



# Interactive Online Computer Gaming Platform for Rehabilitation of Children with Cerebral Palsy

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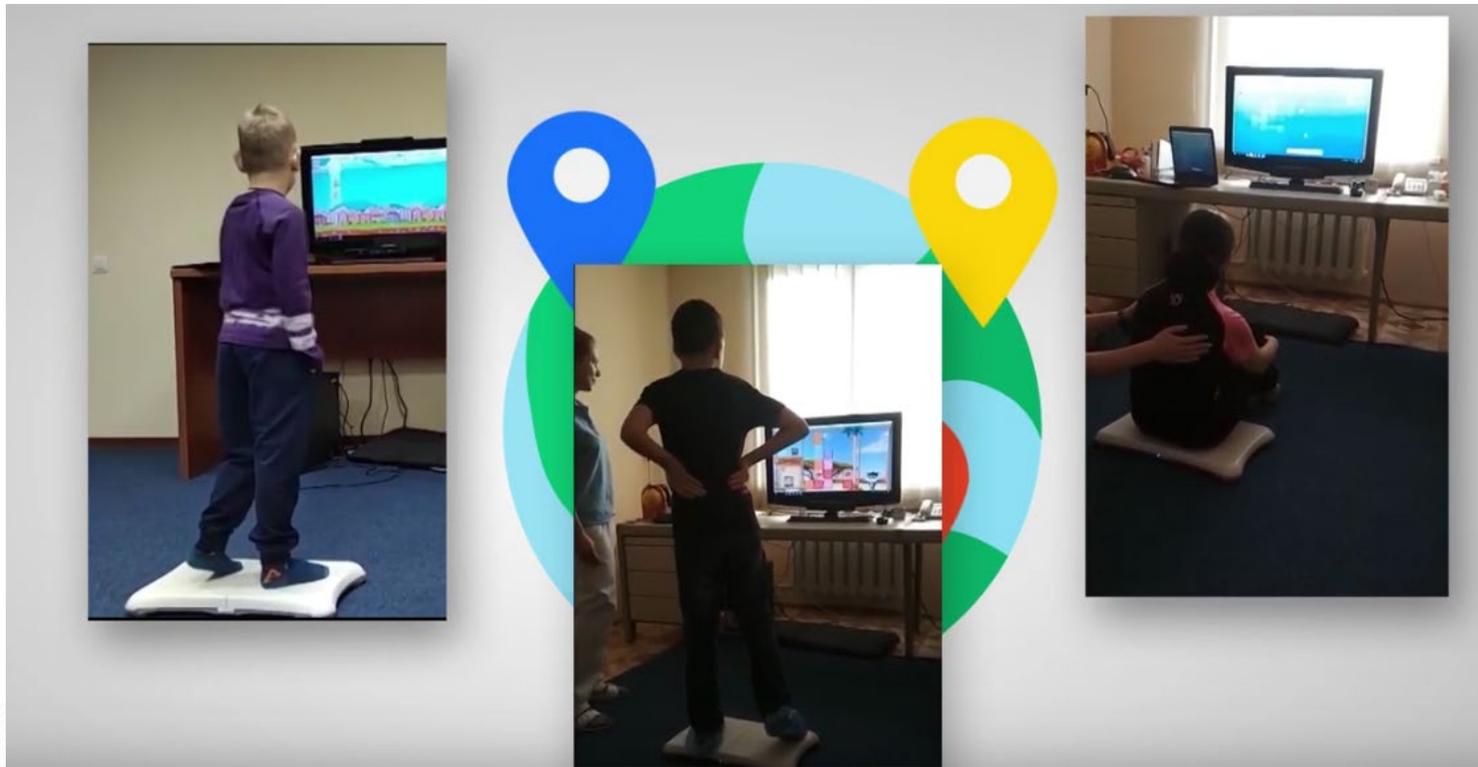
# Brief overview of the project

The main objective of ABLEGAMES project is to launch a social platform of personalized games to dramatically enhance the living conditions of people with Cerebral Palsy (CP).

The online platform and games focused on improving motor skills and visual-motor coordination for youths with CP offers control mechanisms that allow the therapists / caregivers to adequately personalize the games and also monitor the progress of the patients.



