WEATHER SERVICE TO SUPPORT AUTONOMOUS DRIVING IN ADVERSE WEATHER CONDITIONS

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Adverse winter weather conditions

Slipperiness
Darkness
Snowfall
Freezing rain
Fog

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Total hours of adverse weather conditions causing the most challenges for the AVs in Finland
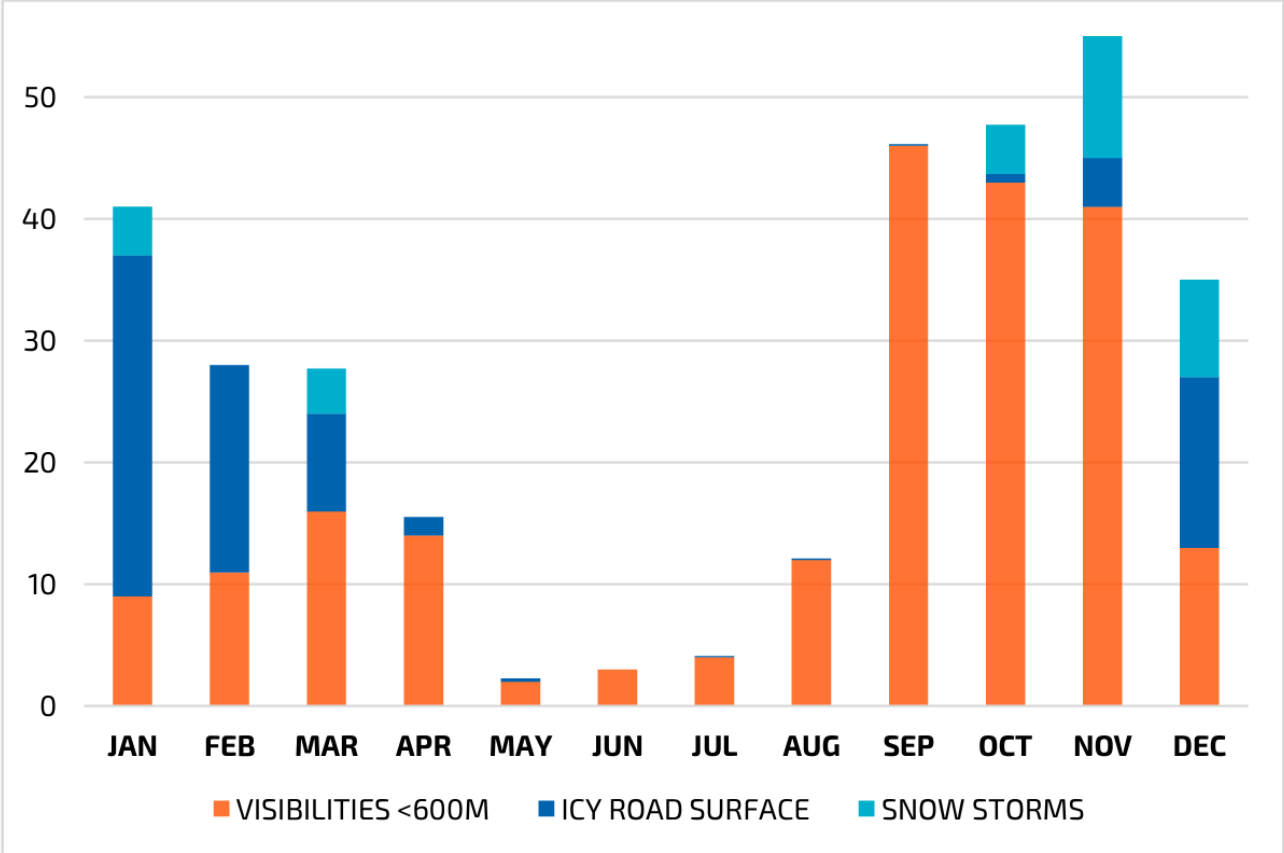
Helsinki-Tampere motorway
15 RWS's, 10 year data

