of interactive SHAP-based visualizations on the fly, with smooth transitions and detailed tooltips for enhanced usability; and Umbraco CMS was employed to embed the interface within the project's website while ensuring that access to the page and underlying data is protected by the CMS's authentication system. The result is a responsive, user-driven interface that mirrors the original analytical outputs while supporting dynamic exploration across different models, clinical conditions, and prediction subgroups.

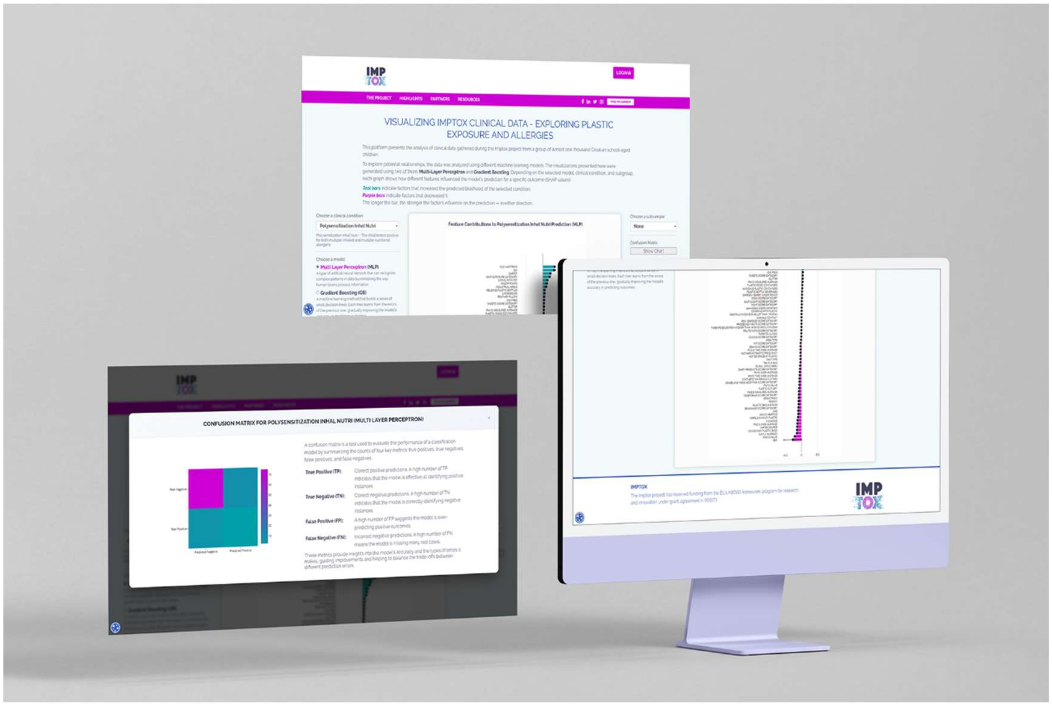

Figure 2: Imptox Data Visualization Platform

Platform Functionality and User Experience

The online report is built as an interactive platform that allows users to explore model predictions and exposure categories related to allergic outcomes. It has been designed with clarity and usability in mind, targeting stakeholders who may not necessarily have a technical background in machine learning, yet require an evidence-based overview of clinical patterns linked to plastic and environmental exposure. The interface prioritizes visual interpretation: it was deliberately designed

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to let the graphs take center stage, while keeping on-screen text minimal and focused on essential explanations that are needed to understand the graphs.

While three machine learning models were explored during the data analysis phase (see Deliverable 1.9), the platform currently visualizes results from two: Multi-Layer Perceptron (MLP) and Gradient Boosting (GB).

Graph Visualization

The central area of the interface displays SHAP-based bar charts representing how various exposure categories (e.g. microbead exposure, air pollution levels, sex, lifestyle habits) influenced the model's prediction for the selected clinical outcome. **SHAP values** (SHapley Additive exPlanations) quantify how much each individual factor contributed to a model's prediction, either increasing or decreasing its likelihood.

- **Teal bars** represent exposure categories that increased the predicted likelihood of the selected condition.
- **Purple bars** represent exposure categories that decreased it.

By moving the cursor across the bars, the exact value – including the standard error – is indicated on the graph, as in the figure below.