# Brief overview of the project





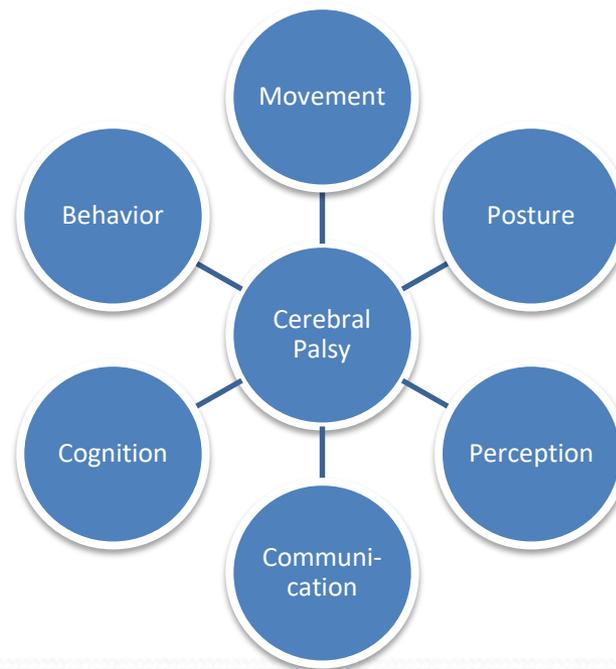
# Epidemiology of Cerebral Palsy

- 17 million of people with cerebral palsy worldwide
- Overall prevalence is 2 per 1000 live births
- 41 % children are limited in daily activities and movements
- 31 % need to use special equipment





# Cerebral Palsy syndromes





# Challenges in game development for the children with CP

- Gross motor control
- Manual Ability
- Visual-motor integration
- Visual-spatial processing
- Attention
- Differences in players' abilities



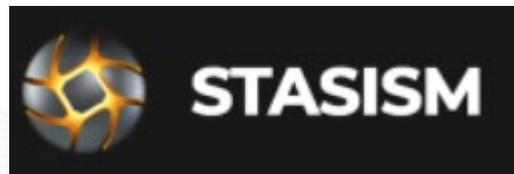
# Gameplay Requirements

- Avoid fast pace
- Simple control scheme
- Do not require multiple simultaneous actions
- Avoid repeated inputs (button mashing)
- Automate the player's input
- Still entertaining and fun



# Stasism

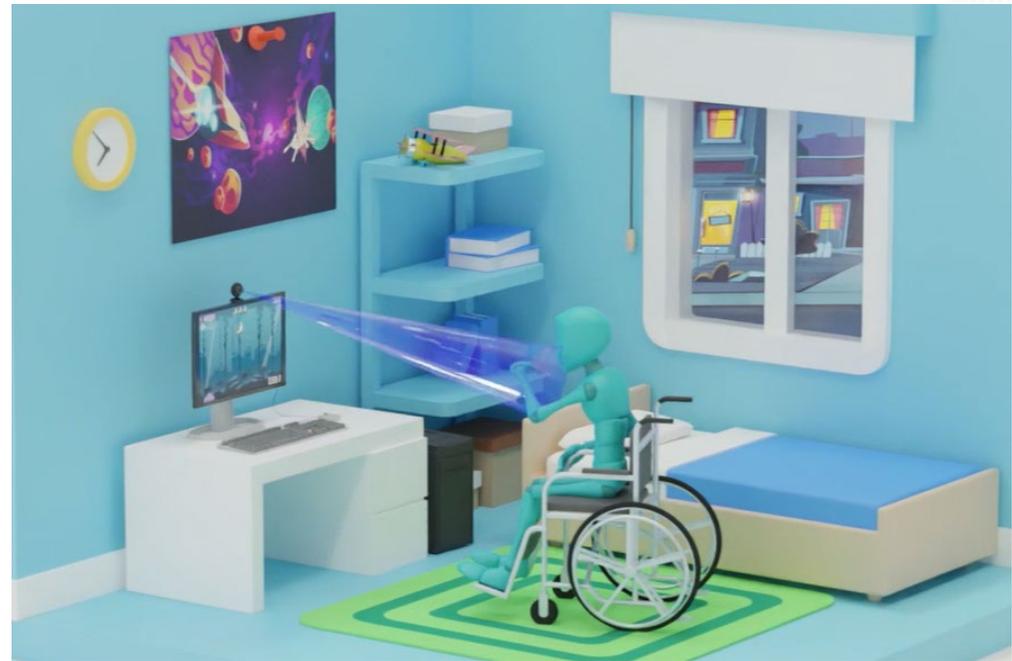
Stasism is the commercial product obtained as result of the AbleGames project. It is the perfect social online gaming platform for people with Cerebral Palsy. Our therapeutic physical video games are made exclusively for them and will help improve their motor skills, coordination and balance.