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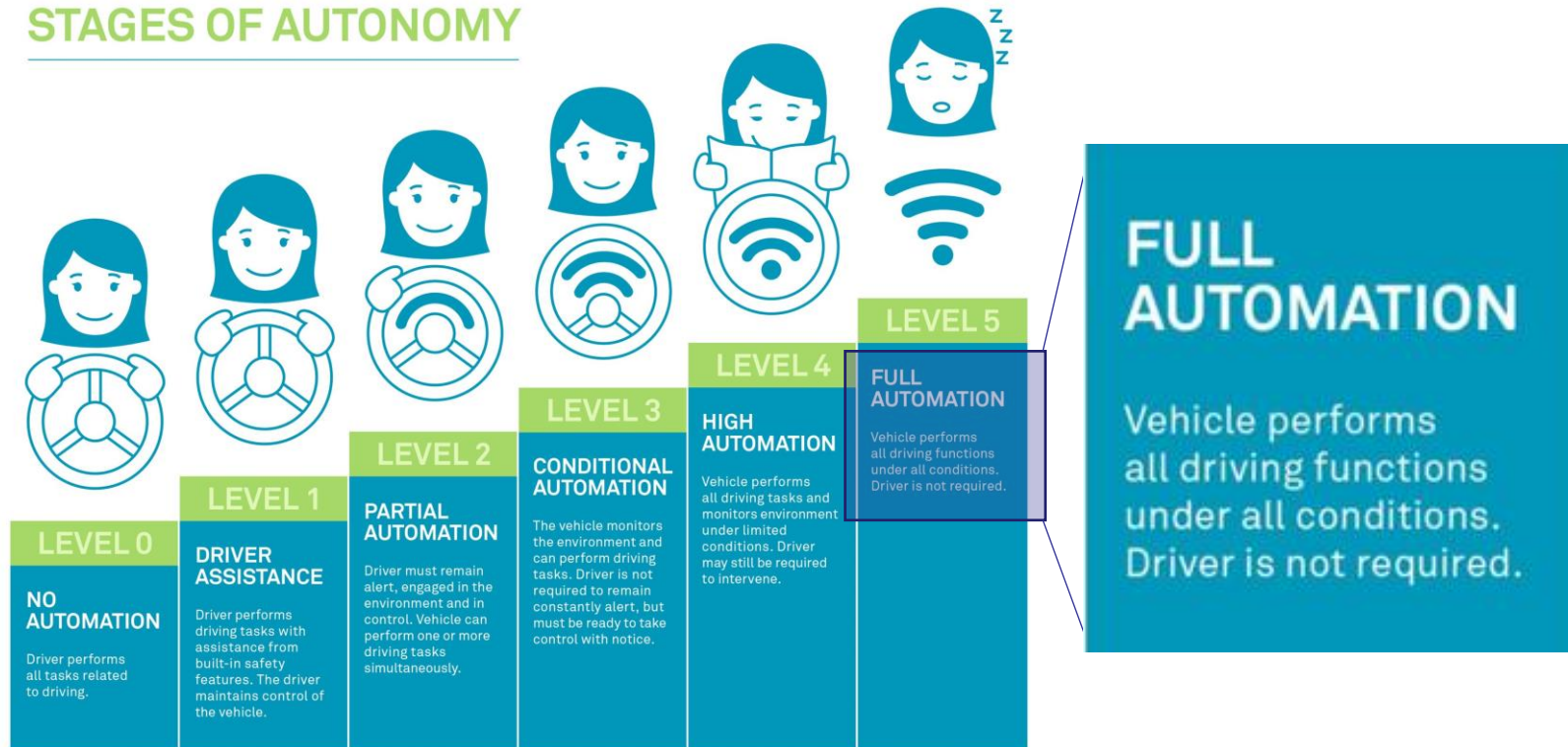FINNISH METEOROLOGICAL INSTITUTE

Test track in Sodankylä, North Finland

SODANKYLÄ

67°25′N 026°35′E

Miniature vehicle

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Levels of automous driving

STAGES OF AUTONOMY

LEVEL 0

NO AUTOMATION

Driver performs all tasks related to driving.

LEVEL 1

DRIVER ASSISTANCE

Driver performs driving tasks with assistance from built-in safety features. The driver maintains control of the vehicle.

LEVEL 2

PARTIAL AUTOMATION

Driver must remain alert, engaged in the environment and in control. Vehicle can perform one or more driving tasks simultaneously.