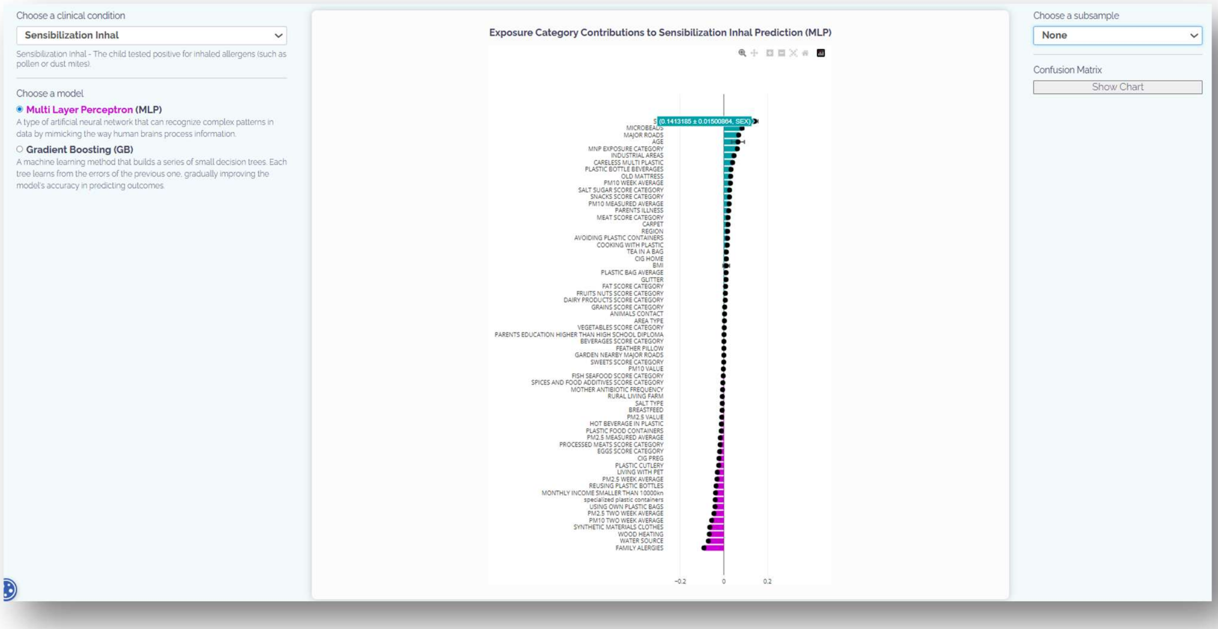

Figure 3: Display of the precise SHAP value – including the standard error – as the viewer moves the cursos across the bars. The SHAP value of +0.1431 indicates that "Sex" increased the model's likelihood of predicting a positive case. The accompanying ±0.0150 shows the standard error, meaning in this particular case (small standard error) that the effect was consistent across individual cases.

The longer the bar, the stronger the factor's influence on the prediction - whether positive or negative. Users can zoom in, hover for details, and switch views dynamically using the dropdowns.

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Interface Overview

Users can explore the platform through a set of clearly labeled options that allow them to tailor the visualizations to their specific interest.

Clinical Condition Selector

This dropdown menu allows users to choose among different allergic outcomes that were modeled in the analysis. These include:

- **Any Allergy**: The child self-reported at least one allergic condition.
- **Sensitization**: The child tested positive for at least one allergen.
- **Sensitization – Inhalant/Nutritional**: The child tested positive for one or more inhalant or nutritional allergens, respectively.
- **Polysensitization**: The child tested positive for more than one allergen, regardless of type.
- **Polysensitization – Inhalant/Nutritional**: Multiple positive results for inhalant or nutritional allergens.
- **Polysensitization – Inhalant Plus Nutritional**: Positive results for both inhalant and nutritional allergens.

When users select a clinical condition, a brief explanation appears instantly to clarify what each term means.

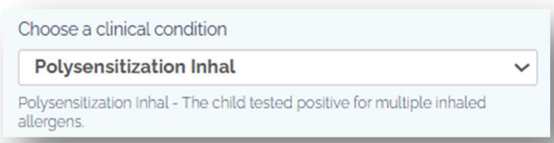

Figure 4: Example of a clinical condition with explanation

Model Selector

Users can choose between two models:

- **Multi-Layer Perceptron (MLP)**: A type of artificial neural network capable of identifying complex patterns in the data.
- **Gradient Boosting (GB)**: A model based on decision trees that incrementally improves prediction accuracy by correcting previous errors.

Both model choices are displayed with their respective explanations on the screen for users to easily understand how each model works before exploring the visualizations.

Subsample Selector

The platform allows users to filter model predictions by subsample, providing deeper insight into how the model behaves across different clinical outcomes. By default, the graphs display global results, which reflect the average contribution of each exposure category to the model's predictions across all test cases via SHAP values. However, once a clinical condition is selected (e.g., *Polysensitization Inhalant*), users can refine their view by choosing from specific prediction subgroups to see how individual exposure categories influenced the model's output in more detail:

- **True Positives (TP):** The model correctly predicted a positive case.
- **True Negatives (TN):** The model correctly predicted a negative case.

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- **False Positives (FP):** The model incorrectly predicted a positive case.
- **False Negatives (FN):** The model incorrectly predicted a negative case.

