D4.5 Open Call Announcement and Guide for Applicants [OC1]

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Abbreviations

AI: Artificial Intelligence
EC: European Commission
EoI: Expressions of Interest
DoA: Description of Action
GA: Grant Agreement
GfA: Guide for Applicants
KPIs: Key Performance Indicators
OC: Open Call
SME: Small and Medium Enterprise
BMP: Bonseyes Marketplace
AI4EU: AI on demand platform

Executive Summary

This deliverable provides a set of documents to inform the potential applicants and other involved parties of the details of the first open call of BonsAPPs for its successful execution, including:

- Guide for Applicants (GfA) – a step-by-step guide with detailed information on the application process and AI Industry Challenges.
- Open Call Announcement (CA) – an overview on key data such as the identification of the project and the call, the activities eligible for financial support, total available funding, key dates, participation duration and further information and contact points that will be published by Project Officer on the EC Competitive Calls website.

Document Revision History

Version	Date	Modification Reason	Modified by
V0	14/05/2021	V0 Sent to Selection Committee for review until 26.05	FBA
V2	31/05/2021	Version 2 with SC comments implemented	FBA
V3	23/07/2021	Version 3 after Quality Review and Project Officer´s approval	FBA
V4	17/08/2021	Version 4 with AI Industry Challenges included. Submitted to EC portal	BCA/FBA

Guide for Applicants
1st Open Call

Open date for proposals: the 1st of September, 2021 at 00:00 CEST (Brussels Time).
Deadline: the 28th of October, 2021 at 17:00 CEST (Brussels Time).

Version 4: 17/08/2021

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1. Basic Info about BonsAPPs

BonsAPPS is a EU-funded H2020 project that will help SMEs in their digitalization process by allowing them to access, implement and make use of Artificial Intelligence in an easy and affordable way through fully functional cycle for the AI development that can be done through Bonseyes Marketplace: a high-quality and versatile AI-as-a-Service Platform that reduce time and cost of AI@Edge development, and can be used to develop AI@Edge solutions.

Over the duration of the project, BonsAPPs will launch 2 Open Calls (OC) for **AI Talents** and low-tech SMEs that will lead to the development of 20 Use Cases in total.

Through this 1st Open Call, BonsAPPs will support**:**

- **Who?** 30 AI Talents (data scientists, AI developers and AI integrators)
- **To do what?** Development, integration and deployment of an AI@Edge Solution responding to one of the 10 specific AI Challenges from automotive, manufacturing, healthcare and robotics industries.
- **With what resources?** modular services, such as experimentation, model compression, optimization, benchmarking, deployment on hardware, and security available through the Bonseyes Marketplace Platform.
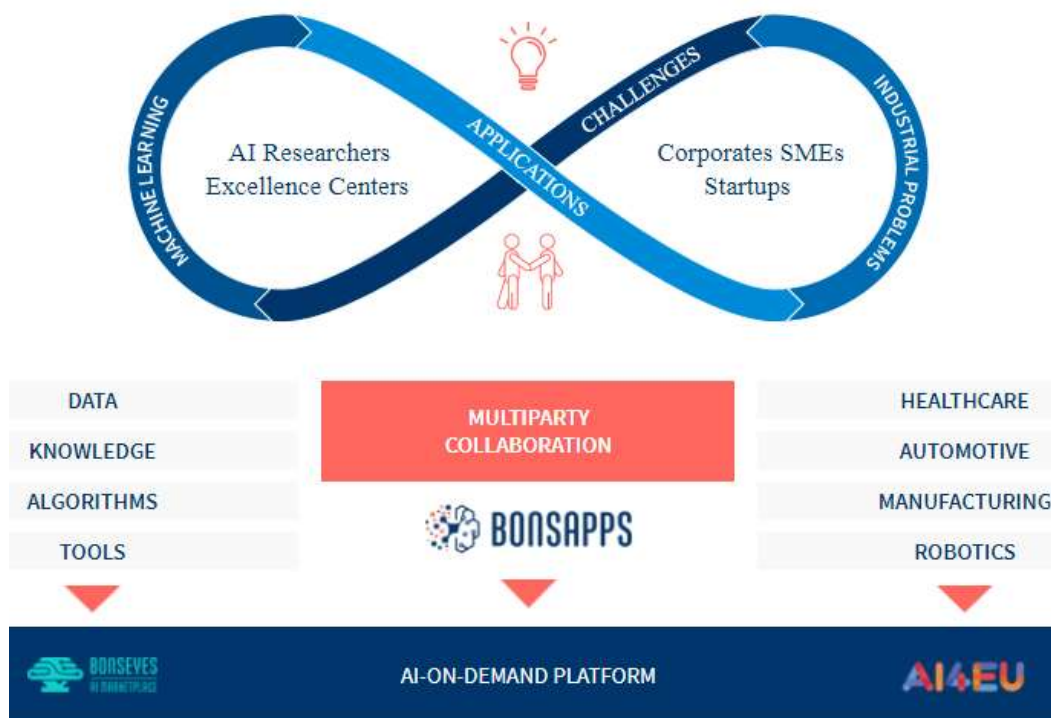
Figure 1 BonsApps open innovation cycle

Who are AI Talents?
The typical profile of the AI talents could be individuals (data scientists, PhDs/post-docs, engineer/developers) or entities, such as SMEs, MidCaps or Research and Technology Organization with internal skills. **AI Talents must demonstrate capacity to execute both AI development and AI integration and deployment tasks with resources and services available through Bonseyes Marketplace**

Open Call 1 Activities | **Focus**

Figure 2 BonsAPPs 1st Open Call focus

This document summarizes the main rules of the BonsAPPS 1st Open Call that will be **open under the ink: https://bonsapps-1oc-ai-talents.fundingbox.com/apply from 1st September 2021 at 00:00 CEST (Brussels Time) with a deadline on 28th October 2021 at 17:00 CEST (Brussels Time).**

The BonsAPPs consortium is led by HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE (CH) and brings together a multidisciplinary team with the necessary expertise on AI technologies: BONSEYES COMMUNITY ASSOCIATION (BCA), FUNDINGBOX ACCELERATOR SP ZOO (FBA), STMICROELECTRONICS SRL (ST-I), BLEKINGE TEKNISKA HOGSKOLA (BTH), ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA (UNIBO), NVISO SA (NVISO), INTERNETSIA, S.L. (ISDI).

2. What do we offer?

Become a certified AI Talent user of Bonseyes Marketplace Platform
Selected AI Talents will become a 'certified AI Talent users' of the Bonseyes Marketplace Platform: a high-quality and versatile AI-as-a-Service Platform that reduce time and cost of AI@Edge development, and can be used to develop AI@Edge solutions for a wide range of developer platforms in the market (ARM Cortex-A CPUs, embedded NVIDIA GPGPUs, Intel CPUs, RISC-V MCUs, ST-I MCUs, etc.).

The BonsAPPs AI-aaS service layer within the AI-on-demand platform will join the industry challenges with reusable research, and will offer monetization opportunities to AI talents in the future.

Get funded for helping to make AI-on-demand effort successful
Each selected AI Talent will receive at maximum 70 000 EUR for the development of an AI@Edge Solution during a two-stage, 5 -months project including up to 10 000 EUR voucher to access HPC Clouds required for model training/optimization/benchmarking.

Bonseyes Marketplace Platform tutorials and support
AI Talents will use Bonseyes Marketplace Platform (AI-aaS service layer within AI-on-demand platform) to develop AI@Edge Apps and Solutions based on Computer Vision, Time Series Analysis, Audio Classification and/or other AI enabling technologies.

BonsAPPs team will provide early access and training in the use of Bonseyes Marketplace Platform.

Licencing rights:
AI Talents will have an ownership of AI Solutions developed during the project. AI Components and AI Solutions developed by AI Talents on the Bonseyes Marketplace Platform will be a possible subject to licencing models that protect data privacy and ownership of data from the original end users but grant AI Talents rights to re-use and commercialise them and develop new AI@Edge products for additional end users.

Business coaching:
10 AI Talents that will enter to 2nd Stage of BonsAPPs programme will receive the support from business mentors to build a business strategy out of the outcomes of the project.

3. Eligibility Criteria

All information provided in application form that will be submitted before the deadline via [online application form](#). will be checked during whole evaluation process against eligibility criteria listed in this Section. Proposals that do not comply with those criteria will be excluded and marked as ineligible.

3.1 Who can apply?

Proposals can be submitted by:

- Natural Person (entrepreneur or PhD Researchers), individually or organized in a team of maximum 5 persons[1] OR
- One Registered Legal Entity that is an SME[2] or Mid Cap[3] or Research and Technology Organization[4]

That are registered/have citizenship or legal residence in:

- [The Member States of the European Union and its Overseas Countries and Territories](#) or
- [Associated Countries to H2020](#) or
- United Kingdom of Great Britain and Northern Ireland

3.2 What types of activities can be funded?

Applicants must demonstrate capacity to execute the development and implementation of low-cost, highly scalable AI Apps and AI Solutions based on Computer Vision, Time Series Analysis, Audio Classification and/or other AI enabling technologies to solve specific AI Industry Challenges within the following sectors:

- Manufacturing
- Automotive
- Healthcare
- Robotics

Each AI Challenge includes its technical specifications, pre trained models, evaluation and sample date that selected AI talents will use to solve the challenge (see Annex II).

Proposals should address development of AI applications towards TRL7 that will operate in an operational environment (Bonseyes Marketplace platform).

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[1] In case of a team, one of the parties will be nominated as a team leader and will be the one signing the FSTP agreement and receiving the grant.

[2] An SME will be considered as such if it complies with the European Commission's Recommendation 2003/361/EC. As a summary, the criteria defining an SME are:
• Headcount in Annual Work Unit (AWU) less than 250;
• Annual turnover less or equal to €50 million OR annual balance sheet total less or equal to €43 million.
Note that the figures of partners and linked enterprises should also be considered as stated in the SME user guide. For detailed information check EU recommendation: https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

[3] MidCap will be considered as such if the staff headcount calculated according to Articles 3 to 6 of the Annex to Commission Recommendation 2003/361/EC has up to 3 000 employees.

[4] Entity, such as university or research institute, irrespective of its legal status (organised under public or private law) or way of financing, whose primary goal is to conduct fundamental research, industrial research or experimental development and to disseminate their results by way of teaching, publication or technology transfer; all profits are reinvested in these activities, the dissemination of their results or teaching

3.3 What are the Industry Challenges?

The AI Industry Challenges to be addressed in 1st Open Call are listed below:

Robotics
- Collision avoidance
- Keyword spotting

Manufacturing
- Defect detection
- Object detection

Automotive
- Gaze detection
- Body part tracking
- Gesture recognition

Health
- Remote vital signs
- Heart rate detection
- 3D Body detection

Figure 3 BonsAPPs 1st Open Call Industry Challenges

The detailed description of each AI Challenge can be found in the Annex II. BonsAPPs aims to select at least 3 proposals per AI Challenge but the final decision of the number of proposals selected per challenge will be made based on the quality and potential of the submitted applications.

3.4 How to apply?

When applying to BonsAPPs 1st Open Call, please also note that:

- Your project should **have a clear European Dimension** meaning that the AI Challenge is to fully exploit the potential of European economy and society. Building notably on Europe's Scientific and Technology strengths in the field. The supported activities should reinforce industrial competitiveness across all sectors and help address societal challenges. The ambition is to bring AI technologies and resources to integrators and innovators in all sectors and actively engage with a wide user community, to foster adoption of AI, via Use Cases experiments.

- **Be on time:** We will evaluate **only** proposals submitted through the online form https://bonsapps-1oc-ai-talents.fundingbox.com/ before the **deadline 28th October 2021 at 17:00 CEST (Brussels Time).** Upon receipt of your proposal, the system will send you a confirmation of your submission.

- **Be exhaustive:** Have you answered all the sections of the application form? It won't be possible to add any information after the deadline. However, you will be able to modify the

form as much as you like even after the proposal is submitted, as long as it is done before the deadline.

- Applicants can submit multiple applications (**maximum one per AI challenge**) If more than one proposal per AI Challenge is identified, only the last proposal which has been submitted in order of time, will be evaluated.[5]

  BUT **neither team members nor any legal entities can be funded twice** by BonsAPPs. If you submit multiple applications for different challenges and more than one proposal will reach the required score after external evaluation phase, only ONE with higher score will be selected for funding.

- only the last proposal which has been submitted in order of time, will be evaluated. Please note that only the application's last edit will be considered

- Your proposal must be written in **English** in all mandatory parts in order to be eligible. Only parts written in English will be evaluated.

- Every question deserves your attention: All mandatory sections of your proposal - generally marked with an asterisk - must be filled in. Make sure that the data provided is true and complete. This is crucial for us to properly assess your proposal. Conversely, any additional material that is not specifically requested in the online application form will not be considered for the evaluation so no point overdoing it.

- We will take into consideration the existence of potential **conflict of interest** among you and BonsAPPs Consortium partners. BonsAPPs Consortium partners, their affiliated entities, employees and permanent collaborators cannot take part in the BonsAPPS Programme. All cases of potential conflict of interest will be assessed on a case-by-case basis.

- **Healthy finances and a clean sheet are a must:** we don't accept entities that are under liquidation or are an enterprise under difficulty according to the Commission Regulation No 651/2014, art. 2.18, or that are excluded from the possibility of obtaining EU funding under the provisions of both national and EU law, or by a decision of both national or EU authority;

- **It is *your* proposal:** your project should be based on your original work or your right to use the resources included in the proposal must be clear. Going forward, any foreseen developments must be free from third party rights, or those third-party rights must be clearly stated.

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[5] Please note that only the application's last edit will be considered.

4 How will we evaluate your proposal?

Our evaluation process is transparent, fair and equal to all participants. Your project will be evaluated in 4 steps before the signature of the Sub Grant agreement, as presented below:

Figure 4 BonsAPPs 1st OC selection process

4.1 Step 1: First Automatic Eligibility Check

The first evaluation step is about verifying some basic requirements based on statements from your proposal. Your proposal will be admissible for the next phase if it:

- Is complete, readable and in English in all mandatory sections.
- Includes the properly filled declaration of honour included in the application form.
- Proposal fulfils the eligibility criteria specified in section 3.1
- You did not exceed the maximum limit of one proposal per challenge[6]

The proposals that do not comply with these criteria will be excluded and informed about the results of this first eligibility check soon after the deadline.

