

Call: H2020-NMBP-20-2018

Topic: A digital 'plug and produce' online equipment platform for manufacturing (IA)



Deliverable No. 5.3

Chatbot Delivered (Iteration 1)

Grant Agreement No.:	822106
Project Title:	WeldGalaxy – Digital Dynamic Knowledge Platform for Welding in Manufacturing Industries
Contractual Submission Date:	Month 12
Actual Submission Date:	Month 12
Responsible partner:	AEONX

Grant agreement no.	822106
Project full title	WeldGalaxy – Digital Dynamic Knowledge Platform for Welding in Manufacturing Industries

Deliverable number	D5.3
Deliverable title	Chatbot Delivered (Iteration 1)
Version	1.0
Type	Report
Dissemination level	Public
Work package number	WP5
Work package leader	EKON
Author(s)	Marzuk KAMAL
Contributors	
Keywords	Chatbot

The research leading to these results has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 822106.

The author is solely responsible for its content, it does not represent the opinion of the European Commission and the Commission is not responsible for any use that might be made of data appearing therein.

"The information contained in this report is subject to change without notice and should not be construed as a commitment by any members of the WeldGalaxy Consortium. The information is provided without any warranty of any kind.

This document may not be copied, reproduced, or modified in whole or in part for any purpose without written permission from the WeldGalaxy Consortium. In addition to such written permission to copy, acknowledgement of the authors of the document and all applicable portions of the copyright notice must be clearly referenced.

© COPYRIGHT 2019 The WeldGalaxy Consortium.
All rights reserved."

DOCUMENT CONTROL

This deliverable is the responsibility of the Work Package Leader. It is subject to internal review for quality assurance.

Version	Date	Author(s)	Change Details
0.1	18/02/19	Marzuk KAMAL	Table of Contents.

Table 1: Document control

1 Contents

2	EXECUTIVE SUMMARY	7
3	Introduction	8
4	The WeldGalaxy Chatbot	9
4.1	Architecture.....	9
4.2	WeldGalaxy Chatbot Messengers.....	11
4.3	Charts and 3D Model visualization in WeldGalaxy messenger	12
4.3.1	Data visualisation	12
4.3.2	3D model visualization	13
4.4	Self-learning – Chatbot learns to understand each user differently	14
4.5	AeonX NLP Engine and Dashboard	15
4.5.1	AeonX NLP Engine High Level Architecture	15
4.5.2	AeonX NLP Dashboard	16
4.6	GDPR compliance	19
5	Chatbot in Action - Examples	21
5.1	Conversational Query	21
5.2	Detailed query input.....	22

List of figures:

FIGURE 1: AN EXAMPLE OF HOW A USER QUERY IS HANDLED BY THE WELDGALAXY CHATBOT.	8
FIGURE 2: A HIGH-LEVEL VIEW OF THE WELDGALAXY CHATBOT ARCHITECTURE TOGETHER WITH KBE AND DKM	9
FIGURE 3: ARCHITECTURE OF THE WELDGALAXY CHATBOT.	9
FIGURE 4: WELDGALAXY CHATBOT MESSENGER WEB MESSENGER (TOP-LEFT), MOBILE MESSENGER APPLICATION (TOP-MIDDLE), MICROSOFT TEAMS CHANNEL (TOP-RIGHT), SKYPE (BOTTOM-LEFT), SLACK (BOTTOM-MIDDLE) AND FACEBOOK MESSENGER.	11
FIGURE 5: WELDGALAXY CHATBOT IS INTEGRATED IN DKM PORTAL	12
FIGURE 6: DEMONSTRATION OF DATA VISUALIZATION FEATURE IN WELDGALAXY MESSENGER	12
FIGURE 7: A DEMONSTRATION OF 3D MODEL VISUALIZATION. (RIGHT) USERS CAN ROTATE, SCALE AND TRANSLATE THE MODEL USING MOUSE AND KEYBOARD.	13
FIGURE 8: EXAMPLES OF 3D MODEL VISUALIZATION OF A WELDING HELMET AND WELDING TORCH	13
FIGURE 9: SELF-LEARNING – (LEFT) CHATBOT LEARNS TO IMPROVE BY ASKING WHAT A USER MEANT TO SAY. (RIGHT) AFTER TRAINING CHATBOT NOW UNDERSTANDS THE NEW QUERY PHRASE.	14
FIGURE 10: AEONX NLP ENGINE CORE COMPONENTS ARE ENCLOSED AS DOCKER CONTAINER AND DEPLOYED IN KUBERNETES CONTRAINER-ORCHESTRATION SYSTEM.	15
FIGURE 11: SCREEN SHOTS OF THE AEONX NLP DASHBOARD.	16
FIGURE 12: TRAINING DATA IS TRANSLATED TO FRENCH, SPANISH AND GERMAN JUST BY ONE CLICK ON "AUTO TRANSLATE". TRANSLATION CAN BE EDITED IF NECESSARY	18
FIGURE 13: WELDGALAXY BOT ASKS FOR USER PERMISSION ON STORING DATA ON FIRST USE. USER CAN CHANGE HER/HIS ANYTIME AT A LATER STAGE.	19
FIGURE 14: AN EXAMPLE OF CONVERSATIONAL QUERY USING THE WELDGALAXY CHATBOT	21
FIGURE 15: CHATBOT DIRECTLY SHOWS RESULT WHEN ALL NECESSARY PARAMETERS ARE PROVIDED	22

List of tables:

TABLE 1: DOCUMENT CONTROL	3
TABLE 2: LANGUAGES, TOOLS AND FRAMEWORKS USED TO BUILD COMPONENTS OF WELDGALAXY CHATBOT	10

2 EXECUTIVE SUMMARY

The main function of the WeldGalaxy chatbot (Chatbot) is to make query process in the Knowledge Based Engineering (KBE) system more efficient and user friendly. Usually, a user searches for information by choosing parameters from many dropdown lists in the KBE platform. The chatbot helps users to get to specific results in a user friendly and conversational way, making it an efficient process. The chatbot can also respond to frequently asked questions on welding technologies.

Here, we describe functional and technical features of the deliverable D5.3:

- WeldGalaxy chatbot Messenger – Web, Android/iOS Mobile application, and Microsoft Teams integration
- WeldGalaxy Messenger custom UI card that can display Images, Buttons, Charts, 3D Models
- AeonX Natural Language Processing (NLP) engine
- Chatbot design and NLP training data preparation dashboard.
- Integration of the chatbot with the Knowledge Based Engineering (KBE) backend REST API (from TVS)
- Integration of the chatbot messenger in the DKM platform (from EKON)
- Steps taken for GDPR compliance

In this deliverable (D5.3), we complete all the frontend implementation of the WeldGalaxy chatbot. Any data retrieved by the chatbot from KBE may require further validation from the experts. However, future updates in KBE database will be automatically reflected in the query responses of the WeldGalaxy chatbot.