These subgroup-specific graphs are especially valuable for understanding potential **sources of bias or over/underestimation** within the model.

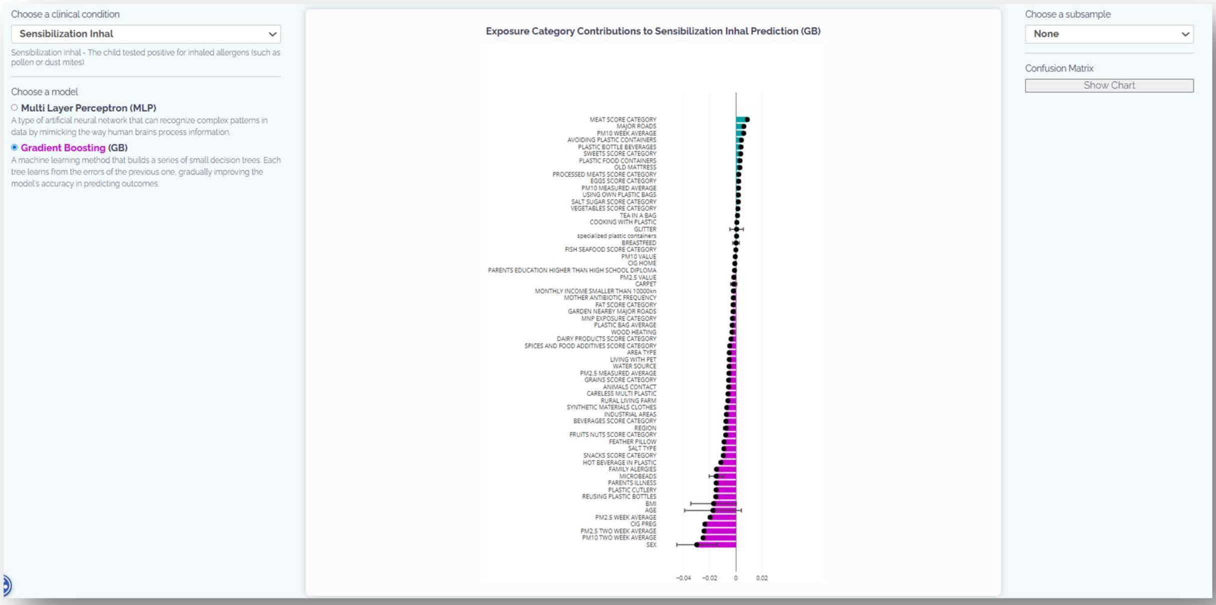

Figure 5: Global Gradient Boosting results for sensitization to inhalant allergens.
This chart displays how different exposure categories influenced the model's prediction that a child tested positive for inhalant allergens. The bars reflect the average SHAP values across all test cases. For instance, *Meat Score Category* appears at the top with a positive SHAP value (teal), indicating that a higher meat consumption score was associated with an increased likelihood of sensitization in the model's prediction. Conversely, exposure categories like *Sex*, *PM10 two-week average*, or *PM2.5 value* show strong negative SHAP values (purple), meaning they were associated with a decreased predicted likelihood.

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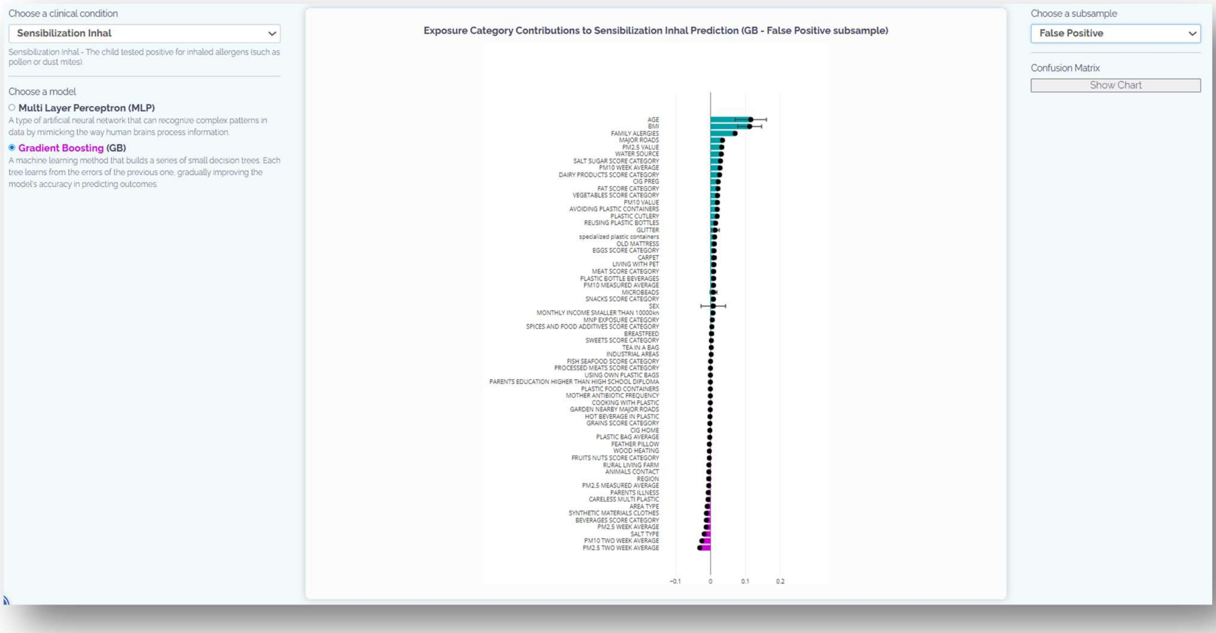