4.2 Step 2: External Evaluation

In this phase, each project will be evaluated by 2 external, independent evaluators with wide expertise in Edge AI. Your project will be evaluated within the following awarding criteria:

EXCELLENCE will evaluate:

·   **Ambition**. Clarity of pertinence of the objectives. Applicants should demonstrate a clear understanding of the end users' needs as defined in the AI Industry Challenges and their added value.

·   **Innovation.** Applicants should show a clear understanding of the specific technical challenges that AI developers-integrators need to solve to respond to the need.

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[6] If more than one proposal per AI Challenge is identified, only the last proposal which has been submitted in order of time, will be evaluated. *Please note that only the application's last edit will be considered*

· **Soundness of the approac**h and credibility of the proposed methodology.

IMPACT will analyse:
· **Market opportunity:** The applicants have to demonstrate their understanding on how valid AI Apps and AI Solutions respond to a given AI Challenge. The applicants should also demonstrate the level of scalability across other industries and the initial commercial strategy plan.
· **Commercial Strategy & Scalability:** The applicants have to demonstrate how the project aligns with current and/or future commercial strategy, taking advantage of new tools and services to improve delivery of AI across Europe, particularly to SMEs/Low tech sectors.
· **Social and Economic Impact:** Environment and low carbon economy contribution, Equal Opportunities, Social impact

IMPLEMENTATION will consider:
· **Team:** The applicants have to demonstrate their technological capabilities and innovation excellence, demonstrating a strong background and skill base.
· **Resources**. Demonstrate the quality and effectiveness of the resources assigned in order to get the objectives/deliverables proposed. *In particular, proposals must demonstrate capacity by the applicant/the team of applicants to execute both AI development and AI integration and deployment tasks*.

Each evaluator will rank the application assigning a score from 0 to 5 for each criterion and produce an Individual Evaluation Report. The final score will be calculated as an average of the individual assessments provided by the Evaluators.

If scores on a project show significant divergence between the two evaluators, a third evaluator will be involved to provide an additional independent assessment of this proposal.

Thresholds needed to pass to the next stage are:
• For each criterion, the minimum threshold is 3 out of 5 points.
• For a total sum of scores, the minimum threshold is 10 out of 15 points.

In case of ties, the following criteria will be used to rank the projects, in order: Implementation score, Impact score, Excellence score, Date of submission: latest submitted proposals go first[7].

All proposals obtaining a score above the threshold, will pass to the next phase. Please note that we need time to process through all the proposals in this phase, so you probably won't hear back from us for a while.

4.3 Step 3: Consensus Meeting

The 'Selection Committee', formed by BonsAPPs consortium partners and three external experts, will decide by a majority (⅔ votes) the list of applicants that pass to the next phase. The discussion will be based on the ranking obtained as a result of the external evaluation.

Whilst normally the highest-ranked proposals will be selected for funding, the Selection Committee might have fair reasons for objecting to a specific applicant (alignment with BonsAPPs goals and scope, number of proposals per AI challenge, the ability to achieve the highest impact possible, commercial competition, as well as the existence of significant ethical concerns or a potential conflict of interest). In this case, the choice may pass to the next-ranked proposal.

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[7] Please note that only the application's last edit will be considered

BonsAPPs aims to select at least 3 proposals per AI Challenge but the final decision of the number of proposals selected per challenge will be made based on the quality and potential of the submitted applications.

The exact number of proposals approved will be decided based on the overall **quality** of the proposals.

4.4 Step 4: Sub Grant Agreement Preparation and Signature

Prior to signing the Sub Grant Agreement, each beneficiary will be requested to provide documents that will be verified by BonsAPPs team to prove eligible formal status[8].

Proposals that will pass the documents review will be invited to sign the Sub Grant Agreement with the BonsAPPs Consortium before the Support Programme starts.

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[8] See detailed list of documents that will be requested in Frequently Asked Questions Document. If you fail to deliver the requested documents on time without clear and reasonable justification, we will exclude you from the further formal assessment and you will be replaced with the proposal from the Reserve list

5 Support Programme and Payment Arrangements

Once the eligibility has been confirmed and the Sub Grant Agreements were signed, selected AI Talents will become an official beneficiary of the BonsAPPs programme.

Support Programme:
Up to 30 selected AI Talents will start the programme in January 2022 by defining their "Individual Use Case Plan" with support of Bonseyes Community Association (BCA), the Support Programme Manager. This document will become an Annex to Sub Grant Agreement and aims to establish the budget planned for execution of the Use Case as well as KPIs and Deliverables that will be taken into account when evaluating the AI Talent performance during a 5-month programme divided in 2 stages:

Stage 1. AI Assets/Apps development. *(+2 months):*
AI Talents will use the BMP services needed, interconnected with HPC clouds for model training and optimization. Stage 1 will end with a Hackathon event where developed AI Apps will be presented and evaluated by the 'Selection Committee', which will select up to 10 to proceed to Stage 2.

Stage 2. AI Solutions development, integration and deployment. (*+3 months):*
AI Talents will continue using the BMP services for benchmarking, to deploy AI Solutions in developer platforms defined by AI Industry Challenges.
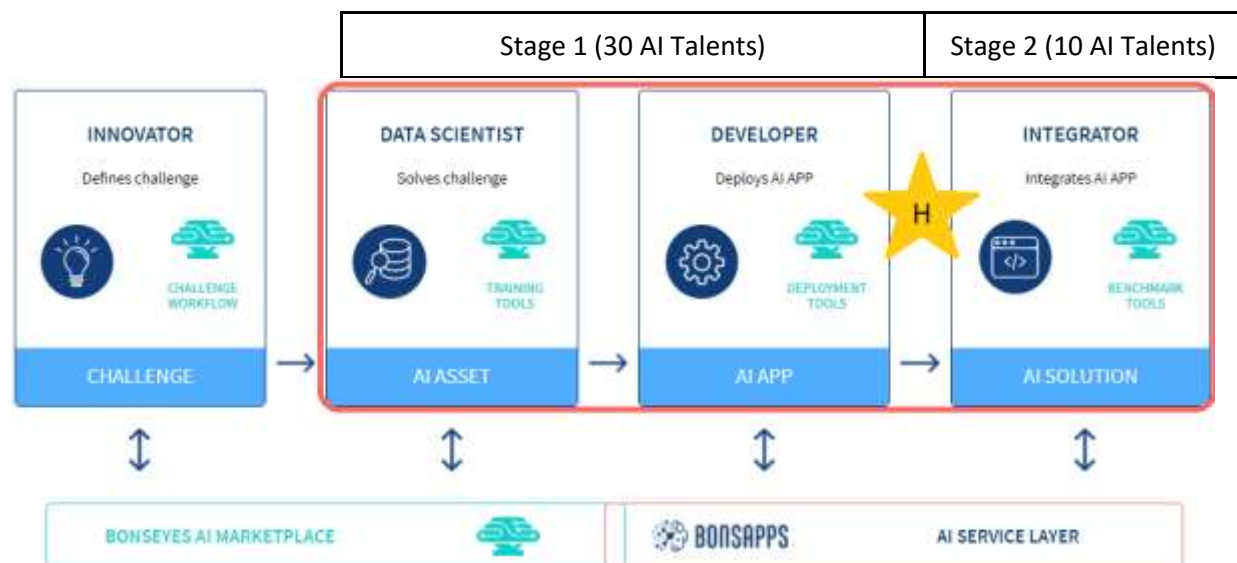

Figure 5 BonsAPPs 1st Support Programme

Details about support provided in each Stage are shown in the Table below:

	Stage 1	Stage 2
Goal	AI Assets and AI Applications	AI Solutions & Integration
AI Talents	30 (3 per challenge)	10 (1 per challenge)
Funding (Lump Sum)	24k EUR	36k EUR
HPC Cloud Vouchers	4k EUR	6k EUR
Duration	2 months	3 months
Support	Early access and training by applying the services provided by the Bonseyes Marketplace	Early access and training by applying the services provided by the Bonseyes Marketplace + Business Mentoring

Table 1 BonsAPPs support provided per Stage

Payments:

The **lump sum payment of the grant** is a simplified method of settling expenses in projects financed from Horizon 2020 funds. It means that the grantee is not required to present strictly defined accounting documents to prove the cost incurred (e.g., invoices), but is obliged to demonstrate the implementation of the project in line with the milestones set for it. Simply speaking, it means that we will carefully assess your progress and quality of your work during Milestones Reviews, not your accountancy. The milestones (deliverables, KPIs and ethical recommendations) will be fixed in the 'Individual Use Case Plan' elaborated at the beginning of the programme.

The lump sum does not release you from the obligation to collect documentation to confirm the costs under fiscal regulation.

Voucher scheme: each beneficiary will be obliged to dedicate 2 000 EUR per month (10 000 EUR in total for both stages) from the total grant amount to cover the costs of HPC Cloud services. Those services will be contracted based on the agreement made directly between each beneficiary and one of the HPC suppliers selected from the pool of providers validated by BonsAPPs.

For a more detailed payment schedule and Milestones Evaluation process please check the Frequently Asked Questions section.

6 Contact us

How can we help you?

If you have questions regarding our Open Call, you can:
- post your question in Helpdesk space
- send us a message to **bonsapps.help@fundingbox.com**

BonsAPPs Team will organize a certain number of online webinars to about this Open Call that will be announced though the BonsAPPs Helpdesk space and social media channels.

Complaints

If, after receiving the results of one of the evaluation phases (when foreseen), you consider that a mistake has been made, you can send us your complaint. To do so please send us your complaint in English by email to **bonsapps.help@fundingbox.com** including the following information:

● your contact details (including email address),
● the subject of the complaint,
● information and evidence regarding the alleged breach.

You have **3 calendar days** to submit your complaint starting from the day after the communication was sent. We will review your complaint within no more than seven calendar days from its reception. If we need more time to assess your complaint, we will inform you by email about the extension.

We will not review anonymous complaints as well as complaints with incomplete information.
Please take into account that the evaluation is run by external experts in the field of Edge AI, and we do not interfere with their assessment, therefore we will not evaluate complaints related to the results of the evaluation other than related to the mistakes in the evaluation of the eligibility criteria.

7 Final provisions

Any matters not covered by this Guide will be governed by Polish law and rules related to the H2020 and EU grants.

Please take into account that we make our best effort to keep all provided data confidential; however, for the avoidance of doubt, you are solely responsible to indicate your confidential information as such.

For the selected grantees, the Sub Grant agreement will include the set of obligations towards the European Commission (for example: promoting the project and giving visibility to the EU funding, maintaining confidentiality, understanding potential controls by the EC/ECA and OLAF).

The BonsAPPs Consortium might cancel the call at any time, change its provisions or extend it. In such a case, we will inform all applicants that have started the application form about such change. Signature of the Sub Grant agreement is an initial condition to establish any obligations among applicants and any Consortium partners (with respect to the obligation of confidentiality of the application).

Did not find what you were looking for?
You may want to check out our Frequently Asked Questions Section.

8 Extra hints before you submit your proposal

A proposal takes time and effort and we know it. Here a few crucial points you should read before submitting your proposal.

- Is your project in line with what BonsAPPs project is looking for? You are not sure? You can consult Sections 1 and 3.

- Did you present your proposal in a way that will convince evaluators? Not sure if you did? Go back to Section 4.3.

- Is your proposal fulfilling all eligibility requirements described in the Guide? Check again Section 3.

- Are you sure you are able to cope with our process of the Sub Grant agreement signature and payment arrangements for selected proposals? You may want to go over Section 5.

- Do you need extra help? Contact us.

Annex I: Information Clause

Processing of personal data in 1st Open Call in BonsAPPs project

CONTROLLER`S IDENTITY AND CONTACT DETAILS

The data controller is FundingBox Accelerator sp. z o.o. (Al. Jerozolimskie 136, 02-305 Warsaw, Poland). In all matters regarding personal data, you can contact us via: **privacy@fundingbox.com**.

PURPOSES, LEGAL BASIS AND PROCESSING PERIOD		
The purpose and legitimate interest of processing	Legal basis for processing	Period
1) To run an Open Call and collect data necessary to evaluate applications submitted in the Open Call	Legitimate interest of FundingBox (based on Article 6, paragraph 1 (f) of GDPR) which is fulfilling the obligations and our other interests related to these purposes	6 years from the end of the year in which the Project ended
2) To realize the Project goals described in the Grant Agreement (e.g., communication, reporting, collaborating with other project partners)		
3) To consider potential complaints		
4) To gather feedback from applicants when the Open Call is over to improve processes		

DATA RECEIVERS

Data controller will transfer personal data only to trusted recipients such as entities belonging to the FundingBox's capital group, IT service providers, accountants, law firms, postal and courier companies (who process personal data on the controller's behalf).

Due to the fact that we use the services of Google LLC, your data may be transferred to the USA. We have concluded an agreement with Google LLC - the so-called Standard Contractual Clauses. This means that in accordance with the decision of the European Commission No. 2021/914 EU of June 4, 2021, your personal data may be processed by this company in the USA. More information about the decision at: **https://eur-lex.europa.eu/legal-content/PL/TXT/?uri=CELEX%3A32021D0914&qid=1623665716691**

To realize the Project data can be transferred also to Project Partners (complete list of the project partners is available at the email address: privacy@fundingbox.com) and European Commission.

RIGHTS OF DATA SUBJECT

Due to the fact that we process your personal data, you have the right to:

1) request access to your personal data,
2) demand the rectification of your personal data,
3) request to remove or limit the processing of your personal data,
4) complain with the supervisory authority (The President of the Personal Data Protection Office, Warsaw, Poland, **https://uodo.gov.pl/en).**

You also have a right to object to processing of your personal data for all purposes indicated above (according to the Article 21 of GDPR).

INFORMATION ABOUT VOLUNTARY OR OBLIGATORY DATA PROVISION

Providing data is voluntary, although it is necessary to participate in the Open Call. Without providing your data, it is not possible to contact you and evaluate the application

BONSAPPS

AI-as-a Service for the Deep Edge

Guide for Applicants, 1st Open Call
Annex II: BonsAPPs Industry Challenges

List of Content

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Robotics
Collision Avoidance
R.1

Robotics Challenge | Collision Avoidance
General Description

RGB or IR Camera

Copyright 2019 © ETH zürich   Credit: Frank K. Gürkaynak & Daniele Palossi
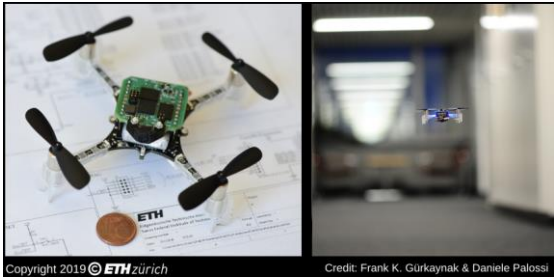
Collision probability

↓

Forward target velocity

& Steering angle

Collision avoidance is a natural problem in mobile robotics that navigate through environments with static and dynamic elements.