The Charts and 3D Model visualisation features are implemented. However, these features will be useful once the KBE API is able to provide data for charts and 3D Models.

3 Introduction

The WeldGalaxy chatbot (Chatbot) is a user friendly channel to search for information in the KBE. The queries can be in the form of unstructured natural language. These unstructured user queries are then processed and parameterized by AeonX NLP Engine and finally AeonX Bot Engine performs parameterized search in the KBE system. In case any necessary parameter is missing from the user input, the chatbot engages in conversation with the user until all the parameters are provided correctly (Figure 1Figure 2). The chatbot responses can be in the form of text and/or interactive UI cards that contain interactive buttons, images, charts and 3D Models.

The chatbot is powered by proprietary AeonX Natural Language Processing Engine (AeonX NLP) that is customized and improved for the WeldGalaxy Project. AeonX NLP engine is supported by AeonX NLP Dashboard. Using this dashboard, a bot designer can easily prepare training data, train and deploy NLP models to production. AeonX NLP engine and AeonX NLP Dashboard supports English, French, German and Spanish among other languages. This allows users to query in any of the 4 languages and get a response from the chatbot.

AeonX Bot Engine connects to the KBE to prepare responses (Figure 2). At the moment, that KBE data are is in English language only, hence, the responses will be in English even though user query may be in one of the 4 languages.

The chatbot can learn from user activity that we call self-learning. If a query is not understood, the chatbot proposes several possible solutions to the user. Upon users' choice, the chatbot learn the usage pattern of each particular user. Therefore, the chatbot becomes more personalized with more user engagement.

The chatbot has multiple input channels such as – WeldGalaxy Web messenger & Android/iOS Mobile messenger, Skype, Microsoft Teams, Slack and Facebook Messenger. Advanced features like charts and 3D model visualization is only available in WeldGalaxy web+mobile messengers.

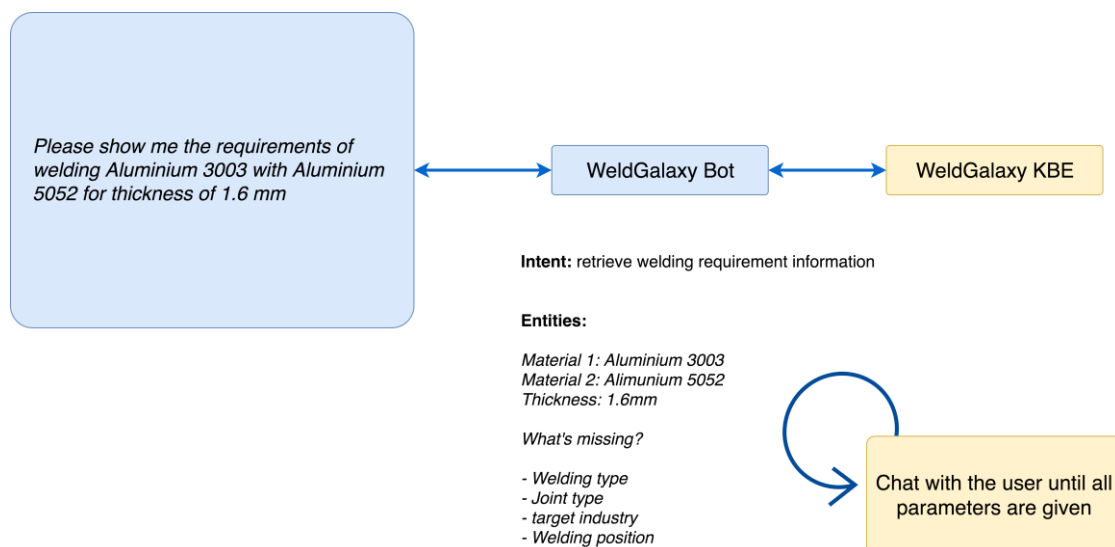


Figure 1: An example of how a user query is handled by the WeldGalaxy chatbot.



Figure 2: A high-level view of the WeldGalaxy chatbot architecture together with KBE and DKM

4 The WeldGalaxy Chatbot

4.1 Architecture

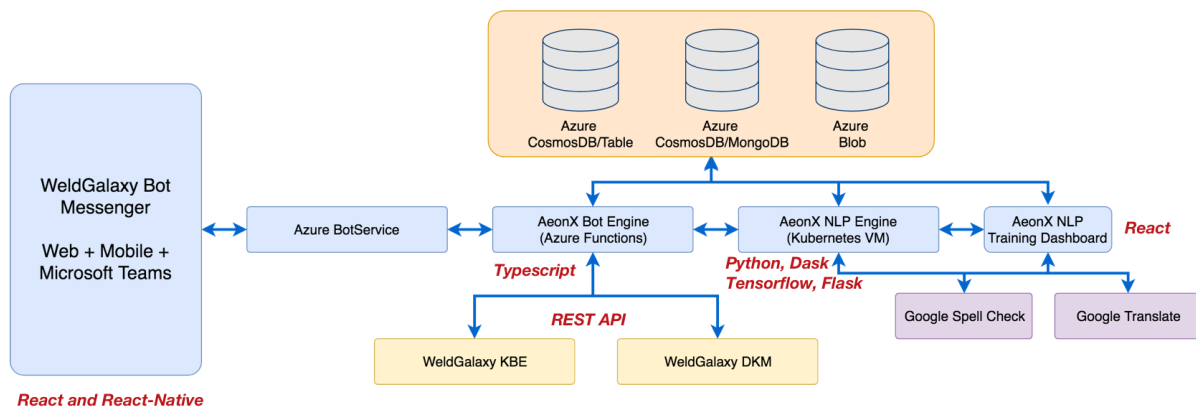


Figure 3: Architecture of the WeldGalaxy chatbot.

The chatbot messenger applications are all connected to Azure Bot Service. The central part of WeldGalaxy chatbot is the AeonX Bot Engine, which connects to all the other components. User queries are sent from the messengers (through Azure Bot Service) to the bot engine. The bot engine then sends the query to AeonX NLP engine to understand the intent and entities (*parameters such as material type, thickness, welding type*) of the query. Once intent and entities are identified, AeonX Bot engine contacts KBE through the KBEREST API to retrieve relevant information such as material properties, requirements, suppliers, compatible welding materials, frequently asked questions etc.

The bot engine is an Azure Function (serverless, similar to AWS Lambda), which is a very low cost service and is charged based on usage. AeonX NLP engine runs on a Kubernetes server. The key advantage of using Kubernetes is that it can automatically spawn new instances of the AeonX NLP engine depending on the workload. Kubernetes auto-allocates on-demand compute resources, making it a very cost-effective machine learning server hosting solution.

