Severe brain injury often results in the so-called disorders of consciousness. However, assessment of the level of consciousness on the basis of observation, is an immense difficulty. Particularly problematic is the diagnosis of unresponsive wakefulness syndrome (UWS; formerly vegetative state), in which the patient even though awaken from coma, does not show behavioral signs of consciousness. Absence of overt signs of intentional behavior may be related to the occurrence of severe motor dysfunction, in extreme cases causing locked-in syndrome (LIS), in which a person retains full awareness but is not able to control their own body. Due to the difficulties in diagnosis the error rate is as high as above 40%. Misdiagnosis may in turn impinge on such important issues as the decision to continue sustaining alive, as well as access to rehabilitation, medical care and prognosis of recovery.

General efforts are aimed towards the creation of methods based on neuroimaging techniques that allow diagnosis of the patient's level of consciousness independent of behavioral assessment. For this purpose, transcranial magnetic stimulation, electroencephalography or magnetic resonance imaging (functional or diffusion weighted). Developed techniques comprise both active and passive methods. Active methods assume patient's cooperation with the researcher. These procedures are based on the assumption that the most convincible way to find an answer to the question of whether the patient is consciously aware, is to use the method which will examine whether the patient is able to intentionally, mentally, follow researcher's commands. The most widely known procedure is the one used for the first time by Owen et al., (2006) in which the patient is alternately asked to perform two tasks, i.e. to imagine playing the game of tennis and imagine moving around her or his home or well known area. Consequently, this leads to a double dissociation of brain activity between tasks and on this basis allows to determine which task was performed by the patient at a given time. However, as practice shows, the active task may be too difficult for some patients to perform, also require cooperation from their side and is tiring for them. Therefore, this method often fail to give clear evidence of conscious command following even in people who are able to communicate with the environment to a limited extent in some other way. On the other hand, passive methods are assumed to permit an assessment of the state of patient's consciousness without his active participation in the study, e.g. on the basis of functional or structural connectivity measures. Therefore, passive methods are free of all the drawbacks of their active counterparts, are much easier to implement and are less burdensome for patients. However, creating them is much more challenging from both a theoretical and a methodological point of view. This is due to, inter alia, that regardless of the incremental progress in the field of consciousness studies, there is still no one consistent, widely accepted theory of the neural substrates of conscious awareness.

Understanding why some, even widespread brain damage cause relatively minor dysfunctions and other of a more focal nature can lead to a disturbance of consciousness is one of the main challenges for researchers working with DOC patients. Unraveling of this issue will ultimately allow predicting which of the DOC patients is consciously aware without relying on methods of behavioral assessment.
Fast development of the field of research on connections in the human brain, the so-called connectomics, contributed to the creation of specialized tools and methods allowing the analysis of the network structure in terms of both global and local organization. Measures have been developed for describing network characteristics affecting the efficiency of the network as a system of information processing. These measures can be used to characterize both functional networks, which depict large-scale neuronal dynamics and structural networks that describe white-matter connections between brain regions. Abnormalities in connectome are suggested to be important factor in neurological or psychiatric diseases and disruptions in organization of brain networks have been detected e.g. in case of schizophrenia. Also, recently study demonstrated that patients with DOC were characterized by altered global network properties of functional network, as well as altered properties in several areas important for conscious processing, that is in frontal, parietal and thalamic regions.

The main objective of this project is to develop a method able to distinguish the level of consciousness of patients with disorders of consciousness. For this purpose, diffusion-weighted imaging and resting-state functional magnetic resonance imaging will be used. These methods enable "reconstruction" of the organization of structural and functional connections in the patient's brain network and allow creating of metrics informing about the disruptions of these networks as compared to healthy subjects. The results of these analyses will be used to differentiate patients in different states of DOC and will also broaden the theoretical knowledge on the neural substrates of consciousness.