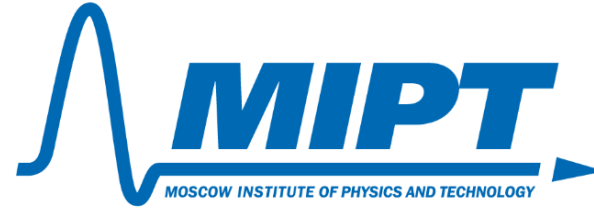


# Skoltech

Skolkovo Institute of Science and Technology



## Machine learning in predicting freezing of gait events using ultra-resource-constrained computational devices

Seikin A. 1\*

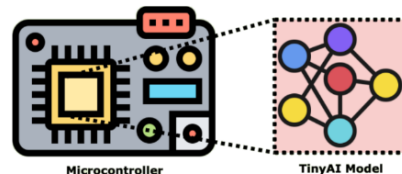
Kirillov B. 2,3,

1 Moscow Institute of Physics and Technology, Dolgoprudny, Russia

2 Center of Material Technologies, Skolkovo Institute of Science and Technology, Moscow, Russia

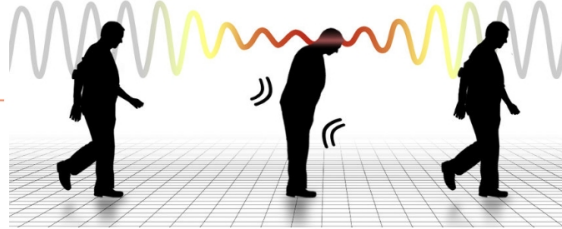
3 Center for Precision Genome Editing and Genetic Technologies for Biomedicine, Institute of Gene Biology, Russian Academy of Sciences, Moscow, Russia

\* seikin.aa@phystech.edu



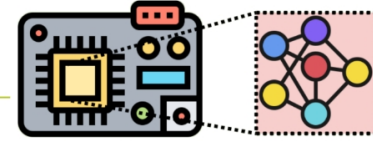
# Motivation & Aim

Freezing of Gait (FOG), a sudden temporary inability to initiate walking, is a severe complication of Parkinson's disease that significantly impacts patients' quality of life



FOG episode

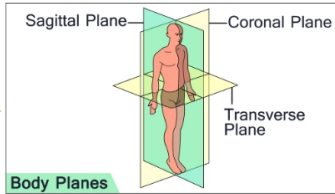
Predicting motor disorders on wearable devices using microcontroller computational resources in an extremely compute-starved environment



Microcontroller

TinyAI Model

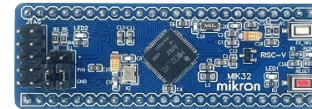
Inplace data labeling as "FOG episode" on ultra small CPU via neural networks



Body Planes

Data collection

Movement data can be digitized using accelerometers



FOG prediction, enabled on resource-constrained devices, paves the way for the development of affordable, reliable, and energy-efficient wearable systems to improve the lives of people with Parkinson's disease

# Methods

open DATA collecting

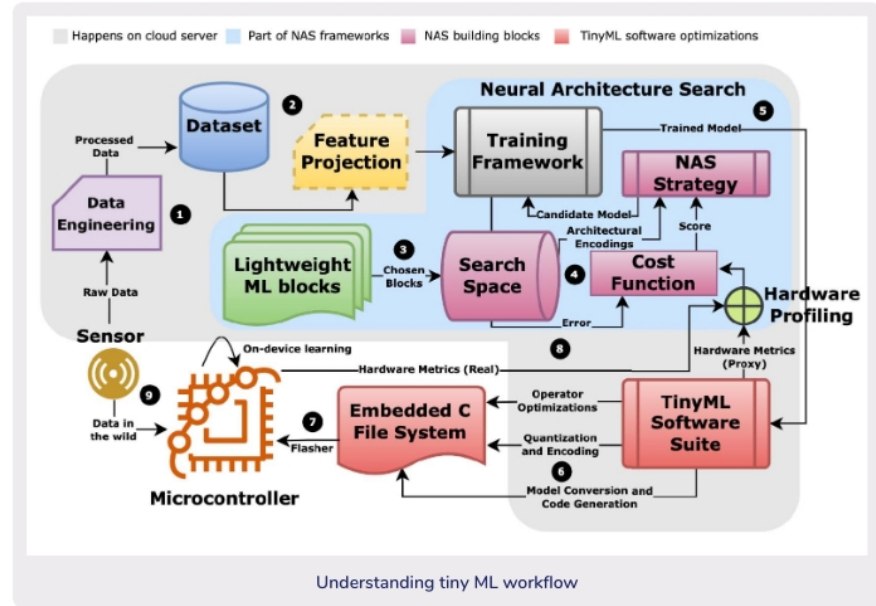
Teaching neural networks (TensorFlow) on server side

Compressing fitted models

Converting compressed models to Binary code

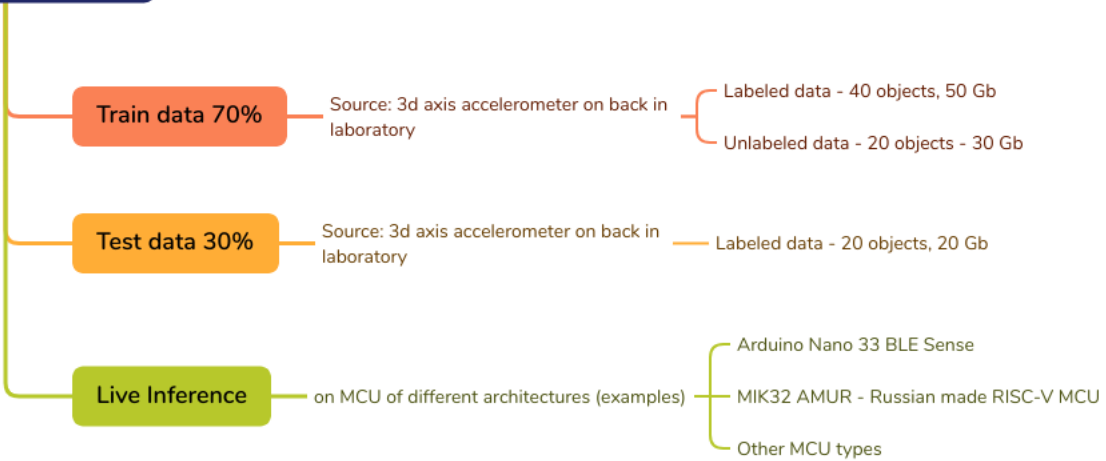
Uploading on MCU\*

Inference on test set via MCU\*



\*MCU - micro controller unit

# DATASET



The main goal is to demonstrate that predicting freezing of gait episodes can be performed on microcontrollers with comparable effectiveness to server or desktop solutions while maintaining autonomy, ideally by implementing the algorithm on a Russian-made microcontroller.

Results					
		ROC-AUC score	Energy consumption	Storage	Memory
Cloud GPU		95%+	kWts	PB	16 GB+
Mobile CPU		90-95%	10W	64 GB Flash	4GB DRAM
Tiny ML algorithm on MCU		85-90%	0.1-0.3 W	32- 2048 kB eFlash	2-1024 kB SRAM