The robot can either navigate through a planned circuit or follow a track through visual cues. During the navigation, the robot needs to detect the possibility of a collision to modify the speed or even the steering angle of the robot.

Industry (AI Solutions)	☐ Automtive ☐ Healthcare ☐ Manufacturing ☑ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Collision avoidance is a natural problem in mobile robotics that navigate through environments with static and dynamic elements. The robot can either navigate through a planned circuit or follow a track through visual cues. During the navigation, the robot needs to detect the possibility of a collision to modify the speed or even the steering angle of the robot.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can this robot navigate following a track, e.g., white tracks or corridor in building, and in the event of an obstacle, avoid it and continue its trajectory?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on collision avoidance on the Zurich bicycle dataset. • Establishing a baseline accuracy on the driving steering angle on the Udacity, a dataset designed to train self-driving cars. • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• The *Zurich Bicycle* dataset has been derived from the open-source Zürich Bicycle dataset by the RPG from the University of Zürich (UZH). Part of it is redistributed here with modified resolution, and in gray-scale to match the configuration of our ultra-low-power camera. • The Udacity dataset dataset includes driving in Mountain View California and neighboring cities during daylight conditions. It contains over 65,000 labels across 9,423 frames collected from a Point Grey research cameras running at full resolution of 1920x1200 at 2hz.

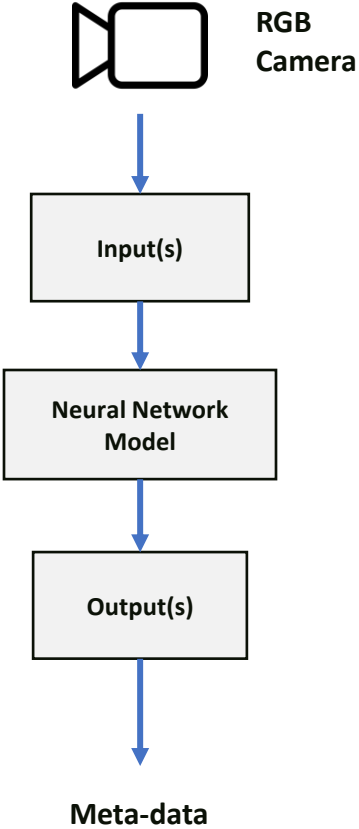| Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://ieeexplore.ieee.org/document/8804776 https://ieeexplore.ieee.org/document/8715489 **Reference Code** https://github.com/pulp-platform/pulp-dronet **Dataset - *Udacity*** https://www.udacity.com/self-driving-car **Dataset – *Zurich Bicycle*** https://github.com/pulp-platform/Zurich_Bicycle_Dataset
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Robotics Challenge | Collision Avoidance
Technical Specifications | Overview

Target velocity of the UAV (target forward velocity *vx,target*): an estimation of the probability of collision with an obstable, which in turn can be used to determine the forward target velocity of the UAV

Steering angle of the UAV (target yaw rate *wyaw,rate*): desired steering direction, following visual cues from the camera such as the presence of obstacles, white lines on the floor or in the street, etc.

Input *Please indicate the input data format and type.*	Description		• Zürich bicycle dataset used for the collision task • Udacity dataset used for the steering task. Dataset designed to train self-driving cars
	Data Format		• The *Zurich Bicycle* dataset: pgm images with resolution 324x244, each tagged with a 0/1 collision label • Udacity dataset: png images with resolution 1920x1200 with csv files for steering angle
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Probability of collision -> Target velocity • Steering angle
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any*	Input	Gray-scale image	Image from on-board forward-looking camera
	Output	Target velocity	An estimation of the probability of collision with an obstable, which in turn can be used to determine the forward target velocity of the UAV
		Steering angle	Desired steering direction, following visual cues from the camera such as the presence of obstacles, white lines on the floor or in the street, etc.

RGB Camera

Input(s)

Neural Network Model

Output(s)

Meta-data

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is collision probability (translated into target velocity) and steering angle in degrees. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Collision Avoidance Accuracy Average and standard deviation of steering angle.
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	• RMSE & EVA (steering angle) • Average classification accuracy & F-1 score (collision prediction)	Latency	>18 FPS
	Accuracy	<=4.0 degrees	Peak Memory	8 MB
	Ethics Bias	<=1.0 degrees	CPU % Usage	<10%
	Availability	99%	Storage	16 MB
Target Platform	• Raspberry 4B: raspberry4b-ubuntu: gcc cross compiler • NVIDIA Jetson Nano: jetson_nano-jetpack4.4: Jetpack 4.4 + Ubuntu Bionic gcc cross compiler • RISC-V based multicore: GWT GAP 8			

Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 20.04 for Ubuntu Focal LTS
Target Hardware	Raspberry Pi 4 NVIDIA Jetson Nano GWT GAP 8

BONSAPPS
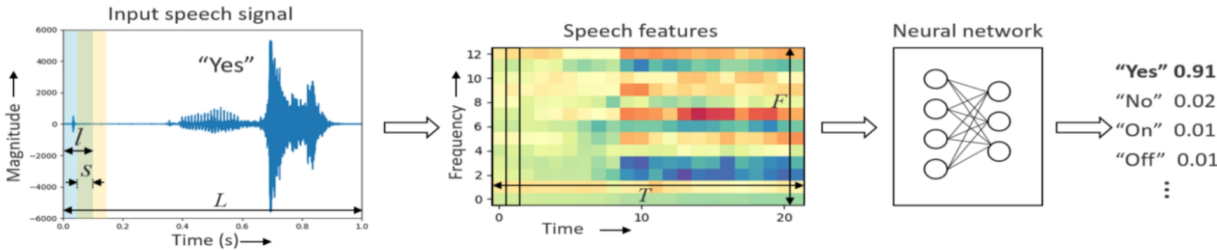### AI-as-a Service for the Deep Edge

Industry Challenges | Robotics
Keyword Spotting
R.2

Robotics Challenge | Keyword Spotting
General Description

Keyword spotting (KWS), a particular case of Automatic Speech Recognition, which is the process of recognizing predefined words from a speech signal. KWS may also serve as a "wake-up" signal to initiate a larger service.

The goal of this challenge is to recognize key words, e.g., stop, start, yes, no, from a speech signal that can be used to interact with a robot for simple direct question answering.

Industry (AI Solutions)	☐ Automtive ☐ Healthcare ☐ Manufacturing ☑ Robotics		
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production		
Task (AI Assets)	☐ Computer Vision ☑ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other		
Application	Computer Vision	Time Series	Natural Language Processing
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring	☐ Speech recognition ☐ Speech synthesis ☑ Keyword spotting
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised	

Robotics Challenge | Keyword Spotting
Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Keyword spotting (KWS), a particular case of Automatic Speech Recognition, which is the process of recognizing predefined words from a speech signal. KWS may also serve as a "wake-up" signal to initiate a larger service. In this challenge, we will use a KWS application either to wake up the Robot, e.g., "Hallo Robot", answer direct questions, e.g., yes, no, ok, or give short commands, e.g., stop, start.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can we communicate with the robot providing single short commands?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline accuracy on the Google Speech Command dataset. Establishing a baseline accuracy on the TrueCobotics datatasets. Validation of robustness using different microphones. Providing an efficient ONNX model, through model compression and quantization. Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	The *Google Speech Command* dataset has 65,000 one-second long utterances of 30 short words, by thousands of different people. The *True Cobotics* dataset contains thousands of one-second long samples for waking up a robot and simple utterances of words.

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://arxiv.org/abs/1711.07128 https://arxiv.org/abs/1901.05049 https://ieeexplore.ieee.org/abstract/document/9188213 **Reference Code** https://gitlab.com/bonseyes/training/projects/keywordspotting_bfh **Dataset – *Google Speech Commands*** https://ai.googleblog.com/2017/08/launching-speech-commands-dataset.html **Dataset – *TrueCobotics*** Under request
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Robotics Challenge | Keyword Spotting
Technical Specifications | Overview

Microphone

Speech signal

Pre-processing → Neural Network Model → Post-processing → Meta-data

Waveform of speech signal → MFCC Spectogram → AI App Algorithm → Label prediction →

Label prediction: Output probabilities of each output class over a period of time (1s)

Input *Please indicate the input data format and type.*	Description	Speech input signal from a microphone
	Data Format	Wave files of 1 second long
	Data Type	☐ Image ☐ Meta-Data ☐ Time Series ☑ Audio
Output *Please indicate the output data format and type.*	Description	Label prediction
	Data Format	• JSON meta-data
	Data Type	☑ Meta-Data

Meta-data Definitions *Please define precisely any*	Input	MFCC spectogram	Input speech signal is framed into overlapping frames. From each frame (F) MFCC speech features are extracted.
	Output	Label prediction	Output probabilities of each output class over a period of time (1s)

Microphone

Input(s)

Neural Network Model

Output(s)

Meta-data

Evaluation Procedure

The evaluation will be carried out at a speech signal level based on reference datasets. For each input speech signal frame, the result is label prediction. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy error on dataset Average and standard deviation of latency
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

| Performance	Model Accuracy		Deployment	
	Metric	TOP-1 and TOP-5 accuracy	Latency	< 30 ms (RPi 4B)
	Accuracy	> 90%	Peak Memory	256 KB
	Ethics Bias	---	CPU % Usage	<10%
	Availability	99%	Storage	500 KB
Target Platform	• Raspberry 4B: raspberry4b-ubuntu: gcc cross compiler • NVIDIA Jetson Nano: jetson_nano-jetpack4.4: Jetpack 4.4 + Ubuntu Bionic gcc cross compiler • RISC-V based multicore: GWT GAP 8			
Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out			
Format	Docker Image			
Output	Evaluation Report (see table for details)			
Docker Version	Docker 20.04 for Ubuntu Focal LTS			
Target Hardware	Raspberry Pi 4B NVIDIA Jetson Nano GWT GAP 8			

Industry Challenges | Manufacturing
Defect Detection
M.1

Manufacturing Challenge | Defect Detection
General Description
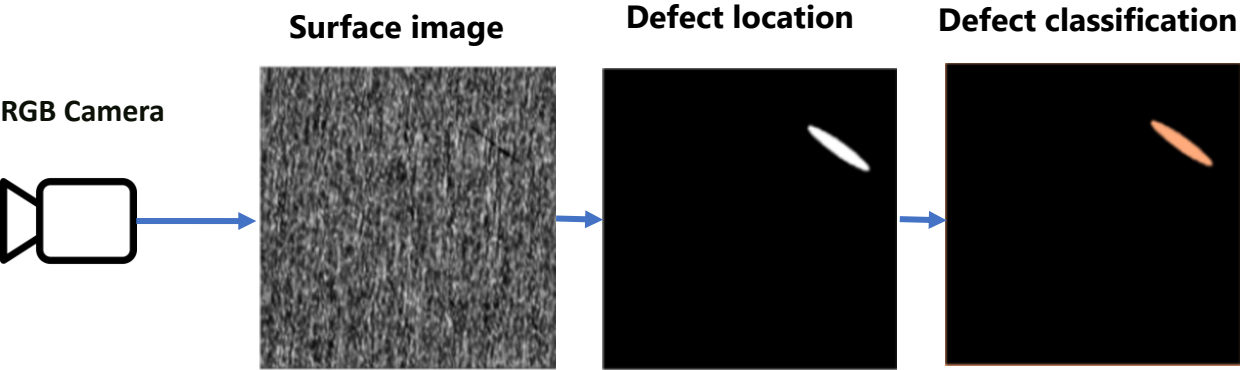
RGB Camera

Surface image → Defect location → Defect classification

In order to ensure zero defect in manufactured components and products, quality inspection is a key capability that manufacturing companies should develop. Manual inspection is tedious, labor intensive and often error prone. Vision-based automated quality inspection is a promising technology for manufacturing companies. AI is a potential enabler to develop such solutions.

Must work globally across several types of industrial products and several categories of defects.