All the AeonX NLP training data and trained models are stored in Azure CosmosDB/MongoDB. Azure CosmosDB/Table and Blob storage is used to store bot session and dialog templates. Also, Blob storage is used to host the web messenger JavaScript code.

The WeldGalaxy Chatbot web messenger is integrated with the DKM web portal (Figure 5). The Web bot messenger shares all the security features of the DKM platform. A user can only use the WeldGalaxy bot once signed in.

Component	Language/Framework/Tools
Chatbot web messenger	React, Typescript, NodeJS, Bing Speech, Three, d3, charts
Chatbot Mobile messenger application	React Native, Typescript, NodeJS, Bing Speech
AeonX NLP Engine (Machine Learning)	Python, Tensorflow, scikit-learn, nltk, Flask, dask, kubernetes, docker
AeonX NLP Dashboard	React, Typescript, NodeJS, Express, Redis, Google Translate, Google spell check, Google translate
AeonX Bot Engine	Azure Function, NodeJS, Typescript, AeonX bot framework
Database	Azure CosmosDB/MongoDB, Azure Table, Azure Blob

Table 2: Languages, Tools and Frameworks used to build components of WeldGalaxy Chatbot

4.2 WeldGalaxy Chatbot Messengers

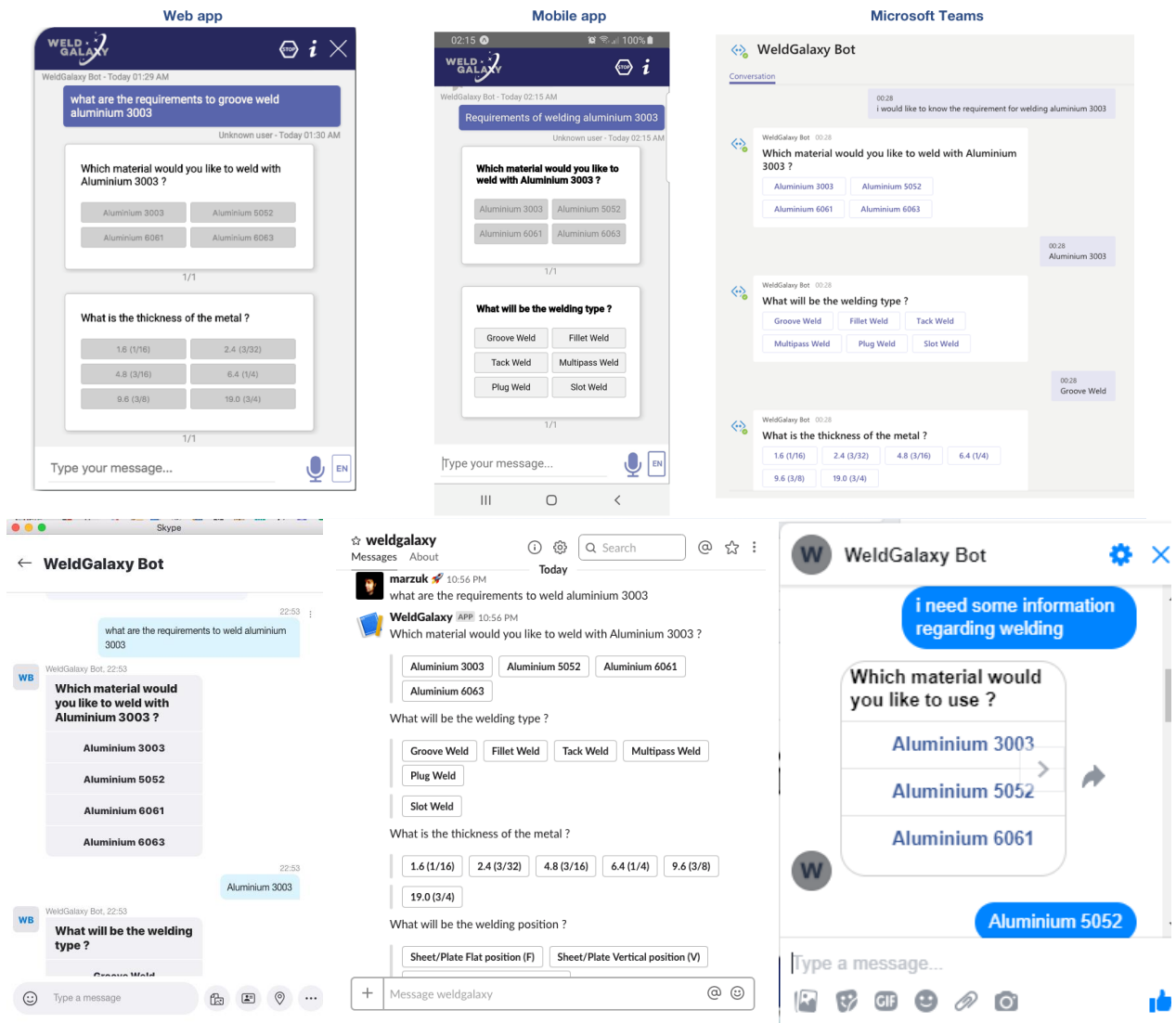


Figure 4: WeldGalaxy Chatbot Web messenger (top-left), Mobile Messenger Application (top-middle), Microsoft Teams channel (top-right), Skype (bottom-left), Slack (bottom-middle) and Facebook messenger.

The messengers are the portals to the WeldGalaxy chatbot. The web messenger is fully responsive and works seamlessly on both desktop and mobile web browsers. The messengers support both text and voice user inputs.

We also developed an Android+iOS Mobile app messenger that has all the features of the web messenger. Finally, we have also created a WeldGalaxy bot channel in Microsoft Teams, Skype, Slack and Facebook Messenger so that a user can use the bot using regular messengers.

WeldGalaxy messengers are integrated in the DKM portal (Figure 5).