# Stasism

The system uses AI algorithms for providing customized automatic recommendations for the games settings to guarantee the patient's therapeutic goals and also for controlling the games using low-cost webcams.





# Stasism

The system can be controlled using a **webcam** or a **balance board**.





# Rehabilitation using Computer Games

It provides all the components required for a successful motor learning, such as:

- repeated and consistent practice of the same task
- tracking movement accuracy
- real time feedback
- optimal challenge level
- recording and analysis of the performance
- Suitable serious games make therapy more fun and engaging





## Benefits for the users

- Improving their physical therapy through play
- Achieving their customized therapeutic goals





## Benefits for the users

- Stasism is all about Cerebral Palsy
- BECOMING PART of an inclusive social community made exclusively for you
- Play together. Have fun together. Bond together.



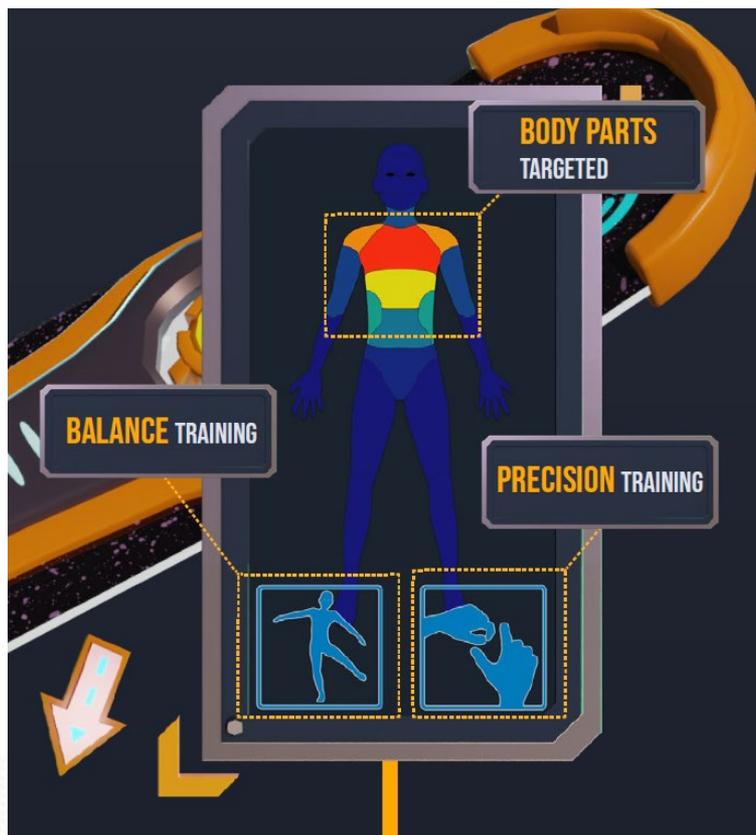


## Pilot Sites testing the platform

<b>Pilot Sites</b>	<b>Country</b>	<b>Responsible partner</b>
Elita Rehabilitation Center	Ukraine	ICR
International Clinic of Rehabilitation	Ukraine	ICR
Ukrainian Medical Rehabilitation Center	Ukraine	ICR
Dzherelo Children's Rehabilitation Centre	Ukraine	ICR
Fundacio L'Espiga	Spain	URV
Taller Baix Camp	Spain	URV
Fundació Gandhi	Spain	URV
St Gabriel School	Ireland	MAC



## Benefits for the users



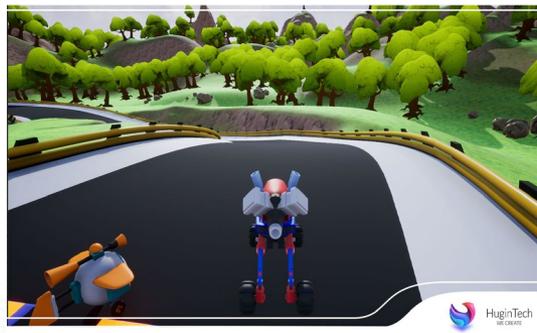


# Games controlled with a single webcam





# Game example: Crazy Racing car





# DIAGNOSTIC TOOLS



## Dynamic Balance test game

- Simple and short test of Dynamic balance (ability to transfer the vertical projection of the center of gravity around the supporting base of support).
- Patient shifts the center of pressure left right to hold within the specified limits for 3 seconds.
- Can be performed in different positions, including standing with support and sitting.