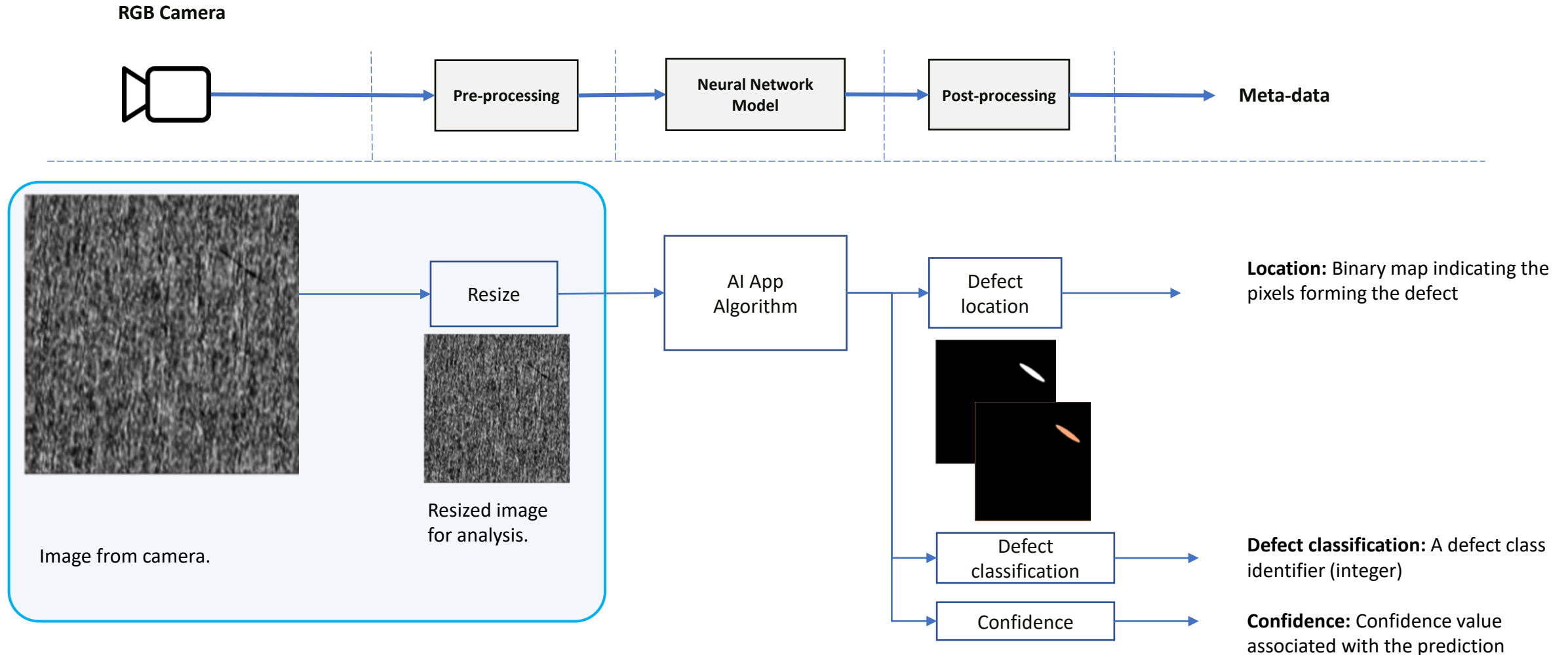| Industry (AI Solutions)	☐ Automotive ☐ Healthcare ☑ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☑ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Manufacturing Challenge | Defect Detection
Detientationaled Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	In order to ensure zero defect in manufactured components and products, quality inspection is a key capability that manufacturing companies should develop. Manual inspection is tedious, labour intensive and often error prone. Vision-based automated quality inspection is a promising technology for manufacturing companies. AI is a potential enabler to develop such solutions.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Does a surface of a manufactured part contain a defect?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on defect detection on the DAGM20117 / KolektorSDD/KolektorSDD2 data sets • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• Automatic Defect Inspection Using the NVIDIA End-to-End Deep Learning Platform, 2019 (https://developer.nvidia.com/blog/automatic-defect-inspection-using-the-nvidia-end-to-end-deep-learning-platform/) • Jakob Bozi et al., Mixed supervision for surface-defect detection: from weakly to fully supervised learning, arXiv:2104.06064v3 [cs.CV] 20 Apr 2021

| Datasets, Tools, and Resources	

Tools and Resources
Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.
	• Reference papers:
	  o https://arxiv.org/pdf/2104.06064v3.pdf
	  o https://ieeexplore.ieee.org/document/8715489
	  o https://www.sciencedirect.com/science/article/abs/pii/S0007850616300725
	• Reference github:
	  o https://github.com/NVIDIA/DeepLearningExamples/tree/master/TensorFlow/Segmentation/UNet_Industrial
	• The DAGM 2007 dataset
	  o https://conferences.mpi-inf.mpg.de/dagm/2007/prizes.html
	• The KolektorSDD dataset :
	  o https://paperswithcode.com/dataset/kolektorsdd
	• The KolektorSDD2 dataset :
	  o https://paperswithcode.com/dataset/kolektorsdd2

Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Manufacturing Challenge | Defect Detection
Technical Specifications | Overview

Input *Please indicate the input data format and type.*	Description	• Image from RGB or IR camera.		
	Data Format	• 8bit grayscale image of [width x height] • JSON meta-data		
	Data Type	☑ Image ☐ Meta-Data ☐ Time Series		
Output *Please indicate the output data format and type.*	Description	• Defect location • Defect class		
	Data Format	• JSON meta-data		
	Data Type	☑ Meta-Data		
Meta-data Definitions *Please define precisely any*	Input	N/A	N/A	
	Output	Defect location	Binary map indicating the pixels forming the defect	
		Defect class	A defect class identifier (integer)	
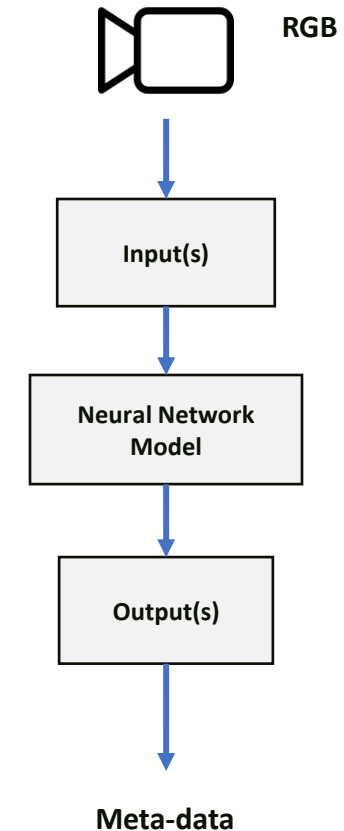
RGB

Input(s)

Neural Network Model

Output(s)

Meta-data

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is defect detection and classification accuracy. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Defect Detection & Classification Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	**Model Accuracy**		**Deployment**	
	Metric	F1 (Precision / recall)	Frame Rate	30 FPS
	Accuracy	>= 95%	Peak Memory	200 MB
			CPU % Usage	<10%
			Storage	20 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			
Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out			
Format	Docker Image			
Output	Evaluation Report (see table for details)			
Docker Version	Docker 19.03			
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1			

AI-as-a Service for the Deep Edge

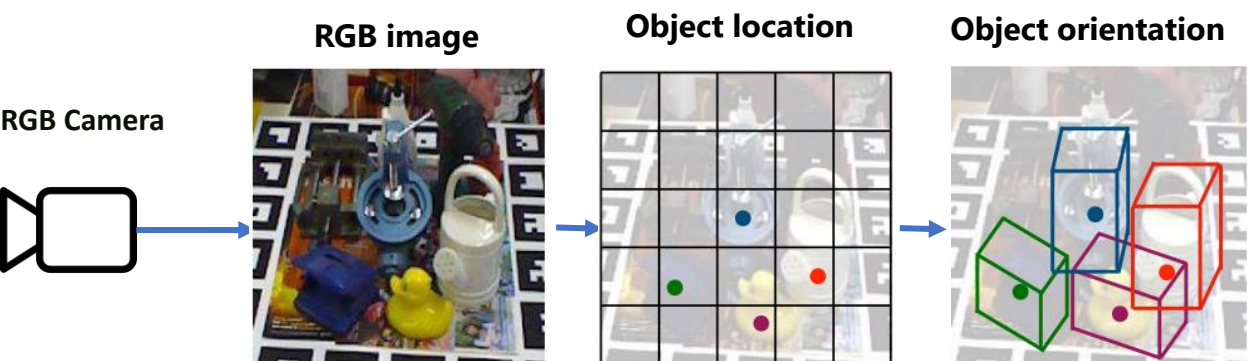# Industry Challenges | Manufacturing
6DoF Object Detection
M.2

Manufacturing Challenge | 6DoF Object Detection
General Description

RGB Camera → **RGB image** → **Object location** → **Object orientation**

The goal of this challenge is to automatically detect object location and orientations (6 Degrees of Freedom – DoF) in a production environment. The capability will be used by high performance feeding systems in Bin Picking scenarios.

Must work globally across several types of industrial products.

Industry (AI Solutions)	☐ Automotive ☐ Healthcare ☑ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☐ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Production lines with different manufacturing and assembly stations/machines are often interconnected using transfer systems like conveyors. In order to feed the production lines with well positioned/oriented components and parts, a feeding system is often needed. Bin picking is one of the major challenges to solve in order to have high performance feeding system. Vision based and AI enabled 3D object detection with six degrees of freedom (6DoF) is an essential capability.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	What is the location and the orientations of a 3D object (manufactured parts)?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	• Establishing a baseline accuracy on 3D object detection using Fraunhofer IPA Bin-Picking and LINEMOD datasets • Providing an efficient ONNX model, through model compression and quantization. • Deployment on a set of arm-based platforms through ONNXruntime, LPDNN or TensorRT. • Integration of the whole workflow as an end-to-end AI asset.
References *Reference material available.*	• Yongzhi Su et al. SynPo-Net—Accurate and Fast CNN-Based 6DoF Object Pose Estimation Using Synthetic Training, 2021

Datasets, Tools, and Resources	

Tools and Resources
Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.
	• Reference papers:
	  ○ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7796199/
	  ○ https://arxiv.org/pdf/2011.05669.pdf
	  ○ http://openaccess.thecvf.com/content_cvpr_2018/papers/Tekin_Real-Time_Seamless_Single_CVPR_2018_paper.pdf
	• Reference github:
	  ○ https://github.com/microsoft/singleshotpose
	• Fraunhofer IPA Bin-Picking :
	  ○ https://www.bin-picking.ai/en/dataset.html
	• LINEMOD dataset :
	  ○ https://bop.felk.cvut.cz/datasets/
	• MVTEC ITODD data set (A DATASET FOR 3D OBJECT RECOGNITION IN INDUSTRY)
	  ○ https://www.mvtec.com/company/research/datasets/mvtec-itodd

Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Manufacturing Challenge | 6DoF Object Detection
Technical Specifications | Overview

RGB Camera

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

Image from camera.

Resize → Resized image for analysis.

AI App Algorithm

Object Location

Location: 2D bounding box
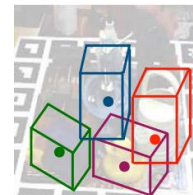
Object orientation

Orientation: 3D bounding box

Object classification

Classification: class probabilities

Confidence

Confidence: Confidence value associated with the prediction

Manufacturing Challenge | 6DoF Object Detection
Technical Specifications | Input and Output

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AI-as-a-Service for the Deep Edge

Input Please indicate the input data format and type.	Description	• Image from RGB camera.
	Data Format	• 32bit RGB image of [width x height] • JSON meta-data
	Data Type	☑ Image ☐ Meta-Data ☐ Time Series
Output Please indicate the output data format and type.	Description	• Object location • Object orientation • Object classification • Detection & classification prediction confidence
	Data Format	• JSON meta-data
	Data Type	☑ Meta-Data

Meta-data Definitions Please define precisely any	Input	N/A	N/A
	Output	Object location	Bounding box
		Object orientation	
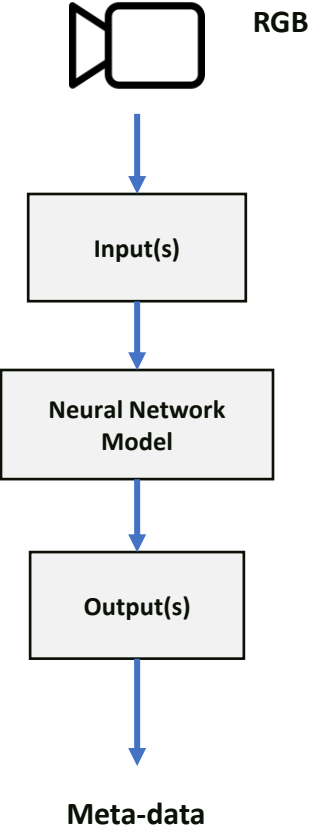
RGB

Input(s)

Neural Network Model

Output(s)

Meta-data

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is object location (bounding box) and object orientation. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Object location & orientations Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

| Performance	Model Accuracy		Deployment	
	Metric	PE: % of correctly estimaed position using 2D projection error (PE) ADD: % of correctly estimaed position using Average 3D Distance (ADD) of model vertices	Frame Rate	30 FPS
	Accuracy	>= 90%	Peak Memory	200 MB
			CPU % Usage	<10%
			Storage	20 MB
Target Platform	Bonseyes Developer Platforms	NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1		

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out			

Format	Docker Image			
Output	Evaluation Report (see table for details)			
Docker Version	Docker 19.03			
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1			

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Health

Remote Vital Signs

H.1

Healthcare Challenge | Remote Vital Signs
Overview

RGB Camera

3D Face Landmarks

Skin Regions of Interest

3D Headpose
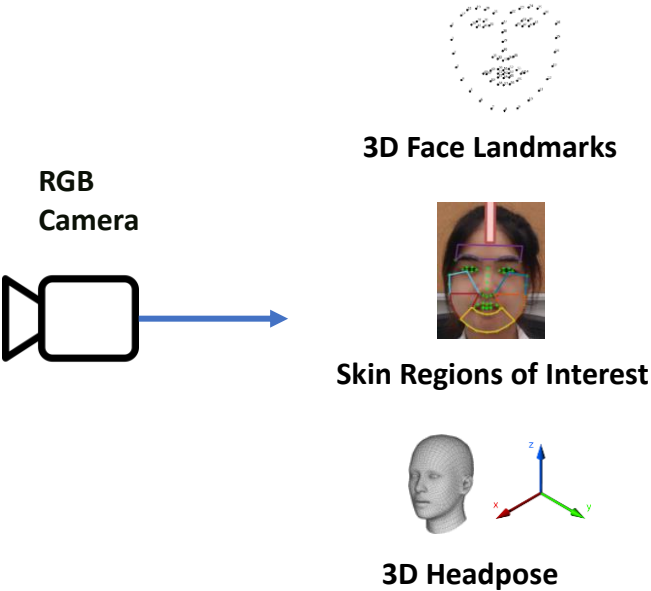
3D Face Detection reveals key information on a person's state. It is an important clue for understanding Vital Signs. In a health assessment, information extracted from observation of 3D Face Landmarks, Skin Regions of Interest for rPPG and 3D Headpose can be used to provide information on head and eye movements, liveness and consciousness which can be used to assess Remote Vital Signs.

Must work globally across all people, of all ages, across the world. Must be robust in "at home" settings outside of a laboratory as well as in care facility conditions which may mean imperfect lighting conditions and occlusions found where a patient is, for example, resting in bed.