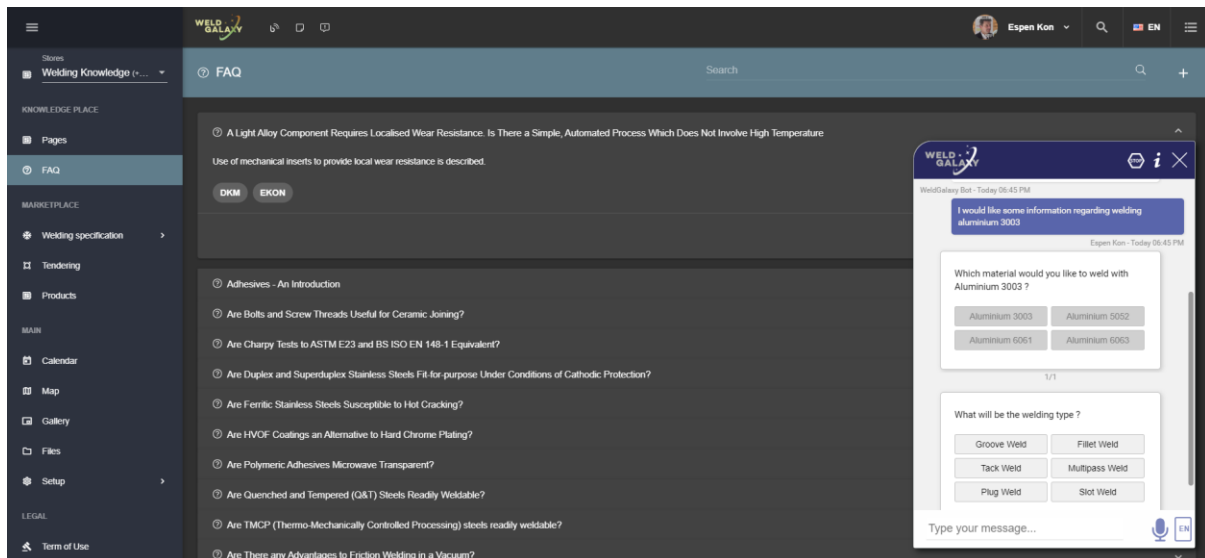


Figure 5: WeldGalaxy chatbot is integrated in DKM portal

4.3 Charts and 3D Model visualization in WeldGalaxy messenger

4.3.1 Data visualisation

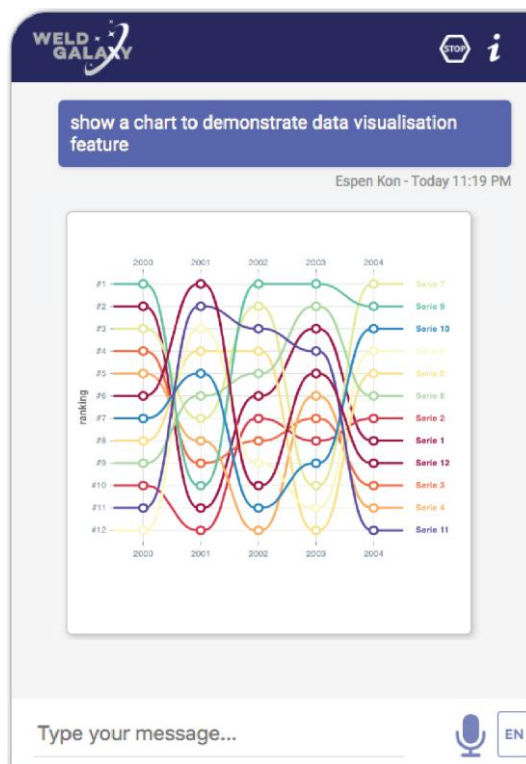


Figure 6: Demonstration of data visualization feature in WeldGalaxy messenger

The WeldGalaxy chatbot messenger supports data visualization. This custom made feature is special to WeldGalaxy chatbot messengers and is not available in Teams, Skype, Slack or Facebook messengers.

This feature is fully functional (Figure 6). However, we are waiting for KBE API to be ready to provide data for visualisation.

4.3.2 3D model visualization

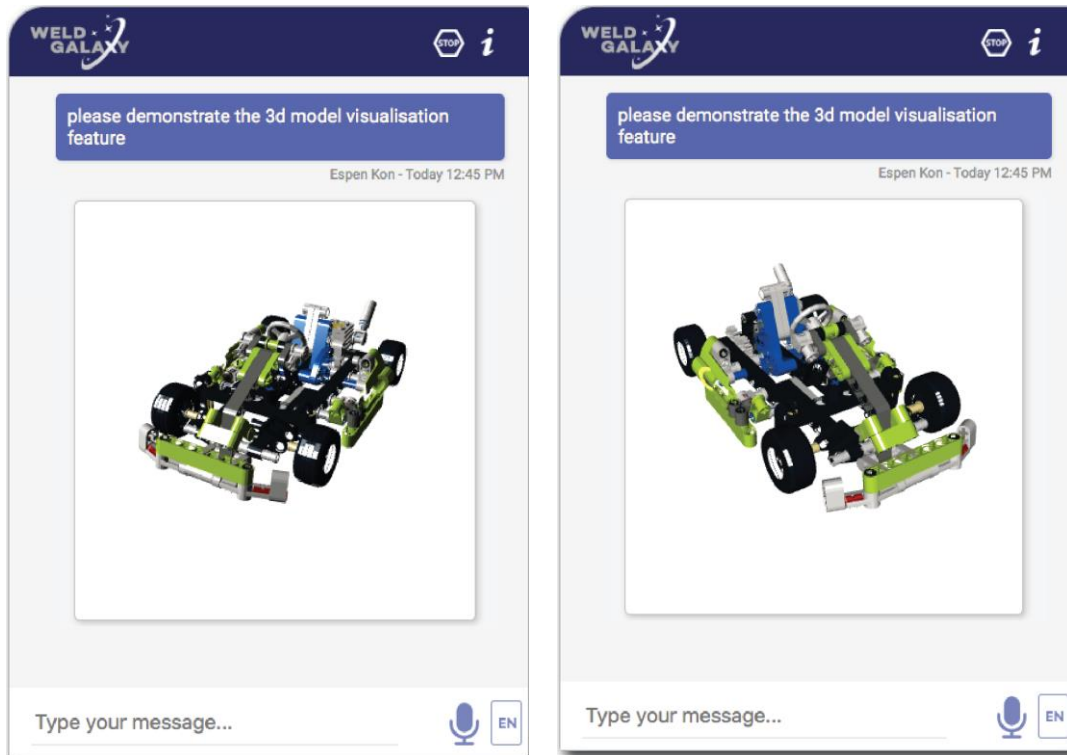


Figure 7: A demonstration of 3D model visualization. (Right) Users can rotate, scale and translate the model using mouse and keyboard.