## Diagnostic tools: Dynamic balance tool





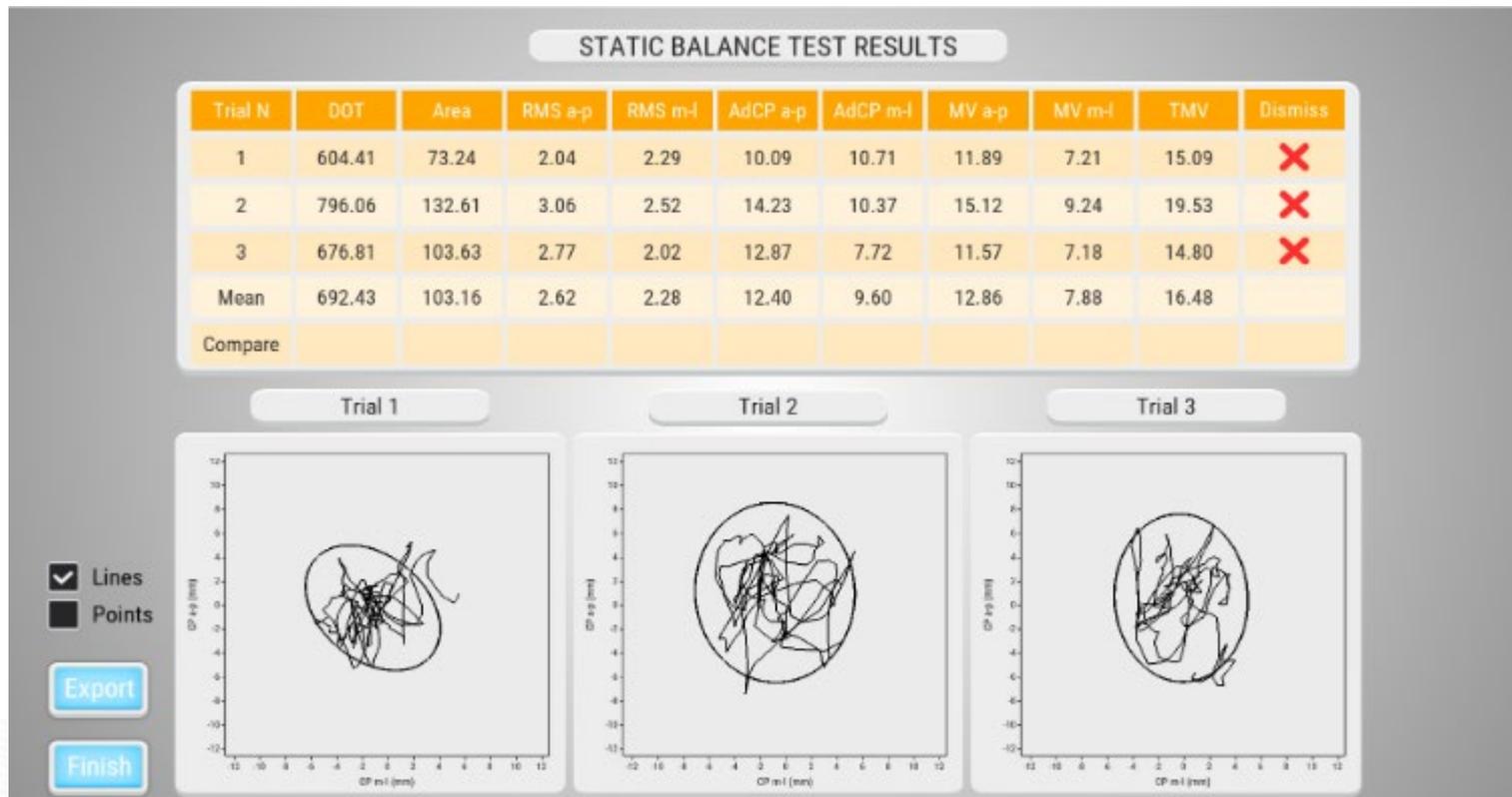
## Dynamic Balance test game

- Aim: to objectively assess the patient's progress.
- Similar to classical Stabilometry test (objective study of body sway during quiet standing).
- Patient stands still on the board trying not to move with eyes open.
- 3 trials each 10-sec duration.
- Only for patients that can stand independently.