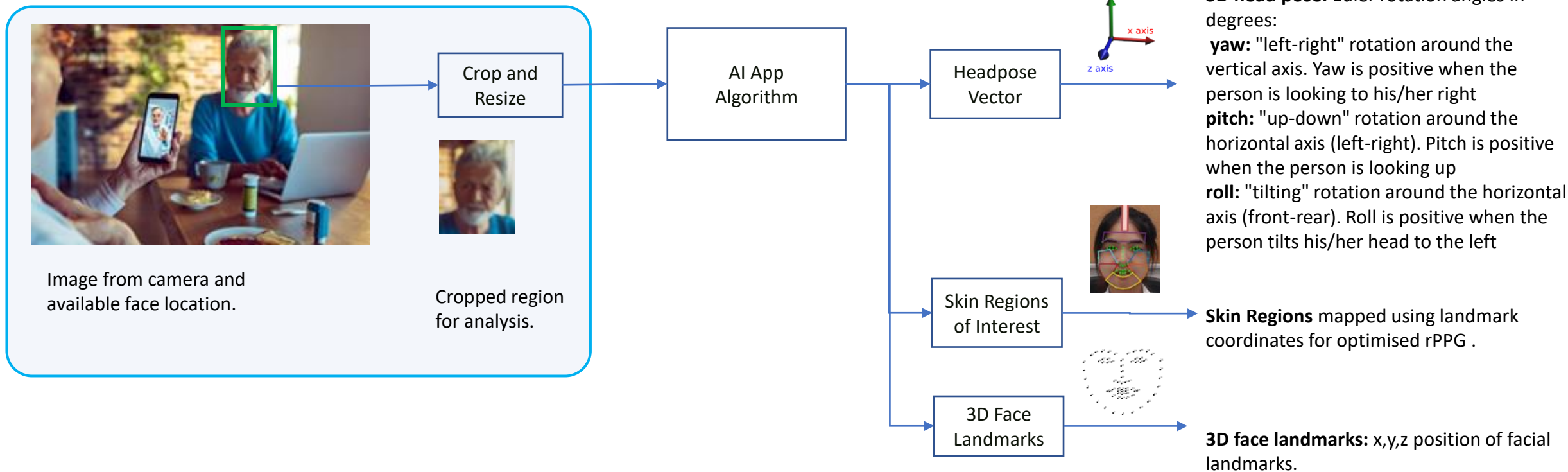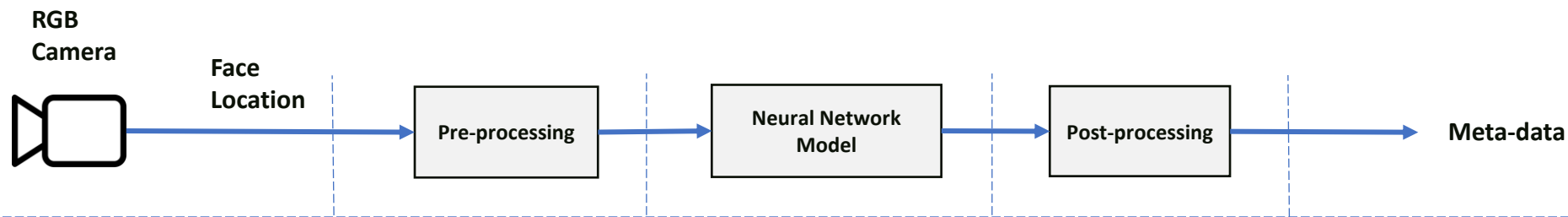| Industry (AI Solutions)	☐ Automotive ☑ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Healthcare Challenge | Remote Vital Signs
Detailed Description

BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	As part of the process of monitoring in both clinical and home care situations there is a common need for non-invasive observation of various measures of a patients condition. This includes the remote observation of vital signs which can be done through assessment of head and eye movements through tracking of head pose and facial landmarks along with skin regions of interest for rPPG.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can head pose, landmarks and skin regions of interest be sufficiently accurately observed such that they can be used for remote observation of vital signs?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of facial landmark, head pose and skin region observations leading to development of production systems for deployment as clinical tools using standard mobile platforms. Validate usage of 3D landmarks in remote photoplethysmography (rPPG) monitors of heart rate without requiring physical contact.
References *Reference material available.*	Assessment of Deep Learning-based Heart Rate Estimation using Remote Photoplethysmography under Different Illuminations https://arxiv.org/pdf/2107.13193

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	Reference Paper https://arxiv.org/pdf/2106.03021.pdf Reference Code https://github.com/MCG-NJU/SADRNet Dataset-300W-LP and Dataset-AFLW2000-3D http://www.cbsr.ia.ac.cn/users/xiangyuzhu/projects/3ddfa/main.htm
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge | Remote Vital Signs
Overview

RGB Camera

Face Location

Pre-processing → Neural Network Model → Post-processing → Meta-data

Image from camera and available face location.

Crop and Resize

Cropped region for analysis.

AI App Algorithm

Headpose Vector

Skin Regions of Interest

3D Face Landmarks

3D head pose: Euler rotation angles in degrees:
 yaw: "left-right" rotation around the vertical axis. Yaw is positive when the person is looking to his/her right
pitch: "up-down" rotation around the horizontal axis (left-right). Pitch is positive when the person is looking up
roll: "tilting" rotation around the horizontal axis (front-rear). Roll is positive when the person tilts his/her head to the left

Skin Regions mapped using landmark coordinates for optimised rPPG .

3D face landmarks: x,y,z position of facial landmarks.

y axis
x axis
z axis

BONSAPPS
AI-as-a-Service for the Deep Edge

Input *Please indicate the input data format and type.*	Description		• Image from RGB camera. • <u>2D Face Location</u> within image.
	Data Format		• 24bit color image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• 3D face landmarks and the yaw, pitch and roll Euler angles for head pose. • Skin Regions mapped using 3D face landmark coordinates
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Face Location	Location of face bounding box within image (x,y,width,height) in pixels. (0,0) is top left of image.
	Output	3D head pose	Euler rotation angles in degrees: yaw: "left-right" rotation around the vertical axis. Yaw is positive when the person is looking to his/her right pitch: "up-down" rotation around the horizontal axis (left-right). Pitch is positive when the person is looking up roll: "tilting" rotation around the horizontal axis (front-rear). Roll is positive when the person tilts his/her head to the left
		3D face landmarks	x, y, z position of each facial landmark
		Skin Regions	Mapped using facial landmark coordinates

RGB Camera

Input(s)

Neural Network Model

Output(s)

Meta-data
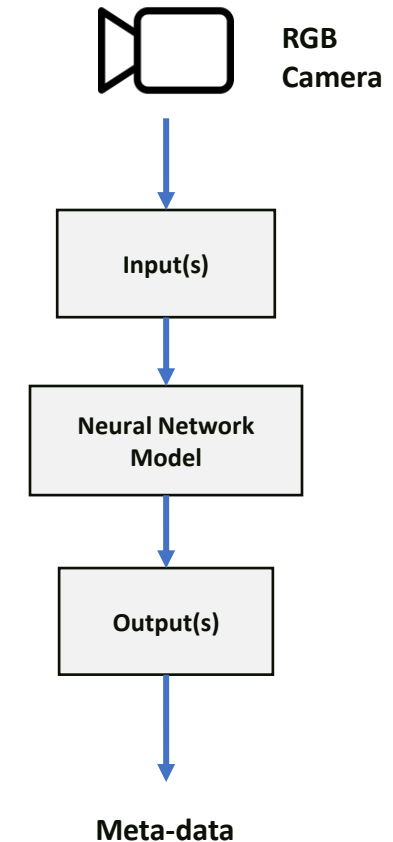
Healthcare Challenge | Remote Vital Signs
Technical Specifications | Evaluation and Performance

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is %age error in the measurement of 3D face landmarks, head pose and face region location. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame Rate	20 FPS
	Accuracy	4% Headpose	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	N/A
	Availability	TBA	Storage	TBA
Target Platform	Bonseyes Developer Platforms |iPhone 10 and above			

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Landmark and Headpose Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

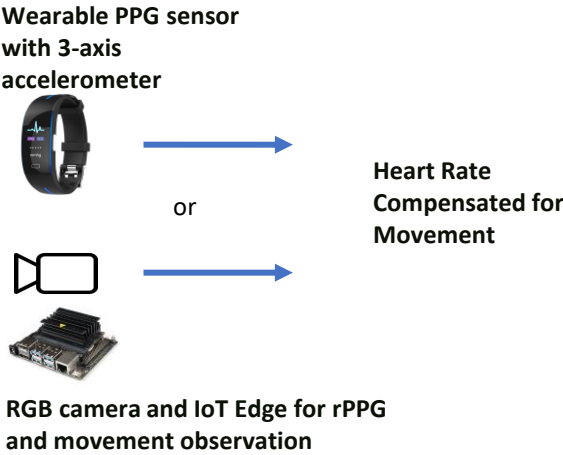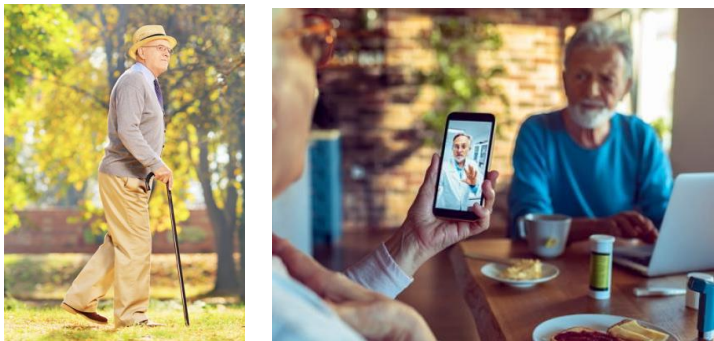| Evaluation API	Command Line Interface Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	iPhone 10 and above

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AI-as-a Service for the Deep Edge

Industry Challenges | Health
Heart Rate Detection
H.2

Healthcare Challenge| Heart Rate Detection
Overview

Wearable PPG sensor with 3-axis accelerometer

or

Heart Rate Compensated for Movement

RGB camera and IoT Edge for rPPG and movement observation

Time Series Analysis provides details on a signal such that condition information can be estimated. It has important application within Patient Monitoring for human Heart Rate Detection, providing heart rate information compensated for movement. There is a choice of methods for generating the needed information including:

(i) a PPG (photoplethysmography) sensor combined with a 3-axis accelerometer in a wearable device or
(ii) rPPG (remote PPG) observed, along with movement observation, through an RGB camera.

A PPG sensor observes the capillaries in the wrist which fill with blood when the heart ventricles contract. The light emitted by the PPG sensor is absorbed by red blood cells in these capillaries and a photodetector will see the drop in reflected light. When the blood returns to the heart, fewer red blood cells in the wrist absorb the light and the photodetector sees an increase in reflected light. The period of this oscillating waveform provides the pulse rate.

rPPG-based methods observe subtle colour variations of human skin. Pulsatile blood propagating in the cardiovascular system changes the blood volume in skin tissue. The oxygenated blood circulation leads to fluctuations in the amount of haemoglobin molecules and proteins thereby causing variations in the optical absorption and scattering across the light spectrum. The period of oscillation of these fluctuations as shown by the colour variation provides the pulse rate.

Must be robust under real world conditions providing meaningful information for patients in all activity levels from rest to extreme levels of movement.

Industry (AI Solutions)	☐ Automotive ☑ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☑ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☑ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Healthcare Challenge| Heart Rate Detection
Detailed Description

BONSAPPS
AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Within patient monitoring there is a need for robust solutions providing meaningful information on key parameters such as heart rate for patients under all activity levels from rest to extreme levels of movement. Data related to heart rate and movement can be collected from either: (i) a PPG (photoplethysmography) sensor along with a 3-axis accelerometer embedded along with and MCU in a wearable device. or: (ii) rPPG (Remote PPG) and movement data collected via an RGB camera and IoT Edge embedded system. The collected Time Series data needs to be analyzed in order to provide a detection result which is compensated for physical movement.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can a time series analysis of the data provide by either (i) a physical sensor based system with embedded MCU or (ii) a camera based system with IoT Edge processing sufficiently robust and accurate movement compensated heart rate detection?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishment of a baseline performance for time series analysis: (i) of PPG plus 3-axis accelerometer data on an embedded MCU or (ii) of rPPG data plus movement data via image capture on an IoT Edge system so as to provide robust heart rate detection compensated for movement leading to development of production device and systems utilising such methods.
References *Reference material available.*	Non-contact Pain Recognition from Video Sequences with Remote Physiological Measurements Prediction https://arxiv.org/pdf/2105.08822.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Papers** PPG and rPPG https://arxiv.org/pdf/2104.09313.pdf PPG https://www.mdpi.com/2079-9292/10/14/1715 rPPG https://arxiv.org/abs/2007.08213 rPPG https://arxiv.org/pdf/2004.12292.pdf **Reference Code** PPG https://github.com/MAlessandrini-Univpm/rnn-ppg-har rPPG https://github.com/ZitongYu/PhysNet **Dataset** https://github.com/yangze68/BH-rPPG-dataset https://sites.google.com/view/ybenezeth/ubfcrppg https://osf.io/fdrbh/
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge | Heart Rate Detection

Wearable PPG sensor with 3-axis accelerometer

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

PPG and 3-axis accelerometer data

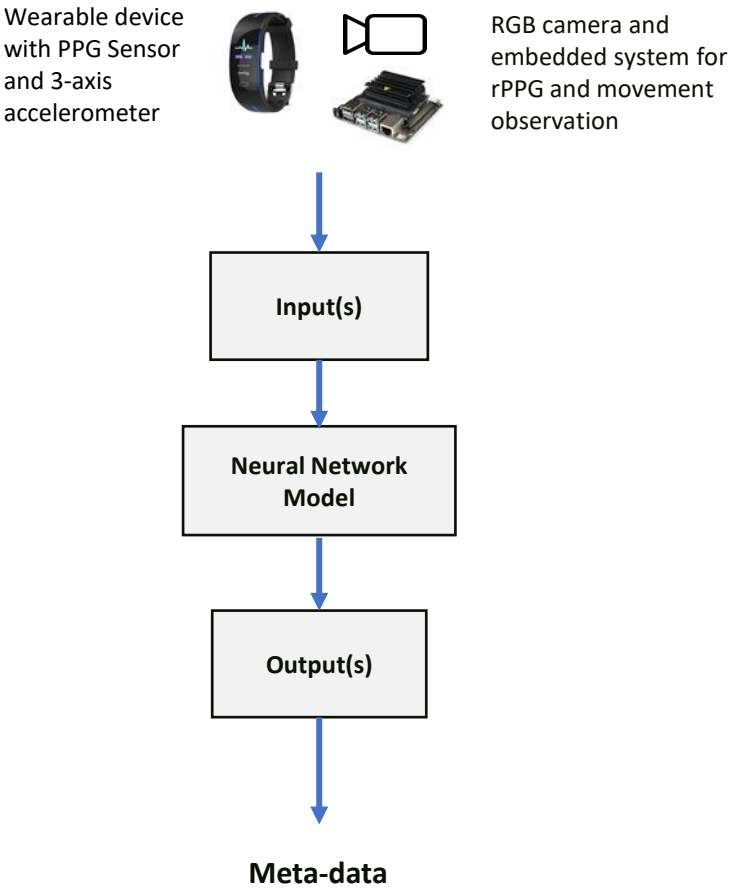rPPG and observed movement data

Time Series Data → AI App Algorithm → Heart Rate →

Heart Rate estimation compensated for patient movement using Time Series Analysis of PPG or rPPG and Motion Data