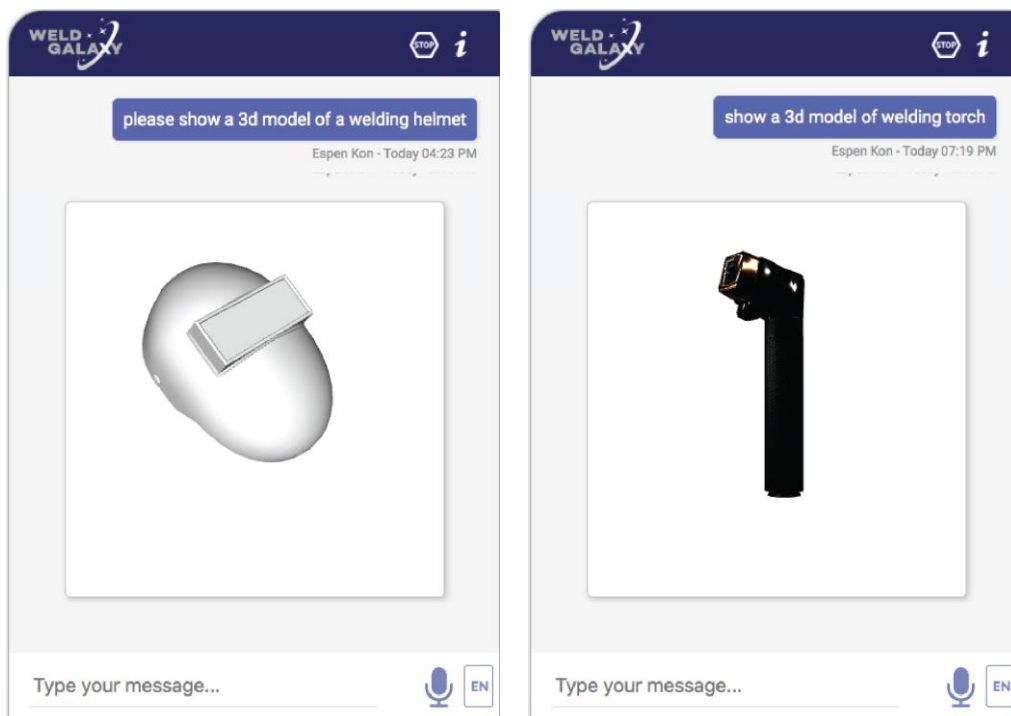


Figure 8: Examples of 3D model visualization of a welding helmet and welding torch

WeldGalaxy chatbot messenger (Web+Mobile) can display interactable 3D models of various formats (obj, mtl, dae, gltf, json). This feature is implemented on WeldGalaxy web and mobile messengers. However, Skype, Teams, Slack and Facebook messengers do not have this feature.

At the moment, 3D model data is not available in the KBE. Once KBE is ready, the chatbot display 3D models as a response chatbot query.

4.4 Self-learning – Chatbot learns to understand each user differently

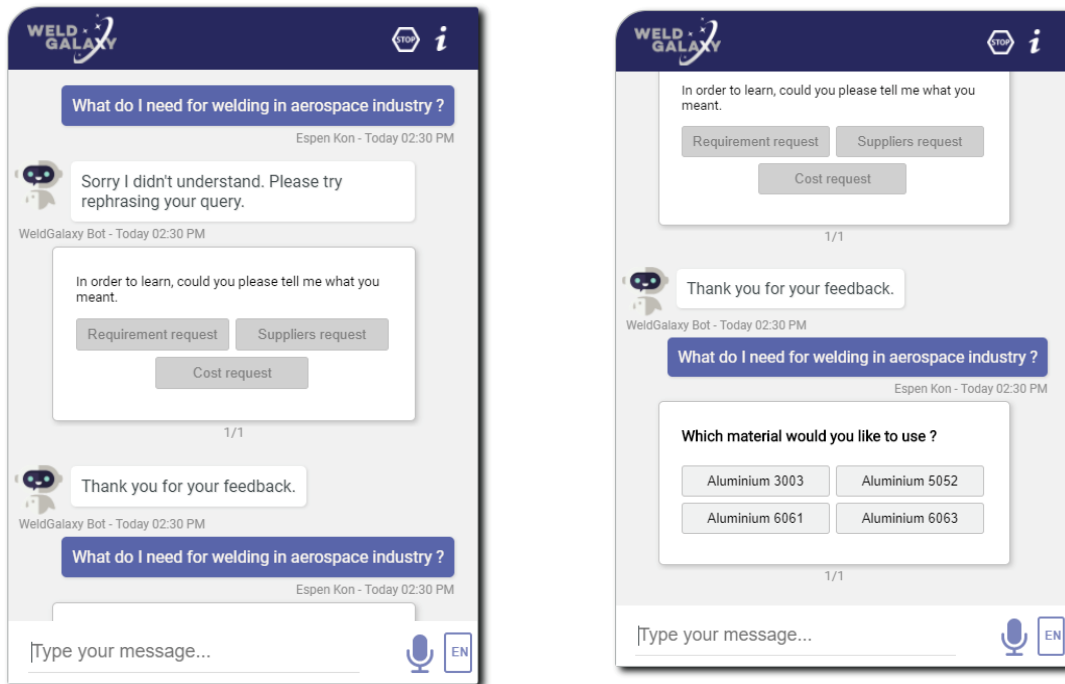


Figure 9: Self-learning – (left) Chatbot learns to improve by asking what a user meant to say. (right) after training chatbot now understands the new query phrase.

There are cases when the chatbot may not understand the phrasing of query. In order to understand the user better, the chatbot ask what the user meant to say. If a user a responds from one of the proposed choices (Figure 9), the chatbot will learn from that and personalize that particular phrase for the user (Figure 9 right). Other users do not see this update. If the chatbot admin identifies this phrase as a correct one, he/she will add to the global NLP model to make the update available to app users.

4.5 AeonX NLP Engine and Dashboard

4.5.1 AeonX NLP Engine High Level Architecture

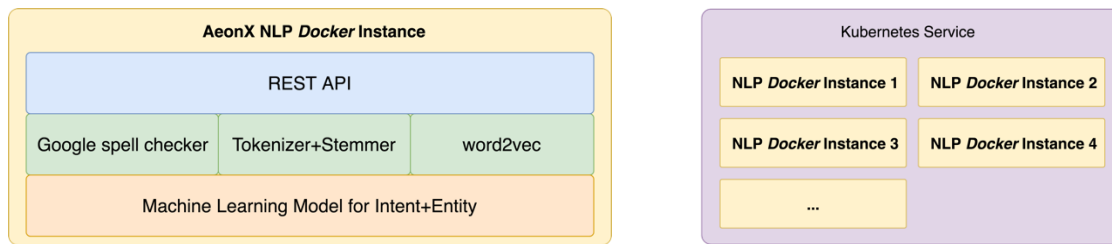


Figure 10: AeonX NLP Engine core components are enclosed as Docker container and deployed in Kubernetes container-orchestration system.

AeonX NLP engine is composed of three major layers. The core is the machine learning model that needs to be trained using training data. There are two independent machine learning models per language. One for classification of the user query phrases and second is to extract entity or parameters that are required to perform a formatted search in the KBE. AeonX Bot engine communicates with the NLP engine through its REST API. The entire engine is containerized using docker in ubuntu 18.04 environment.

The machine learning engine is built using scikit-learn and Tensorflow/Keras framework, which are open source machine learning frameworks and highly optimized for fast computation.

Machine learning models take a lot of computational resources. To handle scaling of AeonX NLP engine on-demand we have used Kubernetes container-orchestration platform. The Kubernetes platform automatically spawns new instances of the docker containers depending on the workload. On low workload, Kubernetes destroys the instances to save computational cost.