# Diagnostic tools: Static balance tool





## Diagnostic tools: Static balance tool

**DOT** - total displacement of sway;

**Area** - the area of the 95 % confidence ellipse;

**RMS a-p, RPS m-l**: root mean square of displacement in anterior – posterior and media – lateral direction;

**AdCP a-p, AdCP m-l**: the distance between the maximum and minimum center of pressure displacement;

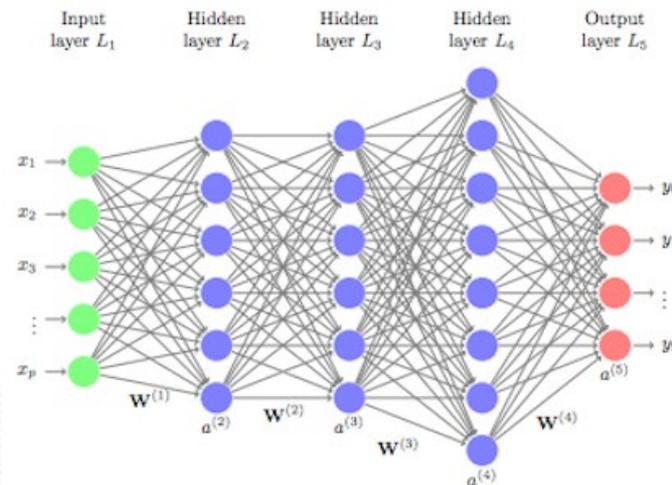
**MV a-p, MV m-l**: mean velocity in anterior – posterior and media – lateral direction;

**TMV** – total mean velocity.



# ABLEGAMES INTELLIGENT IMAGE ANALYSIS USING DEEP LEARNING

Deep learning (DL) algorithms which are a submodule of machine learning algorithms are used to extract accurate posture information contained in the monocular image captured by the camera.





# ABLEGAMES INTELLIGENT IMAGE ANALYSIS USING DEEP LEARNING

These DL algorithms use convolutional neural networks in order to automatically extract visual features to identify arms, hands and limbs.

The input and expected output datasets are used to teach the system how to behave to get a desired response.



# ABLEGAMES INTELLIGENT IMAGE ANALYSIS USING DEEP LEARNING

The datasets used to train the deep learning models for 3D landmark detection are described below:

- **Input data:** Images captured by a single webcam containing body parts, such as the person's hands, his limbs and his trunk.
- **Output data:** information of the corresponding 3D spatial location of each one body parts corresponding to the associated input 2D image.



# ABLEGAMES INTELLIGENT IMAGE ANALYSIS USING DEEP LEARNING

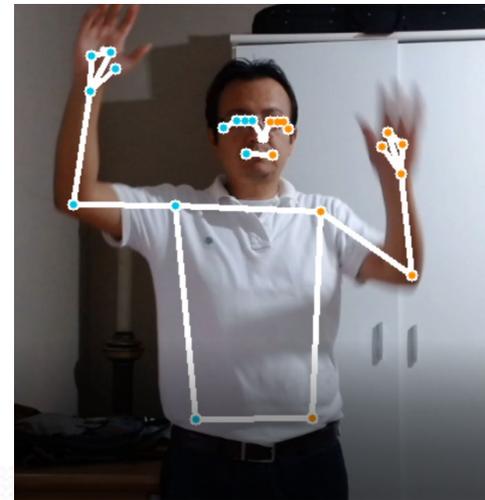
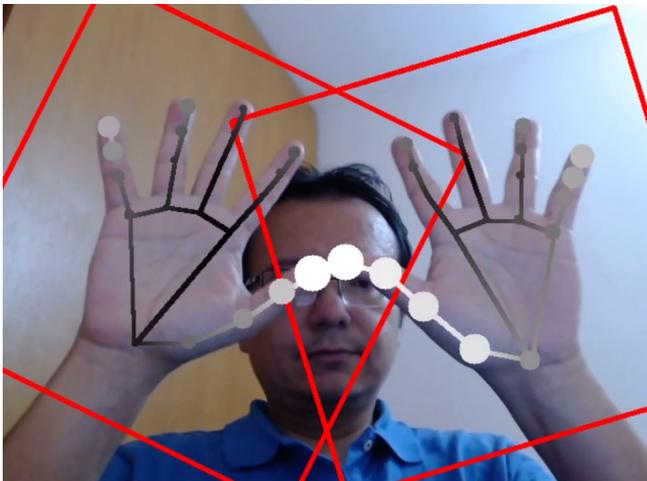
The MediaPipe framework developed by Google has been integrated to allow a real-time response. The obtained trained model is finally deployed as a DL lite model to guarantee that no expensive Graphical Processing Units (GPUs) devices are required by the final user.