Input *Please indicate the input data format and type.*	Description	• PPG (photoplethysmography) sensor data • 3-axis accelerometer data OR • Image from RGB camera. • <u>2D Face Location</u> within image.
	Data Format	• Time series data • JSON meta-data OR • RGB image of [width x height] for rPPG (remote photoplethysmography) • 8bit grayscale image of [width x height] for movement observation • JSON meta-data
	Data Type	☑ Image ☑ Meta-Data ☑ Time Series
Output *Please indicate the output data format and type.*	Description	• Heart rate estimation compensated for motion data.
	Data Format	• JSON meta-data
	Data Type	☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	PPG or rPPG	Uncorrected waveform with potential movement induced noise.
		Motion Data	x / y / z acceleration data in m/s^2
	Output	Heart Rate (BPM)	Measured value compensated for movement induced noise

Wearable device with PPG Sensor and 3-axis accelerometer

RGB camera and embedded system for rPPG and movement observation

Input(s)

Neural Network Model

Output(s)

Meta-data

Healthcare Challenge| Heart Rate Detection
Technical Specifications | Evaluation and Performance

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AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out appropriate to each method based on reference datasets of signal and ground truth for PPG and image stream and ground truth for rPPG. For each method , the result is the %age error in estimated heart rate versus the ground truth. Deployment metrics will be collected and measured for latency, samplerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy of heart rate measured compared to ground truth.
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame or Sample Rate	60 Frames or Samples/sec
	Accuracy	TBA	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	N/A
	Availability	TBA	Storage	TBA
Target Platforms per Method	Bonseyes Developer Platforms |ST Microelectronics STM32H747 Bonseyes Developer Platforms |NVIDIA Jetson Nano			

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	ST Microelectronics STM32H747 for PPG or NVIDIA Jetson Nano for rPPG

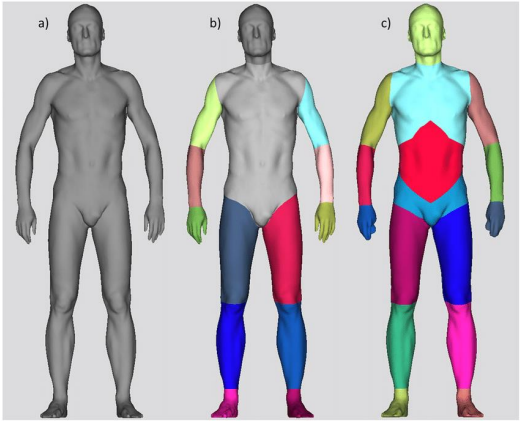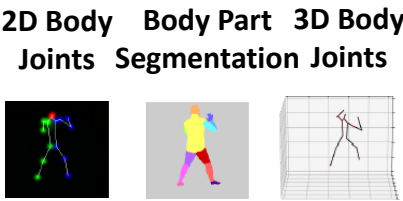**BONSAPPS**

AI-as-a Service for the Deep Edge

Industry Challenges | Health
3D Body Detection
H.3

Healthcare Challenge | 3D Body Detection
Overview

RGB Camera

2D Body Joints **Body Part Segmentation** **3D Body Joints**

Height, Weight, Volume

3D Body Detection provides information on a patient's body using body part segmentation and 3D joint estimation from 2D estimation. Height, weight and volume information estimates can be made in order to support patient care workflow in, for example, body scanning operations. The patient's image to be collected via an RGB camera and the image to be processed on an IoT Edge embedded system.

Must work across all body types. Must be robust in clinical environments with variable lighting conditions.

Industry (AI Solutions)	☐ Automotive	
	☑ Healthcare	
	☐ Manufacturing	
	☐ Robotics	
Maturity	☐ Idea / Concept	
	☑ Experimentation	
	☐ Industrialization	
	☐ Production	
Task (AI Assets)	☑ Computer Vision	
	☐ Natural Language Processing	
	☐ Medical	
	☐ Methodology	
	☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection	☐ Audio Classification
	☑ Scene Segmentation	☐ Bio-signal Monitoring
	☐ Face Recognition	☐ Predictive Maintenance
	☑ Image Classification	☐ Health Monitoring
Learning Problem	☑ Classification	☑ Supervised
	☑ Regression	☐ Unsupervised
		☐ Self-supervised

Healthcare Challenge | 3D Body Detection Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Within some patient care workflows there is a need for automatic estimation of patient parametric data to assist in management of the work flow, for example in helping with the set up and control of some equipments. An automated estimation of a patients Height, Weight and Volume has potential to be of great use in such applications as, for example, management of the CT scanning process.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can 3D Body Detection from images collected via an RGB camera and processed on an IoT Edge embedded system provide a sufficiently accurate estimation of patient Height, Weight and Volume?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishment of a baseline performance on an edge platform of automatic observation of patient Height, Weight and Volume leading to development of production systems to assist in the management of patient workflow.

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://arxiv.org/pdf/2107.02259.pdf **Reference Code** https://github.com/gulvarol/bodynet **Datasets** https://www.di.ens.fr/willow/research/surreal/data/ https://github.com/fleinen/SURREALvols SURREALVols adds body part volumes and the person's body height to the SURREAL dataset.
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Healthcare Challenge | 3D Body Detection
Overview

RGB Camera

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

2D Body Joints → AI App Algorithm → Height Estimate → **3D Body Detection** :

Weight Estimate

Volume Estimate

Height, **Weight** and **Volume** estimates for workflow support.

Image from camera.

2D body parts for analysis.

Available as Datatool for Reference Datasets

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AI-as-a-Service for the Deep Edge

Input *Please indicate the input data format and type.*	Description		• Image from RGB camera.
	Data Format		• 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Height, Weight and Volume estimates
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
***Meta-data Definitions** Please define precisely any meta-data.*	Input	Image from camera	Image from workspace including human subject
	Output	Body Characteristic Estimates	• Height in metres • Weight in kilograms • Volume in cubic metres

RGB Camera

Input(s)

Neural Network Model

Output(s)

Meta-data
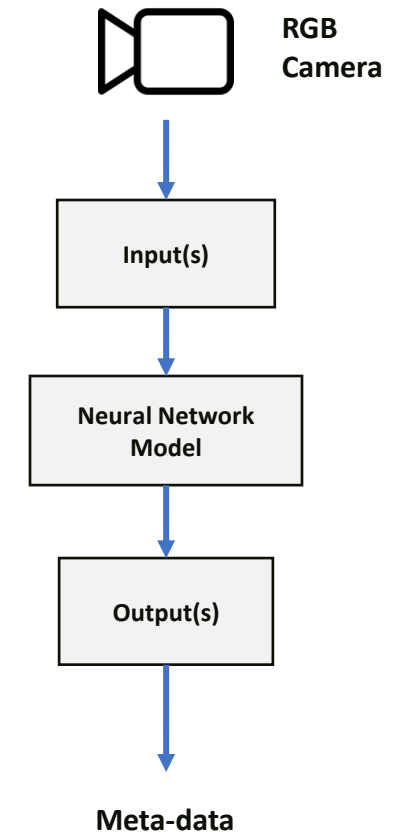
Healthcare Challenge | 3D Body Detection
Technical Specifications | Evaluation and Performance

BONSAPPS
AI-as-a-Service for the Deep Edge

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is an %age error in the estimate of height in metres, weight in kilograms and volume in cubic metres . Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Accuracy of Height, Weight and Volume estimates
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	TBA	Frame Rate	0.2 FPS
	Accuracy	10% of volume	Peak Memory	TBA
	Ethics Bias	TBA	Memory Bandwidth	TBA
	Availability	TBA	Storage	TBA
Target Platform	Bonseyes Developer Platforms	NVIDIA Jetson Nano		

| Evaluation API	Command Line Interface Example: docker run --rm -v /data:/data -v /out:/out evaluation-tool \ --target-url http://target-hardware.local:8080/inference \ --dataset-dir /data --output-dir /out
Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson Nano

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AI-as-a Service for the Deep Edge
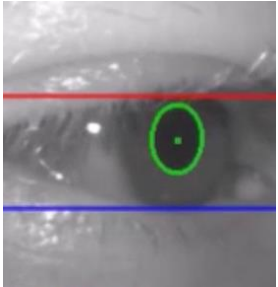
Industry Challenges | Automotive
Gaze Detection
A.1

Automotive Challenge | Gaze Detection
General Description

RGB or IR Camera

Driver
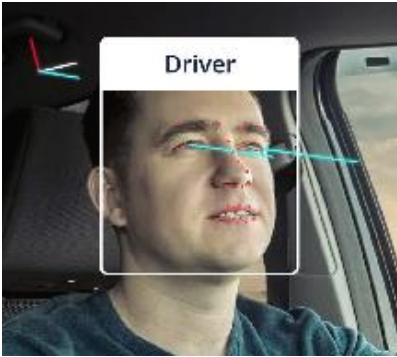
Eye Closure

Gaze estimation reveals where a person is looking. It is an important clue for understanding human intention. In driving, gaze can be combined with gestures to understand intended interaction with objects, or used with eye state information to determine if the driver is distracted or drowsy to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

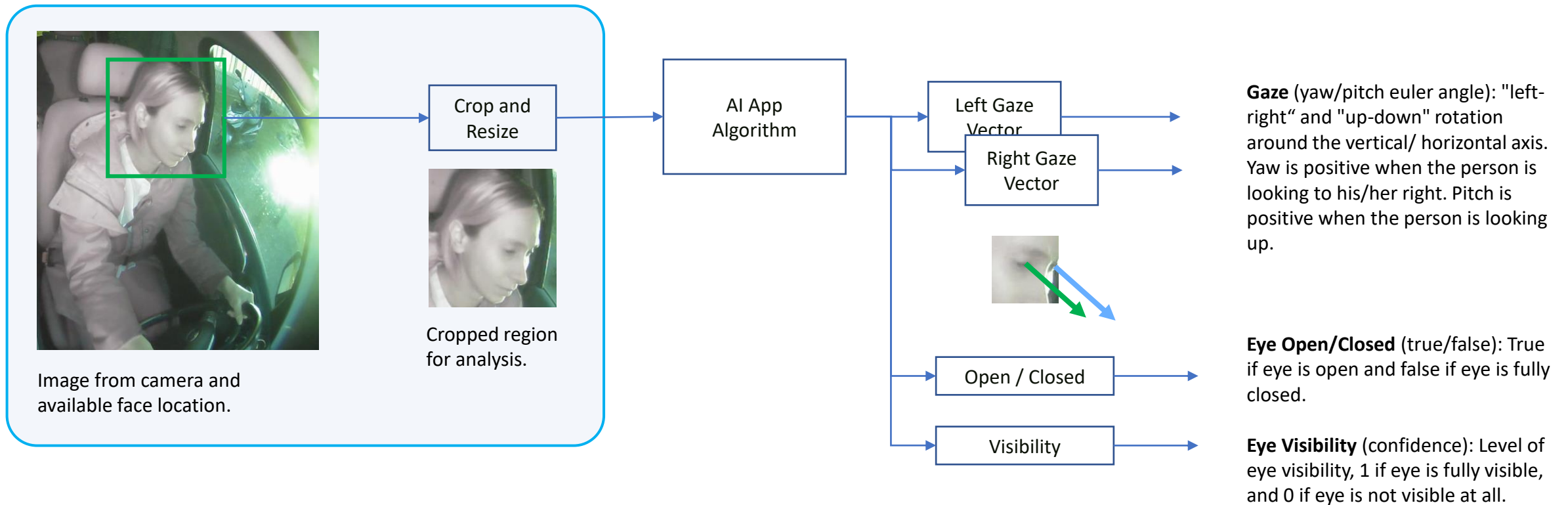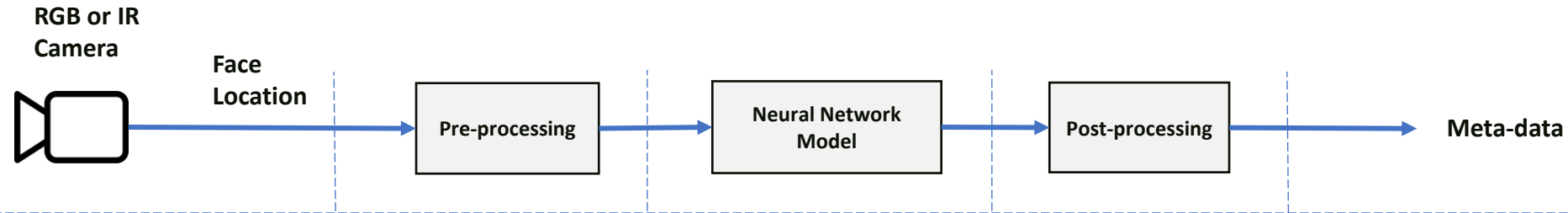| Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	**Computer Vision**	**Time Series**
	☐ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☑ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Gaze Detection
Detailed Description

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AI-as-a-Service for the Deep Edge

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Distraction while driving is common but it is widely considered dangerous due to its potential for causing distracted driving and crashes. A high number of crashes are related to conducting calls on a phone and texting while driving which takes drivers "eyes off the road" that results in drivers being distracted, decreasing the driver's awareness on the road, leading to more car crashes.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can eye gaze and state be accurately detected to be used to detect distraction and drowsiness?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting dangerous driver activities leading to developing a production system deployed to production vehicles from 2024 onwards with the goals to reduce the number of accidents and save lives through early detection and warning of dangerous driver activities.
References *Reference material available.*	Mobile phone use & distraction (PDF) (Report). Centre for Accident Research & Road Safety - Queensland (CARRS-Q). September 2015. https://research.qut.edu.au/carrsq/wp-content/uploads/sites/45/2017/12/Mobile-phone-distraction-email.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved .*	**Reference Paper** https://arxiv.org/pdf/2105.14424 **Reference Code** https://github.com/yihuacheng/GazeTR **Datasets** MPIIFaceGaze (https://www.perceptualui.org/research/datasets/MPIIFaceGaze/) Office/home environment with real lighting with mall headpose and small gaze angles with low resolution web cameras and participants sitting. ETH-X Gaze (https://ait.ethz.ch/projects/2020/ETH-XGaze/) Lab environment and simulated lighting with large headpose and gaze angles and high resolution cameras with participants sitting.
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Gaze Detection
Technical Specifications | Overview

RGB or IR Camera

Face Location

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

Image from camera and available face location.