4.5.2 AeonX NLP Dashboard

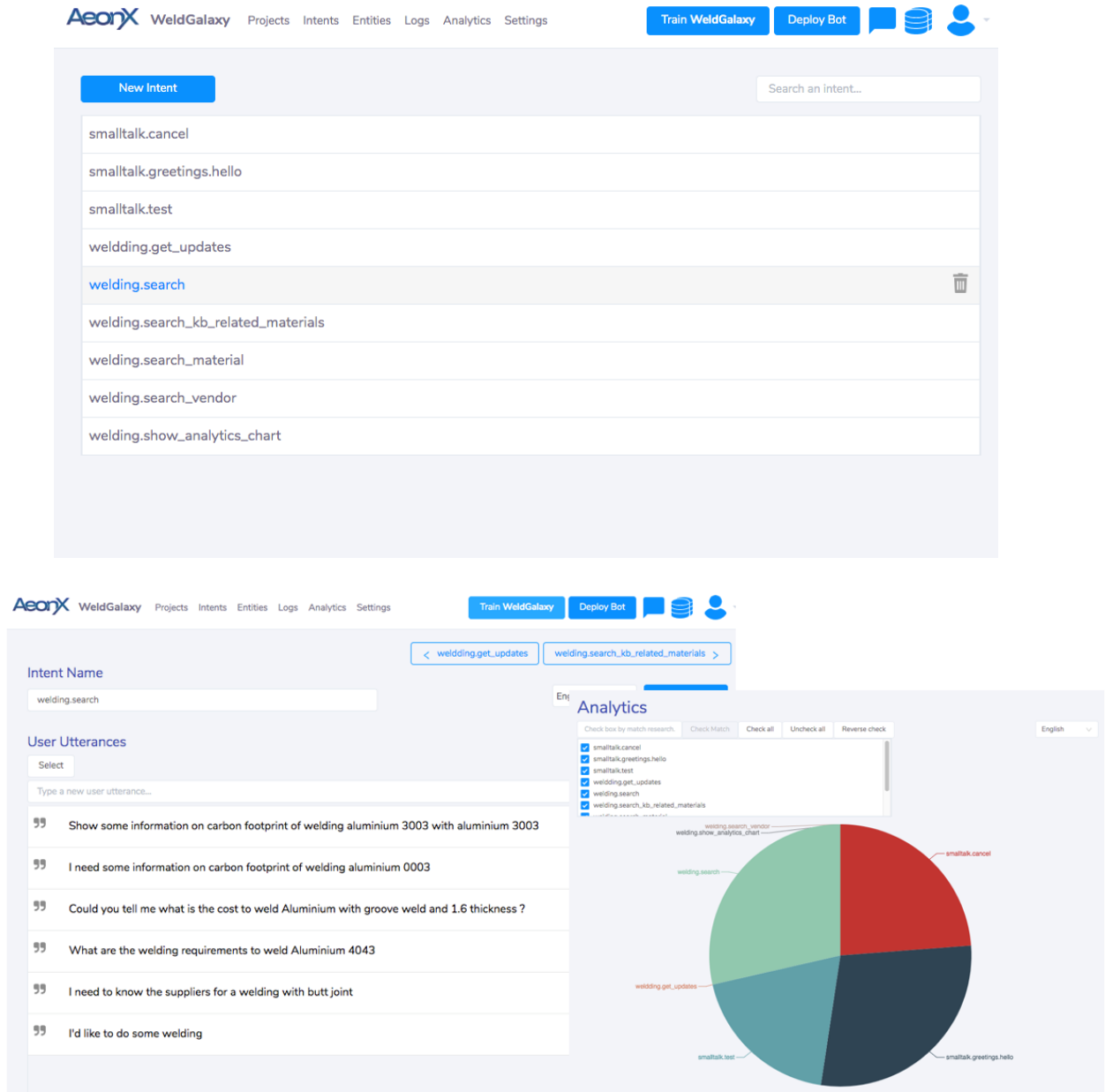


Figure 11: Screen shots of the AeonX NLP Dashboard.

The screenshot shows the AeonX WeldGalaxy interface. At the top, there is a navigation bar with 'WeldGalaxy', 'Projects', 'Intents', 'Entities', 'Logs', 'Analytics', and 'Settings'. On the right, there are buttons for 'Train WeldGalaxy' and 'Deploy Bot', along with icons for chat, database, and user. The main content area is titled 'Intent Name' and shows 'welding.search' in a text input field. To the right of the input field, there is a language dropdown set to 'English' and an 'Auto-Translate' button. Below the input field, there is a 'User Utterances' section with a 'Select' button and a list of utterances. An 'Autotranslate' modal is open, showing the source language as English (UK) and a list of destination languages: Français, Nederlandse, Español, Deutsch, Italiano, Portugese, Türkçe, 日本語, 中文, and 한국말. The 'Translate' button is highlighted. Below the modal, the 'User Utterances' list contains two items: 'I need to know the suppliers for a welding with butt joint' and 'I'd like to do some welding'. At the bottom right of the modal, there are navigation arrows and a page number '1'.

The screenshot shows the AeonX WeldGalaxy interface. At the top, there is a navigation bar with 'WeldGalaxy', 'Projects', 'Intents', 'Entities', 'Logs', 'Analytics', and 'Settings'. On the right, there are buttons for 'Train WeldGalaxy' and 'Deploy Bot', along with icons for chat, database, and user. The main content area is titled 'Intent Name' and shows 'welding.search' in a text input field. To the right of the input field, there is a language dropdown set to 'Français' and an 'Auto-Translate' button. Below the input field, there is a 'User Utterances' section with a 'Select' button and a list of utterances. An 'Autotranslate' modal is open, showing the source language as English (UK) and a list of destination languages: Français, Nederlandse, Español, Deutsch, Italiano, Portugese, Türkçe, 日本語, 中文, and 한국말. The 'Translate' button is highlighted. Below the modal, the 'User Utterances' list contains seven items in French: 'Afficher des informations sur l'empreinte carbone de la soudure de l'aluminium 3003 avec de l'aluminium 3003', 'J'ai besoin d'informations sur l'empreinte carbone de la soudure d'aluminium 0003', 'J'ai besoin d'une empreinte carbone', 'Pouvez-vous me dire quel est le coût de la soudure en aluminium avec soudure à gorge et épaisseur de 1,6?', 'Quelles sont les exigences de soudage pour souder l'aluminium 4043', 'J'ai besoin de connaître les fournisseurs pour une soudure avec joint bout à bout', and 'J'aimerais faire de la soudure'. At the bottom right of the modal, there are navigation arrows and a page number '1'.