Figure 6: Exposure Category Contributions to Sensitization Inhalant – False Positives (GB Model)
This graph shows which exposure categories influenced the model when it incorrectly predicted sensitization to inhalant allergens (false positives). For these cases, *age*, *BMI*, and *family allergies* strongly pushed the model toward a false positive prediction. On the other end, environmental pollution indicators like *PM2.5 two week average* slightly reduced the likelihood of a false positive prediction.

Confusion Matrix

In addition to subgroup-specific visualizations, the platform also provides a **confusion matrix** for each model and clinical condition. While subgroup graphs allow users to explore which exposure categories influenced the model's predictions in different types of cases (e.g., false positives or true negatives), the confusion matrix offers a **quantitative summary** of how often the model made those types of predictions.

It presents four possible outcomes:

- **True Positives (TP):** The model correctly predicted the presence of the condition (e.g., sensitization or allergy).
- **True Negatives (TN):** The model correctly predicted the absence of the condition.
- **False Positives (FP):** The model predicted the condition when it was not actually present - a potential overestimation.
- **False Negatives (FN):** The model failed to predict the condition when it was present - a potential underestimation.

Together, these four metrics reflect the model's overall performance, helping users assess how well it detects real cases and avoids false alarms.

Each confusion matrix is displayed with a brief explanation of the terms to support interpretation by non-technical users.

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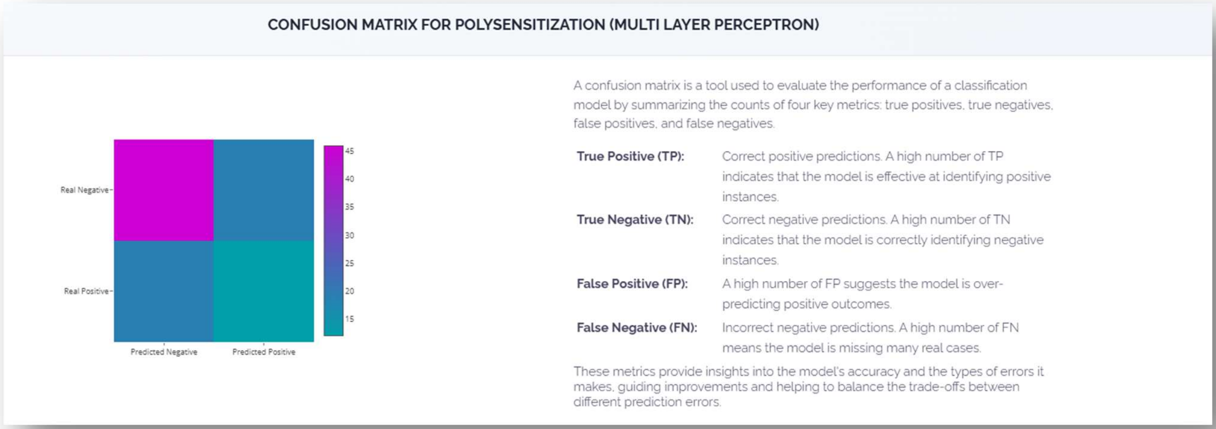

Figure 7: Display of the confusion matrix for polysensitization (MLP model) – including explanation – on the platform.

SUSTAINABILITY AND FUTURE USE

The interactive platform is intended to remain accessible to stakeholders beyond the end of the Imptox project, in line with the project's commitment to long-term impact and dissemination.

The platform will be maintained and remain online for a minimum of three years after the project's conclusion. During this time, it can continue to support engagement with key findings and offer a reference point for researchers, policymakers, and regulators.

In addition, the platform itself represents a **reusable and adaptable digital asset**. Its structure can be leveraged for future projects that aim to visualize complex, model-based data in a clear and accessible way. It has the potential to serve as a template for similar efforts in public health, environmental exposure, or biomedical research contexts, supporting communication and transparent stakeholder engagement.

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