Crop and Resize → Cropped region for analysis.

AI App Algorithm

Left Gaze Vector

Right Gaze Vector

Open / Closed

Visibility

Gaze (yaw/pitch euler angle): "left-right" and "up-down" rotation around the vertical/ horizontal axis. Yaw is positive when the person is looking to his/her right. Pitch is positive when the person is looking up.

Eye Open/Closed (true/false): True if eye is open and false if eye is fully closed.

Eye Visibility (confidence): Level of eye visibility, 1 if eye is fully visible, and 0 if eye is not visible at all.

Automotive Challenge | Gaze Detection
Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description	• Image from RGB or IR camera. • <u>2D Face Location</u> within image.
	Data Format	• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type	☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description	• Gaze • Eyes Open/Closed • Eye Visibility
	Data Format	• JSON meta-data
	Data Type	☑ Meta-Data

Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Face Location	Location of face bounding box within image (x,y,width,height) in pixels. (0,0) is top left of image.
	Output	Gaze	Gaze yaw/pitch as euler angle. "left-right" and "up-down" rotation around the vertical/ horizontal axis. Yaw is positive when the person is looking to his/her right. Pitch is positive when the person is looking up.
		Eyes Open/Closed	Eyes open/closed as binary true or false. True if eye is open and false if eye is closed.
		Eye Visibility	Eye visibility as confidence value between 0.0 and 1.0. Level of eye visibility, 1.0 if eye is fully visible, 0.5 if eye is partially visible, and 0.0 if eye is not visible.
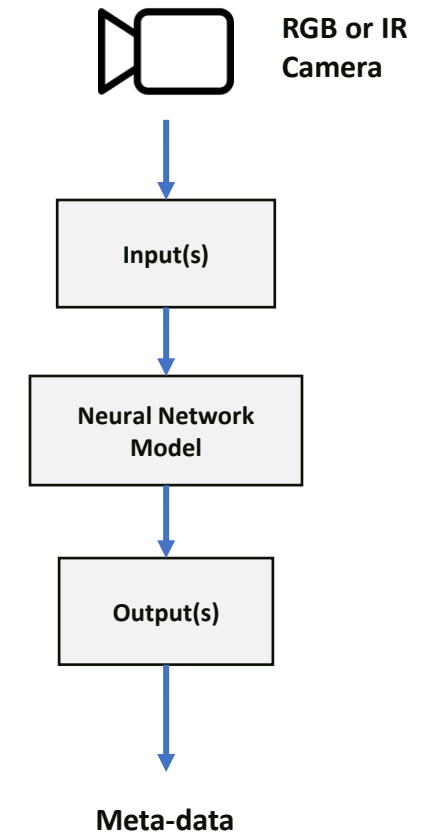
RGB or IR Camera

Input(s)

Neural Network Model

Output(s)

Meta-data

Automotive Challenge | Gaze Detection
Technical Specifications | Evaluation and Performance

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is gaze angle error in degrees. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Gaze Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MAE	Frame Rate	60 FPS
	Accuracy	<=4.0 degrees	Peak Memory	200 MB
	Ethics Bias	<=1.0 degrees	CPU % Usage	<10%
	Availability	99%	Storage	20 MB
Target Platform	Bonseyes Developer Platforms	NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1		

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

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AI-as-a Service for the Deep Edge

Industry Challenges | Automotive
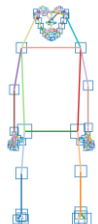Body Part Tracking
A.2

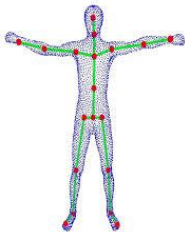# Automotive Challenge | Body Part Tracking
General Description

RGB or IR Camera

2D Body Joints

3D Body Joints

Body part tracking estimates where a person is located in 2D and 3D. It is an important for understanding human behavior and activities. In driving, body part tracking can used to understand driver activities that are linked with distraction, or to detect out of position poses to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

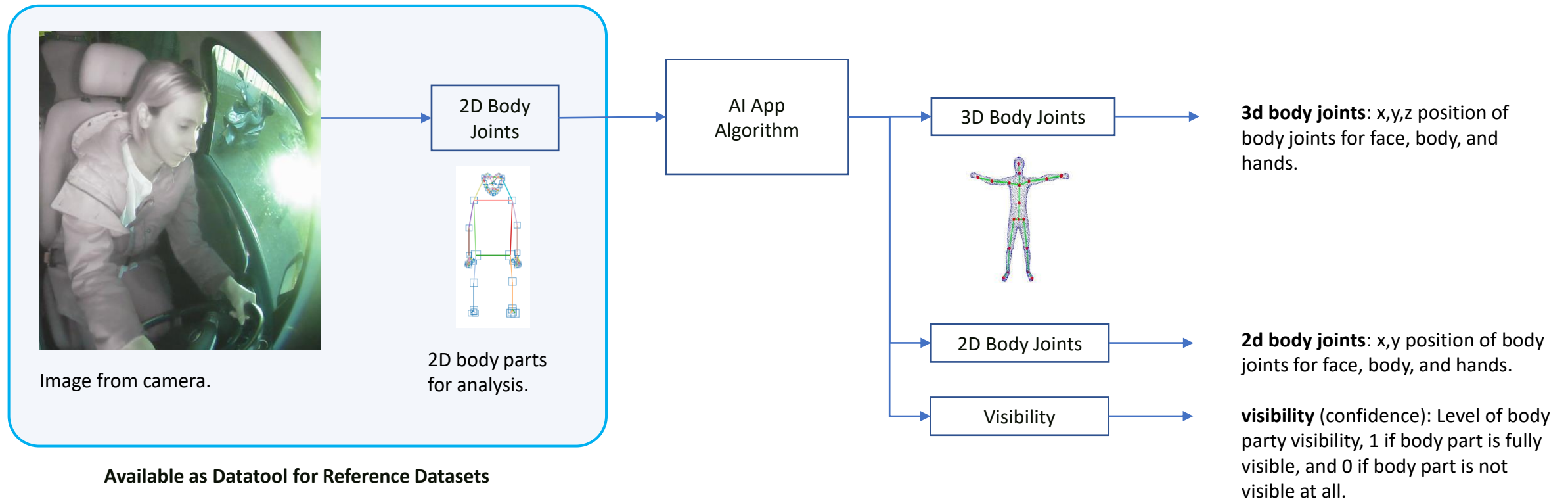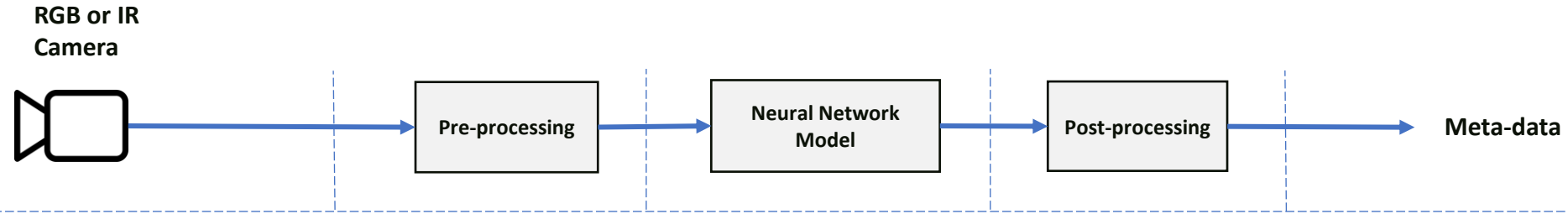| Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Body Part Tracking

Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Understanding the position of the human body is important in observing drivers as this can provide very useful information for ensuring safety. For example, detection of a driver turned around to look in the back seat of a car can indicate: (i) a potentially dangerous situation at a time when the driver is in control of a moving vehicle, or; (ii) a situation where an automated vehicle handing over manual control to the driver is not recommended until the driver returns to a correct position.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can body parts be accurately tracked such that this information can be used to detect potentially dangerous positioning of a driver's body?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting dangerous driver body positioning leading to developing a production system deployed to production vehicles from 2024 onwards with the goals to reduce the number of accidents and save lives through early detection and warning of dangerous driver activities.
References *Reference material available.*	Over the next years, the number of autonomous vehicles is expected to increase. This new paradigm will change the role of the driver inside the car, and so, for safety purposes, the continuous monitoring of the driver/passengers becomes essential. This monitoring can be achieved by detecting the human body pose inside the car to understand the driver/passenger's activity. https://arxiv.org/pdf/2012.13392.pdf

Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Papers** https://arxiv.org/pdf/2105.02465.pdf https://arxiv.org/abs/2107.13994 http://users.ics.forth.gr/~argyros/mypapers/2021_01_ICPR_Qammaz.pdf https://arxiv.org/pdf/2103.10455.pdf https://arxiv.org/pdf/2010.13302v1.pdf **Reference Codes** https://github.com/jfzhang95/PoseAug https://github.com/paTRICK-swk/Pose3D-RIE https://github.com/FORTH-ModelBasedTracker/MocapNET https://github.com/zczcwh/PoseFormer https://github.com/zczcwh/DL-HPE **Datasets** http://vision.imar.ro/human3.6m/ http://gvv.mpi-inf.mpg.de/3dhp-dataset/ http://humaneva.is.tue.mpg.de/datasets_human_1 https://github.com/zhezh/occlusion_person https://people.eecs.berkeley.edu/~zhecao/hmp/
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Body Part Tracking
Technical Specifications | Overview

RGB or IR Camera

Pre-processing → Neural Network Model → Post-processing → Meta-data

Image from camera.

2D Body Joints

2D body parts for analysis.

Available as Datatool for Reference Datasets

AI App Algorithm

3D Body Joints

2D Body Joints

Visibility

3d body joints: x,y,z position of body joints for face, body, and hands.

2d body joints: x,y position of body joints for face, body, and hands.

visibility (confidence): Level of body party visibility, 1 if body part is fully visible, and 0 if body part is not visible at all.

Automotive Challenge | Body Part Tracking
Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description	• Image from RGB or IR camera. • <u>2D Body Part Locations</u> within image.
	Data Format	• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type	☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description	• 2D Body Pose • 3D Body Pose • Body Part Visibility
	Data Format	• JSON meta-data
	Data Type	☑ Meta-Data

Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Body Part Location	Estimated 2D x,y locations of body joints
	Output	2D Body Pose	Refined 2D x,y locations of body joints from 3D estimate
		3D Body Pose	3D x,y,z locations of body joints
		Body Part Visibility	Body joint visibility confidence
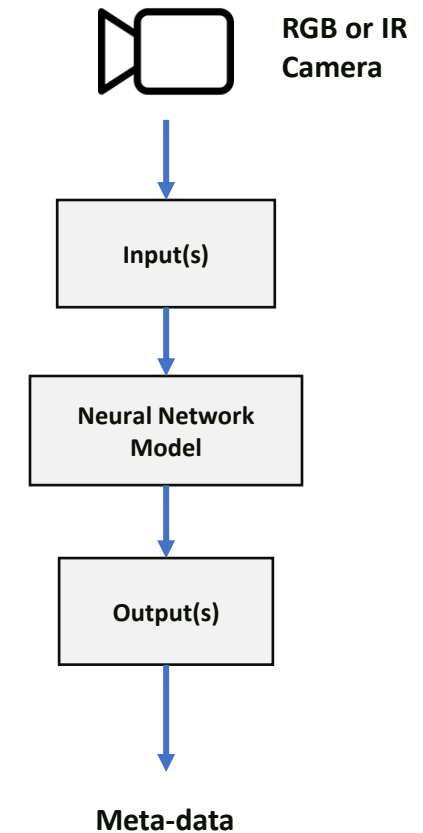
RGB or IR Camera

Input(s)

Neural Network Model

Output(s)

Meta-data

Automotive Challenge | Body Part Tracking
Technical Specifications | Evaluation and Performance

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is 3D body party location error in mm. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	3D Body Part Accuracy
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	MPJPE	Frame Rate	20 FPS
	Accuracy	<= 25mm	Peak Memory	300 MB
	Ethics Bias	<= 10mm	CPU % Usage	<50%
	Availability	99%	Storage	100 MB
Target Platform	Bonseyes Developer Platforms	NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

| Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \
	  --target-url http://target-hardware.local:8080/inference \
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

BONSAPPS

AI-as-a Service for the Deep Edge

Industry Challenges | Automotive
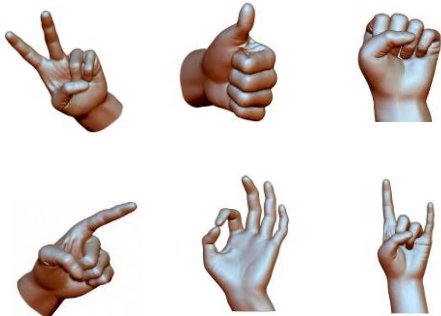Gesture Recognition
A.3

Automotive Challenge | Gesture Recognition
General Description

RGB or IR Camera
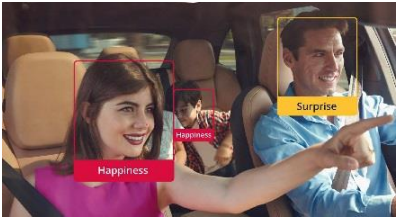
Hand Gestures

Gesture recognition determines a gesture given movements from hand, body, or face body parts. It is an important for understanding human behavior from non-verbal cues or provide commands. In driving, gesture recognition can used to send control commands to human-machine-interfaces, or to detect dangerous behaviors such as micro-sleeps to ensure safe driving when using automation technology.

Must work globally across all people over the world. Must be robust in real driving conditions with harsh and changing lighting conditions and heavy occlusions found inside car environments.