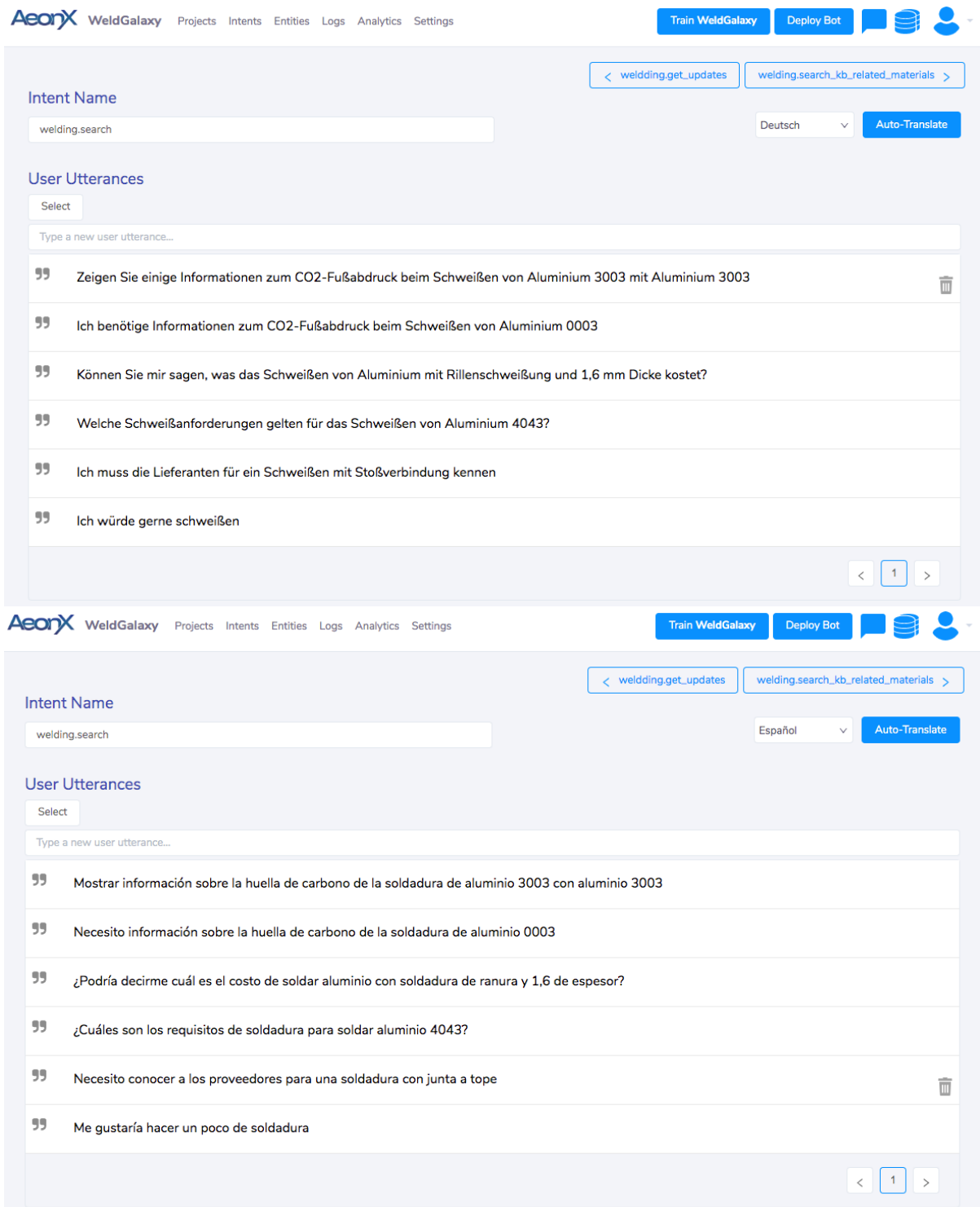


Figure 12: Training data is translated to French, Spanish and German Just by one click on "Auto Translate". Translation can be edited if necessary

AeonX NLP Dashboard (dashboard) makes it very easy to prepare, manage, train and deploy machine learning models for WeldGalaxy chatbot. This dashboard is an independent web application that communicates with the AeonX NLP engine through its REST API.

With the dashboard, a bot designer can do the following

- Prepare training data
- Manage and update training data
- Train an NLP model and test immediately
- Design bot in any one language. A bot designer can auto translate the project into multiple languages with minimal human intervention.
- Define entities parameters specific to welding industry. For example, welding material names, joint types, welding types and typical material thickness etc.
- View bot usage log and bot usage statistics.
- Update the training data from the usage log.

4.6 GDPR compliance

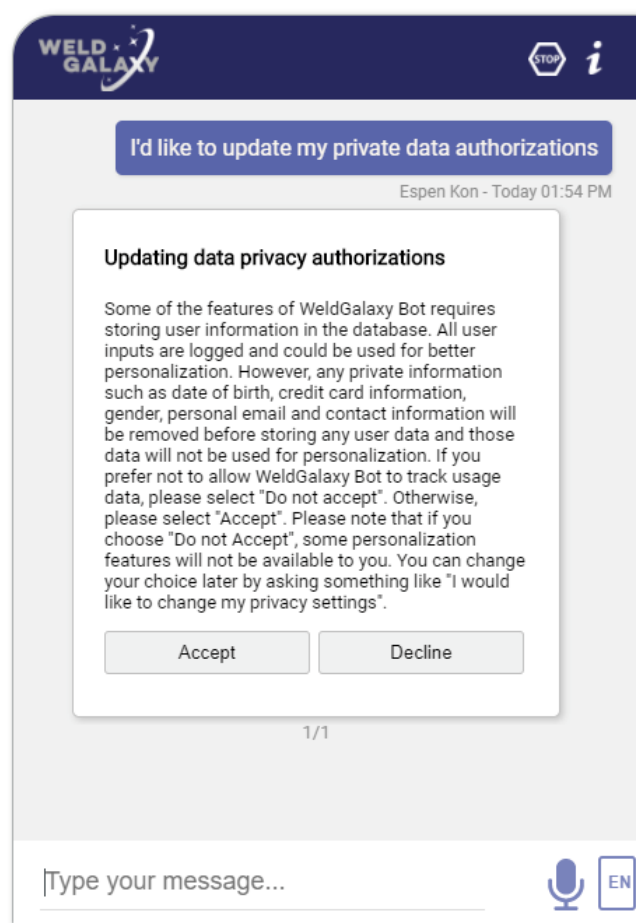


Figure 13: WeldGalaxy bot asks for user permission on storing data on first use. User can change her/his anytime at a later stage.

GDPR regulation requires user must be informed about how the software vendor handles user data, the vendors must be able provide or delete user activity upon request from the user and the vendor must have a way to detect any security breach to notify the users with 72 hours.