LEVEL 3

CONDITIONAL AUTOMATION

The vehicle monitors the environment and can perform driving tasks. Driver is not required to remain constantly alert, but must be ready to take control with notice.

LEVEL 4

HIGH AUTOMATION

Vehicle performs all driving tasks and monitors environment under limited conditions. Driver may still be required to intervene.

LEVEL 5

FULL AUTOMATION

Vehicle performs all driving functions under all conditions. Driver is not required.

FULL AUTOMATION

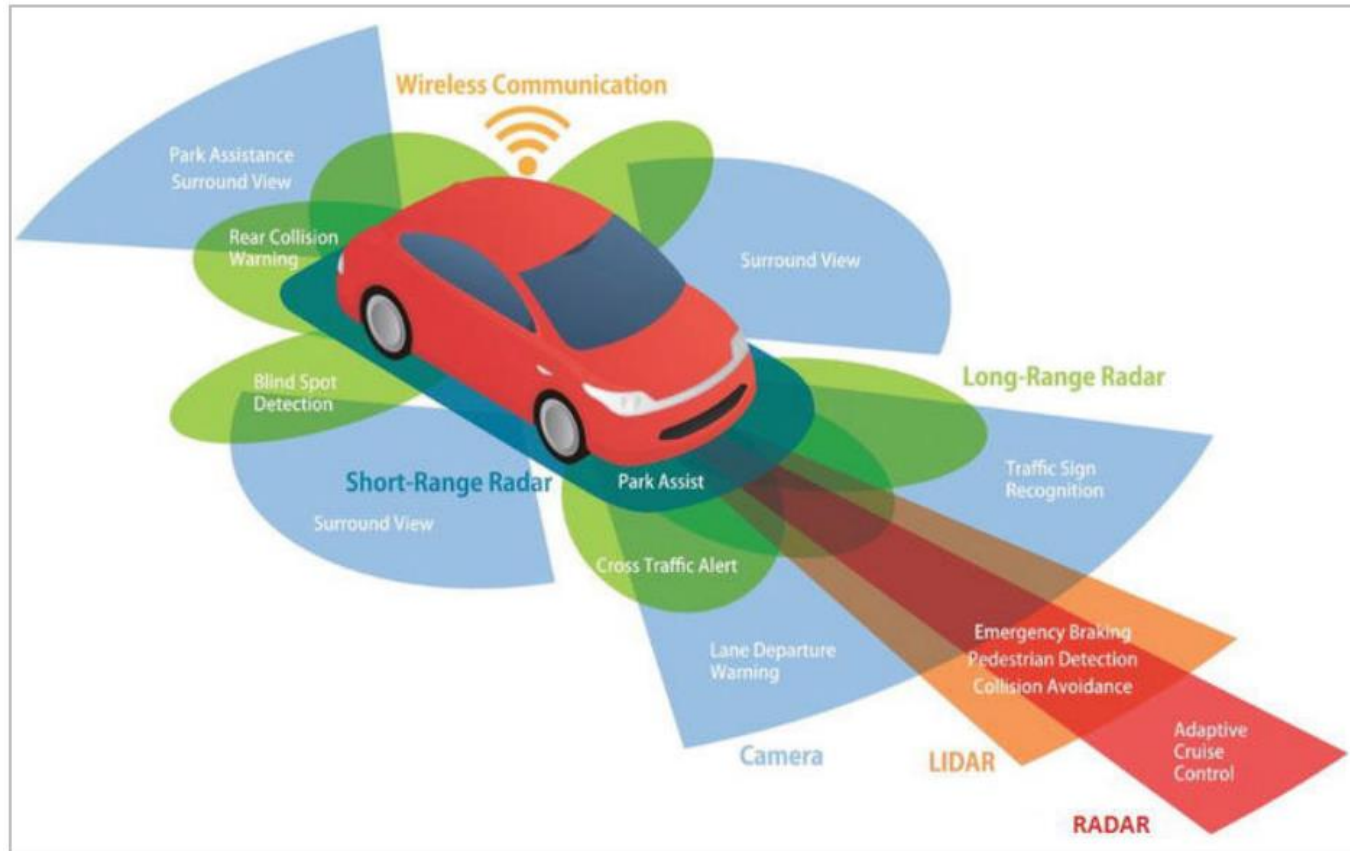Vehicle performs all driving functions under all conditions. Driver is not required.