One of the project goals is guaranteeing **a low-cost input system and cutting-edge technologies, and using MediaPipe deep learning lite models achieves this objective.** The latest released version of the MediaPipe framework is used by AbleGames camera input system at every time a new stable release is available.



# ABLEGAMES INTELLIGENT IMAGE ANALYSIS USING DEEP LEARNING

The camera input system also provides accurate information on the 3D pose location of the upper body landmarks. **This information is used to control the game avatars.**





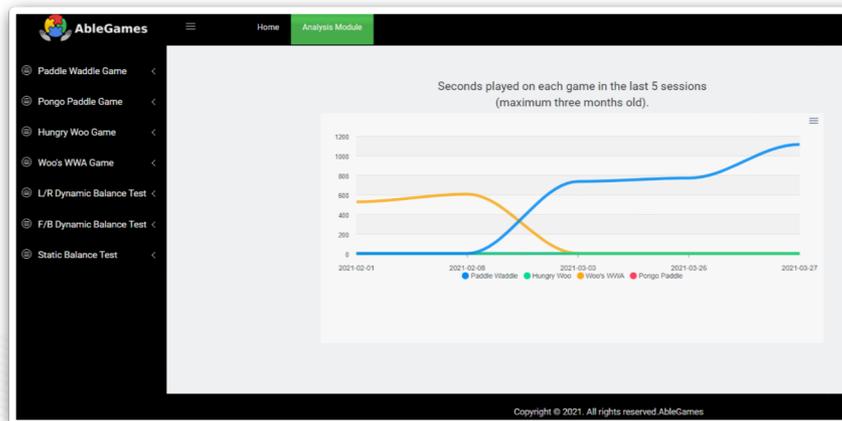
# Example of a game controlled with a single webcam by using DL algorithms





# AbleGames Intelligent Personalization & Progress Analysis module

By analysing the data generated by the AbleGames users, the system provides customized recommendations to players/caregivers suggesting a suitable difficulty level for him/her and the system also provides friend suggestions according to the user most played games as well as his/her gaming time preferences and his/her own performance.





# AbleGames Intelligent Personalization & Progress Analysis

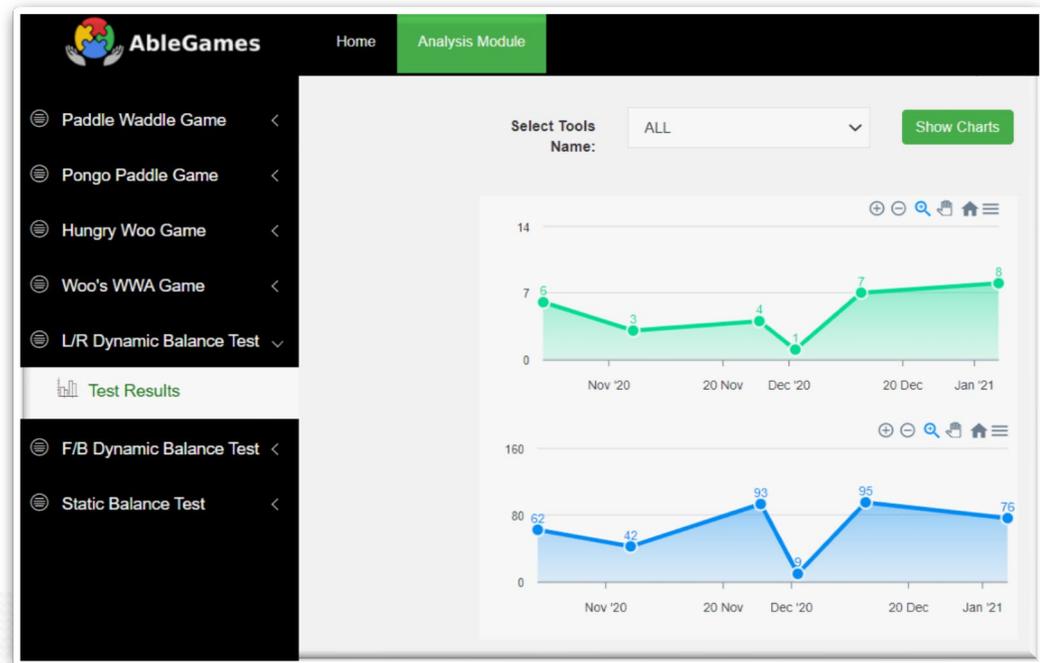
The training process of the predictive models is done by using the data available. These models are re-trained as long as new data are available in order to improve the prediction and recommendation given by the system.