The use cases of the chatbot is query related to welding industry. These queries are not expected to contain any personal data such as user name, age, health etc. Upon having user permission, The log data is used to monitor chatbot performance, accuracy, user engagement, retention and for training

an updated model. Each log data can be traced back to the user. This is necessary to be able to provide or delete user activity data if a user makes requests to the WeldGalaxy chatbot admin.

When the chatbot is used for the first time, a user will be asked for permission to log user activity (Figure 13). If user declines to accept the terms, the user can still use the bot. However, no activity from this particular user will be logged and all personalisation features of the chatbot will be disabled.

The chatbot usage can be monitored using AeonX Dashboard. In case of any unusual activity, the admin will be able to identify that, notify the users and take necessary actions to prevent it.

5 Chatbot in Action - Examples

5.1 Conversational Query

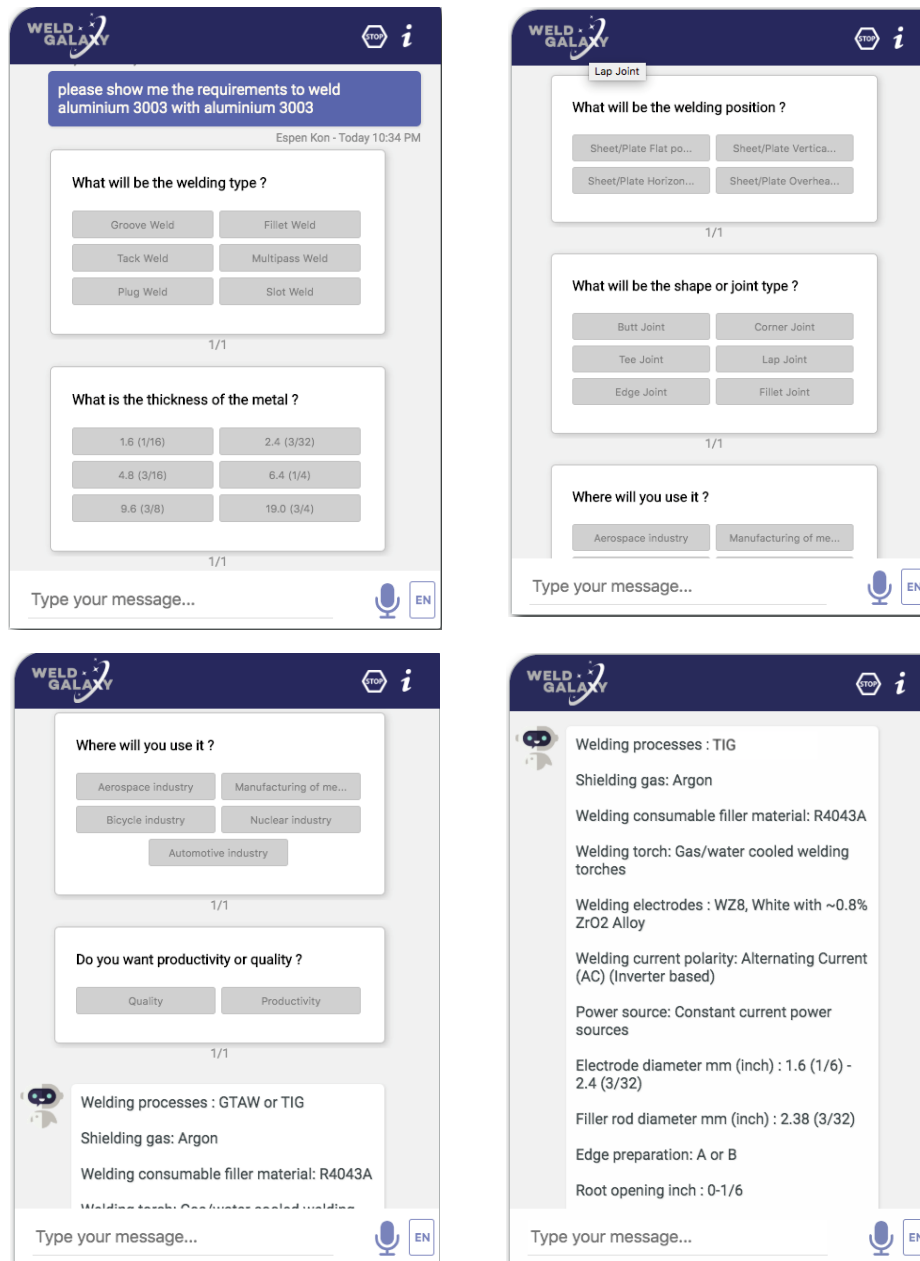


Figure 14: An example of conversational query using the WeldGalaxy chatbot

A user can type in **“please show me the requirements to weld Aluminium 3003 with Aluminium 3003”**. The WeldGalaxy bot then processes the query and realizes that in order to get information effectively, the user needs to provide a few more parameters, such as welding process, welding position, joint type, metal thickness etc. So the chatbot would engage in a dialog with the user to get all the necessary parameters.

5.2 Detailed query input

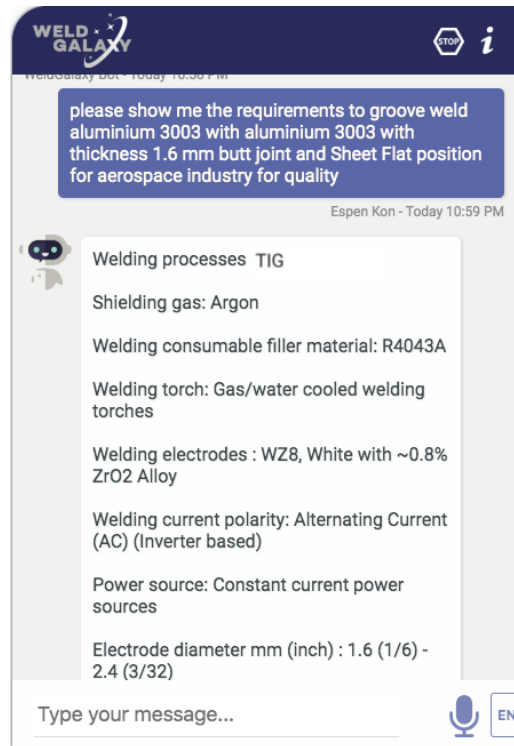


Figure 15: Chatbot directly shows result when all necessary parameters are provided

If a user chooses to write a detailed query such as - **“please show me the requirements to groove weld aluminium 3003 with aluminium 3003 with thickness 1.6 mm butt joint and Sheet Flat position for aerospace industry for quality”** – The bot will immediately show the response without asking for any more parameters.

These examples demonstrate the potential of a single interface chatbot to be useful in diverse set of queries, be it a simple FAQ or a complex query involving a lot of parameters.