Question:
How about driving in winter when there is heavy snowfall and slippery road condition?
Is full automation mode possible in those weather situations?

Answer:
Mayby not (at least now)

Source: https://blog.novatel.com/functional-safety-for-autonomous-vehicles/

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Wireless communication and sensors in self-driving cars

Autonomous driving is strongly dependent of several sensors (camera, lidar, radar) detecting the driving circumstances (obstacles, edge line etc) and wireless communication systems

Source: Pisarov and Mester: The Future of Autonomous Vehicles, 2020. DOI: 10.5937/fme2101029P

Sensors installed on the miniature vehicle

| Device	Detection range	Object detection accuracy	Vulnerability to		
			Rain	**Snow**	**Dark**
Video camera *	>100m *	Mod.	Low	High	Low
Lidar, Velodyne PUCK/ VLP16	>100m	Very high	Mod	Mod	Null
Vehicle radar, Continental SRR 308	>80m	High	Low	Mod	Null
GNSS RTK	∞	Null	Null	Null	Null
Friction, Teconer RWS 431	Spot	Null	Low	Low	Null
ITS services via ITS-G5/5G transceiver	Transm. Delay	Source specific	Null	Null	Null

* image resolution limited due to real-time interpretation

Lidar vs. photography
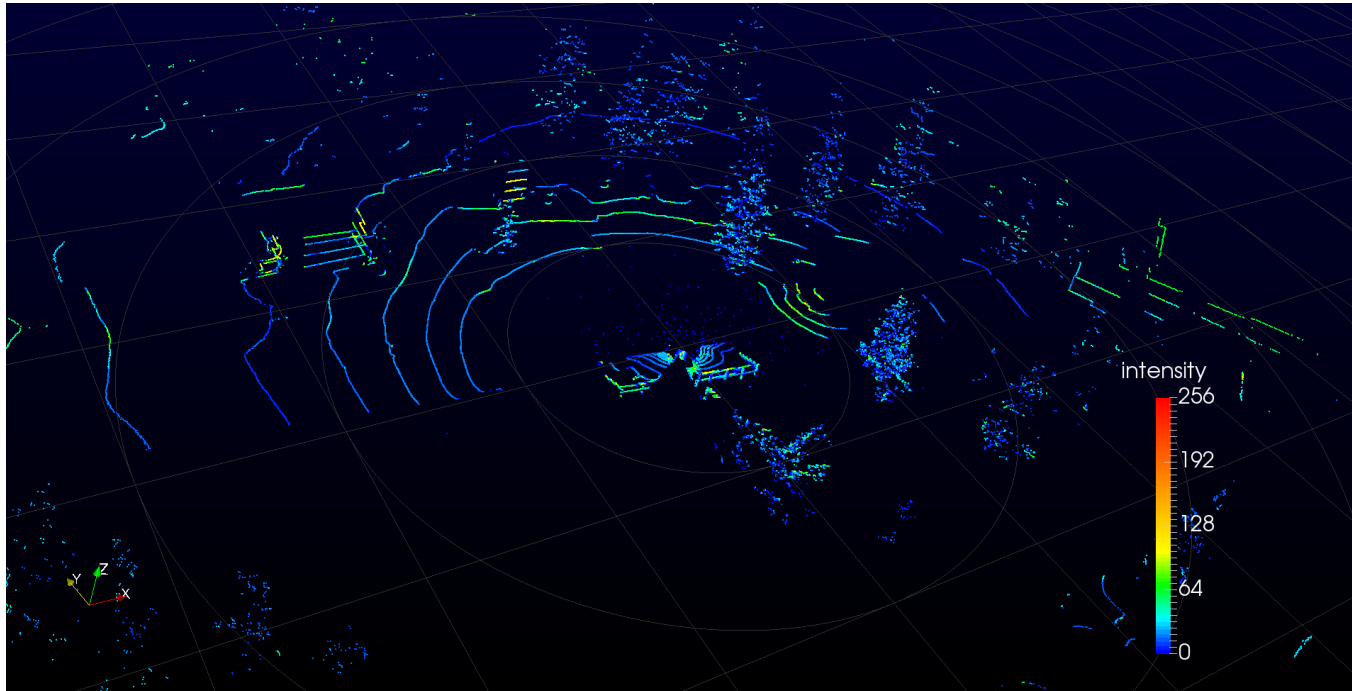
Lidar vs. photography
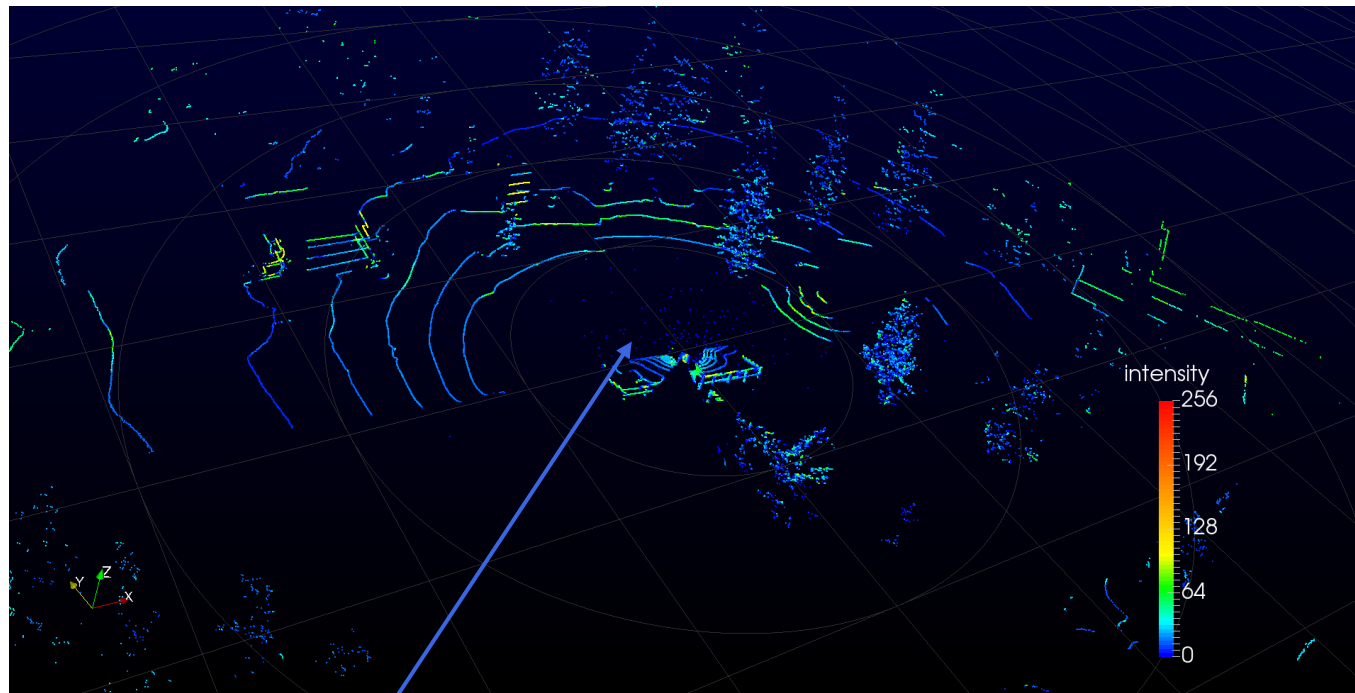
Snowfall visible in the vicinity of the Lidar sensor
(sorry for the bad contrast)

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Concept model of weather-based step-wise autonomous driving mode

Autonomous driving mode	Autonomous driving mode specifics	Road weather and driving conditions	Effect to sensors
0 Error	Must stop / No autonomous driving	Not defined	Unknown location or other error
1 Normal	No need to adjust speed nor driving	Fair weather. Good visibility and dry surface	-
2	Anticipate braking events by lowering speed, increase safety distance	Minor rain or snow / light snowdrift / light fog. Fairly good visibility and friction.	Lidar not detecting completely, camera detecting poorly
3 Difficult	Halve the speed, increase safety distance	Moderate rain or snow / moderate snowdrift / light or dense fog. Reduced visibility or friction.	Lidar not detecting completely, camera not detecting
4	Minimum speed, prepare to stop	Heavy rain or snow / high snowdrift / freezing rain / dense fog. Reduced visibility or friction.	Lidar not detecting completely, camera not detecting, radar not detecting completely, ice and snow on the sensors
5 Very difficult	Must stop / No autonomous driving	Heavy rain or snow / moderate or long lasting freezing rain / heavy fog. Very low visibility or friction.	Lidar and camera not detecting, radar detecting poorly, ice and snow on the sensors