The results obtained from the static and dynamic game-like balance tools together with the data generated by the users while playing the games are used to train several machine learning models.

These models enable the AbleGames platform to predict the score performance of a user in a particular game according to his/her individual motor skills.



# AbleGames Intelligent Personalization & Progress Analysis





# RECOMMENDING THE NEXT APPROPRIATE DIFFICULTY LEVEL

Dynamic and Static balance tools provide relevant data for the recommender module. The results of these tools are used to predict the possible performance of a player in a specific game in order to recommend a suitable difficulty level according to his/her preferences and skills.

The data collected from the balance tools and the games is used to suggest an appropriate difficulty level to keep the patient motivated. Consequently, the recommendation system mitigates the risk of discouraging the player by recommending a level according to his/her skills.



# RECOMMENDING POTENTIAL FRIENDS FOR PLAYING TOGETHER

People enjoy playing together with their peers and at the same time cooperative gaming increases greatly the player's opportunity to reach a higher level of motivation to continue playing. Thus, clustering algorithms have been used to match users according to the common games they usually like to play, their gaming time slots preferences and also their performance.

Thus, the system recommends to each user some available players with similar preferences and performance enabling them to play together. This solution is possible thanks to the valuable data provided by the balance tools results.

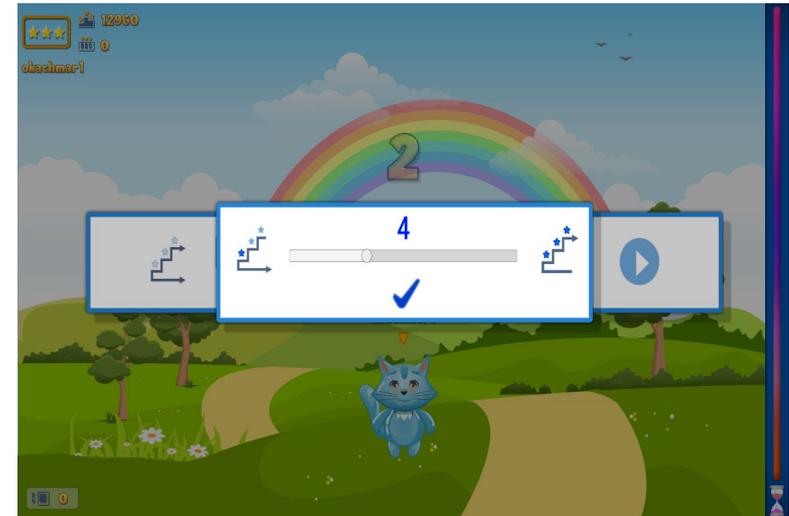


# GAMES DIFFICULTY & LEVEL EDITOR



## Difficulty of the Games

- Children with Cerebral Palsy have different motor capabilities
- Individually adjusted using a 10-points scale





## Level editor

This tool allows that the game dynamics of each game can be customized according to the individual needs of the patient.





# Clinical cases



## Vitaliy, 11 years



Diagnosis: Cerebral palsy, left hemiparesis

MACS (Manual ability classification system): III  
Handles objects with difficulty; needs help to prepare or modify activities

Therapeutic aim: improvement of the hand movements to acquire new skills, like riding a bike

Two-week training of the left-hand movements with the Stasism platform



## Volodia, 9 years



Diagnosis: Cerebral palsy, spastic quadriplegia

GMFCS (Gross motor function classification system): III

Walks using a hand-held mobility device in most indoor settings

Therapeutic aim: improvement of the control of the wheeled chair

Two-week training of the trunk movements with the Stasism platform



# CP patients playing the games





## CP patient playing the games





# Questions?



*This project has received funding from the European Union's Horizon 2020 Programme under grant agreement N° 958637*



# Thanks for your attention!



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