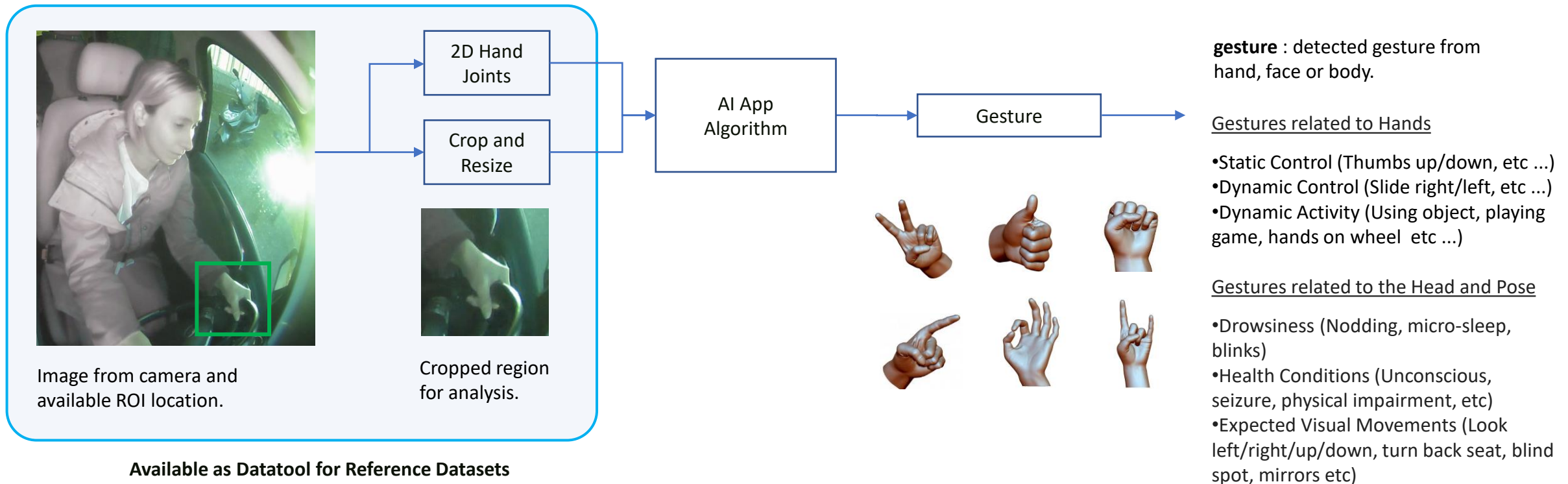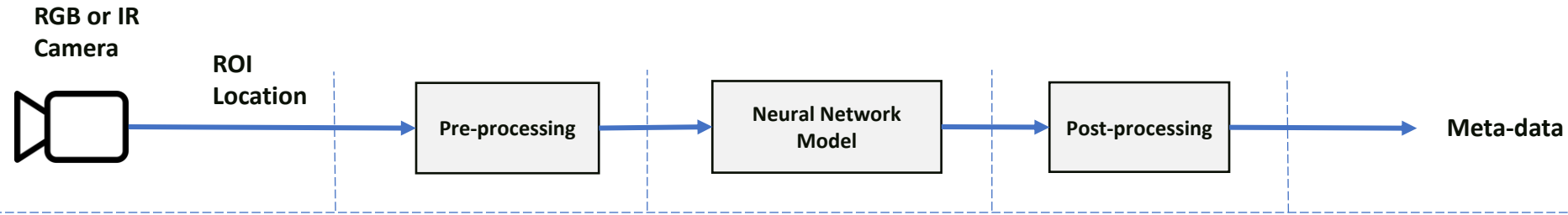| Industry (AI Solutions)	☑ Automotive ☐ Healthcare ☐ Manufacturing ☐ Robotics	
Maturity	☐ Idea / Concept ☑ Experimentation ☐ Industrialization ☐ Production	
Task (AI Assets)	☑ Computer Vision ☐ Natural Language Processing ☐ Medical ☐ Methodology ☐ Other	
Application	Computer Vision	Time Series
	☑ Object Detection ☐ Scene Segmentation ☐ Face Recognition ☐ Image Classification	☐ Audio Classification ☐ Bio-signal Monitoring ☐ Predictive Maintenance ☐ Health Monitoring
Learning Problem	☑ Classification ☑ Regression	☑ Supervised ☐ Unsupervised ☐ Self-supervised

Automotive Challenge | Gesture Recognition

Detailed Description

User Defined Category	
User Problem *Describe the problem or need of your Organization or your customers.*	Understanding human behaviour from non-verbal cues and the provision of commands through gestures is important to improved human-machine-interfaces (HMI). In driving, gesture recognition can used to send control commands to HMI, or to detect dangerous behaviours such as micro-sleeps to ensure safe driving when using automation technology.
User Questions to be Answered *What are the key questions to be answered by the Challenge.*	Can gestures be accurately tracked such that this information can be used to detect commands and potentially dangerous driver states?
Expected Results *What is the expected outcome of the Challenges. To what extent the challenge is providing impact and what impact is expected. How will you measure this impact.*	Establishing a baseline performance of detecting gestures leading to developing a production system deployed to production vehicles from 2024 onwards with the twin goals of (i) reducing the number of accidents and saving lives through early detection and warning of dangerous driver states and (ii) increasing useability through improved HMI.
References *Reference material available.*	Gesture recognition is technology that uses sensors to read and interpret hand movements as commands. In the automotive industry, this capability allows drivers and passengers to interact with the vehicle — usually to control the infotainment system without touching any buttons or screens. https://arxiv.org/pdf/2107.12167 https://arxiv.org/ftp/arxiv/papers/2102/2102.10497.pdf

| Datasets, Tools, and Resources	
Tools and Resources *Please indicate the tools and resources that you will provide to address the challenge: datasets, evaluation methodology, and end-users that might be involved.*	**Reference Paper** https://openaccess.thecvf.com/content_ECCVW_2018/papers/11134/Hou_Spatial-Temporal_Attention_Res-TCN_for_Skeleton-based_Dynamic_Hand_Gesture_Recognition_ECCVW_2018_paper.pdf https://arxiv.org/pdf/2004.03259.pdf https://arxiv.org/pdf/2001.05833.pdf https://arxiv.org/pdf/1907.09658.pdf **Reference Code** https://github.com/V-Sense/ACTION-Net https://github.com/abedicodes/ResNet-TCN https://github.com/mit-han-lab/temporal-shift-module https://github.com/BlurryLight/DD-Net-Pytorch **Dataset** https://deepmind.com/research/open-source/open-source-datasets/kinetics/ http://crcv.ucf.edu/data/UCF101.php https://20bn.com/datasets/something-something/v1 https://20bn.com/datasets/something-something/v2 https://20bn.com/datasets/jester http://www-rech.telecom-lille.fr/DHGdataset/ https://research.nvidia.com/publication/online-detection-and-classification-dynamic-hand-gestures-recurrent-3d-convolutional https://gibranbenitez.github.io/IPN_Hand/ http://jhmdb.is.tue.mpg.de/ http://tosca.cs.technion.ac.il/book/shrec.html
Available Dataset *Will you provide the dataset/data repository to address your challenge?*	☑ Yes ☐ No

Automotive Challenge | Gesture Recognition
Technical Specifications | Overview

RGB or IR Camera

ROI Location

Pre-processing → Neural Network Model → Post-processing → **Meta-data**

Image from camera and available ROI location.

2D Hand Joints

Crop and Resize

Cropped region for analysis.

AI App Algorithm → Gesture

Available as Datatool for Reference Datasets

gesture : detected gesture from hand, face or body.

Gestures related to Hands

- Static Control (Thumbs up/down, etc ...)
- Dynamic Control (Slide right/left, etc ...)
- Dynamic Activity (Using object, playing game, hands on wheel etc ...)

Gestures related to the Head and Pose

- Drowsiness (Nodding, micro-sleep, blinks)
- Health Conditions (Unconscious, seizure, physical impairment, etc)
- Expected Visual Movements (Look left/right/up/down, turn back seat, blind spot, mirrors etc)

Automotive Challenge | Gesture Recognition
Technical Specifications | Input and Output

Input *Please indicate the input data format and type.*	Description		• Image from RGB or IR camera. • <u>2D Hand Part Locations</u> within image.
	Data Format		• 24bit color image or 8bit grayscale image • JSON meta-data
	Data Type		☑ Image ☑ Meta-Data ☐ Time Series
Output *Please indicate the output data format and type.*	Description		• Gesture
	Data Format		• JSON meta-data
	Data Type		☑ Meta-Data
Meta-data Definitions *Please define precisely any meta-data.*	Input	2D Hand Part Location	2d skeleton joint information
	Output	Gesture	Recognized gesture of sequence
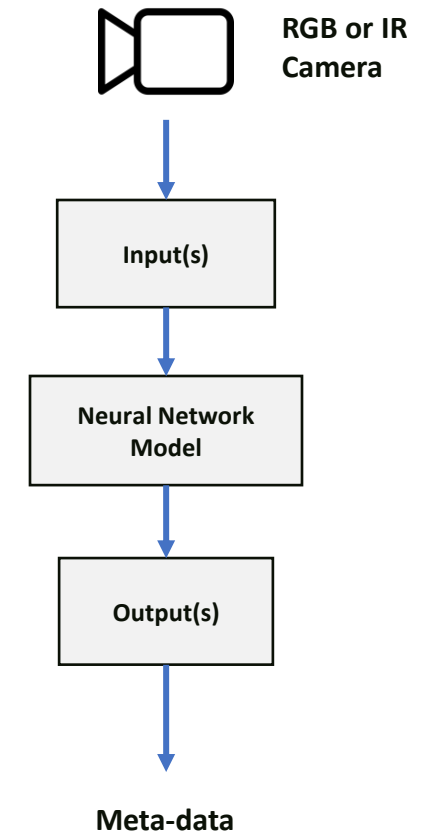
RGB or IR Camera

Input(s)

Neural Network Model

Output(s)

Meta-data

Automotive Challenge | Gesture Recognition
Technical Specifications | Evaluation and Performance

Evaluation Procedure

The evaluation will be carried out at an image level based on reference datasets. For each image, the result is gesture recognized. Deployment metrics will be collected and measured for latency, framerate, and resource utilization such as CPU and GPU overhead. An evaluation docker will be provided to perform the evaluation

Evaluation Report

Format	PDF and JSON File	
Metrics	Model	Gesture Confusion Matrix
	Deployment	Latency Storage Peak Memory (MB) Memory Bandwidth % Usage CPU % Usage GPU % Usage

Performance	Model Accuracy		Deployment	
	Metric	Confusion Matrix	Frame Rate	10 FPS
	Accuracy	95%	Peak Memory	100 MB
	Ethics Bias	< 1%	CPU % Usage	N/A
	Availability	99%	Storage	50 MB
Target Platform	Bonseyes Developer Platforms | NVIDIA Jetson AGX JetPack 4.6.1 TensorRT 8.0.1			

Evaluation API	Command Line Interface
	Example:
	
	docker run --rm -v /data:/data -v /out:/out evaluation-tool \\
	  --target-url http://target-hardware.local:8080/inference \\
	  --dataset-dir /data --output-dir /out

Format	Docker Image
Output	Evaluation Report (see table for details)
Docker Version	Docker 19.03
Target Hardware	NVIDIA Jetson AGX using DLA via TensorRT 8.0.1

Thank you!

Open Call Announcement for 1st Open Call

CALL ANNOUNCEMENT	
Call title:	BonsAPPS 1st Open Call for AI Talents
Full name of the EU funded project:	AI-as-a-Service for the Deep Edge
Project acronym:	BonsApps
Grant agreement number:	101015848
Call publication date:	1st of September, 2021 at 00:00 CEST (Brussels Time)
Call deadline:	28th October 2021 at 17:00 CEST (Brussels Time)
Expected duration of participation (i.e., Support programme):	First stage – 2 months (30 AI talents) Second stage – 3 months (10 AI talents)
Maximum amount of financial support for each third party:	70.000 EUR (including 10.000 EUR for HPC Cloud services)
Submission & evaluation process:	Submission through the application form available on: https://bonsapps-1oc-ai-talents.fundingbox.com/ The selection of the Open Call proposals will be carried out in a four-step process. - Step 1 will check the proposals against eligibility criteria. - Step 2 will involve external evaluation to assess the proposal according to the criteria. - Step 3 will involve the BonsAPPs consortium to choose the proposals based on the external evaluation results and the objectives of the BonsAPPS project. - Step 4 will include the review of legal documents before the Sub Grant Agreement signature. For further information see the Guide of Applicants section 4
Further information:	OC application form: https://bonsapps-1oc-ai-talents.fundingbox.com/ OC helpdesk email: bonsapps.help@fundingbox.com Project website: https://bonsapps.eu/
Applicants and eligibility:	- Natural Person (entrepreneur or PhD Researchers), individually or organized in a team of maximum 5 persons OR - One Registered Legal Entity that is an SME or Mid Cap or Research and Technology Organization That are registered/have citizenship or legal residence in:

	● The Member States of the European Union and its Overseas Countries and Territories or
	● Associated Countries to H2020 or
	● United Kingdom of Great Britain and Northern Ireland

ABOUT BonsAPPs

BonsAPPs is a project funded by European Union's Horizon 2020 research and innovation programme created in line with the **EC's AI Strategy** for building an ecosystem of excellence that can **support the development and uptake of AI across the European Union** that will interoperate with the AI on demand platform (AI4EU).

The main objective is to increase AI usage by enterprises and SMEs which lack internal innovation capabilities through a fully functional cycle for the development of AI Apps at the Edge and the Deep Edge that turns their challenges into feasible and re-usable AI Solutions.

In the frame of this 1st Open Call, **we are looking for AI Talents (data scientists, AI developers and AI integrators)** that will become part of the 5-month BonsAPPs Support Programme during which BonsAPPs partners will offer the access and support to use Bonseyes Marketplace tools and services for the development of an AI@Edge Solution responding to a specific industrial need of sectoral relevance. Each beneficiary will receive at maximum 70 000 EUR for execution of the project.

Selected beneficiaries shall use of Bonseyes Marketplace Platform (AI-aaS service layer within AI-on-demand platform) to develop AI@Edge Apps and Solutions based on Computer Vision, Time Series Analysis, Audio Classification and/or other AI enabling technologies. These AI@Edge Apps and Solutions shall respond to one of the 10 specific AI Industry Challenges related with the development of low-cost, highly scalable AI Apps and Solutions applicable to needs from:
● Manufacturing
● Automotive
● Healthcare
● Robotics