- The driving mode system increases road safety by giving information about reduced driving conditions (friction or visibility).
- Speed and safety distances can be adjusted to enable safety driving
- The service is tested in Sodakylä, North Finland
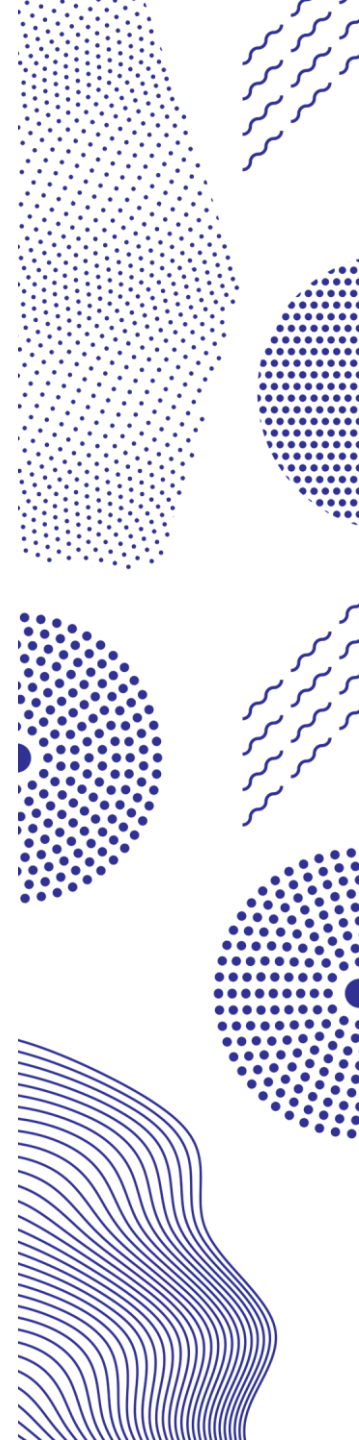
Next steps

- More detailed driving mode classification
- Determine the local driving conditions using
  - LiDAR data (precipitation intensity/form)
  - Vehicle camera
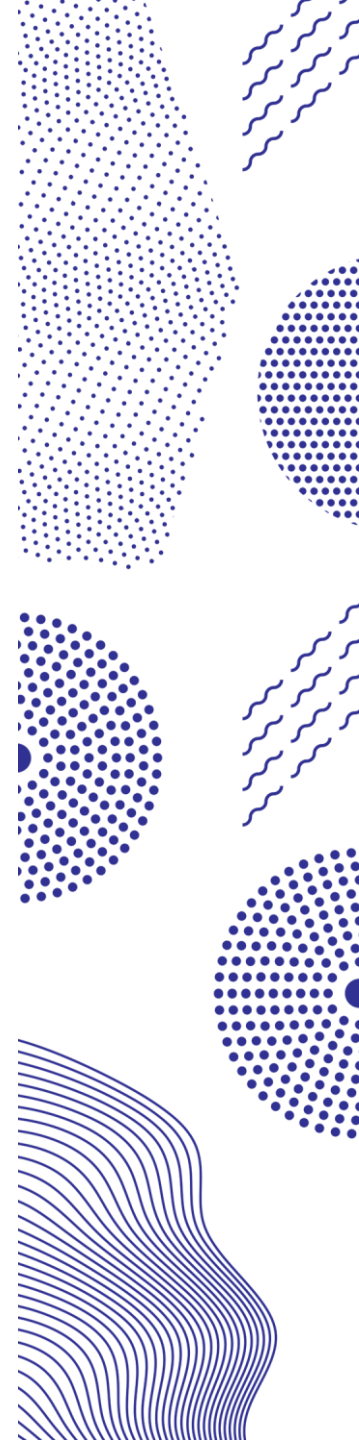
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Thank you for your attention!

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