



# **DAMOCO Toolbox**

## **Brief illustration to the theory**

### **Coupled oscillators approach: main ideas and assumptions**

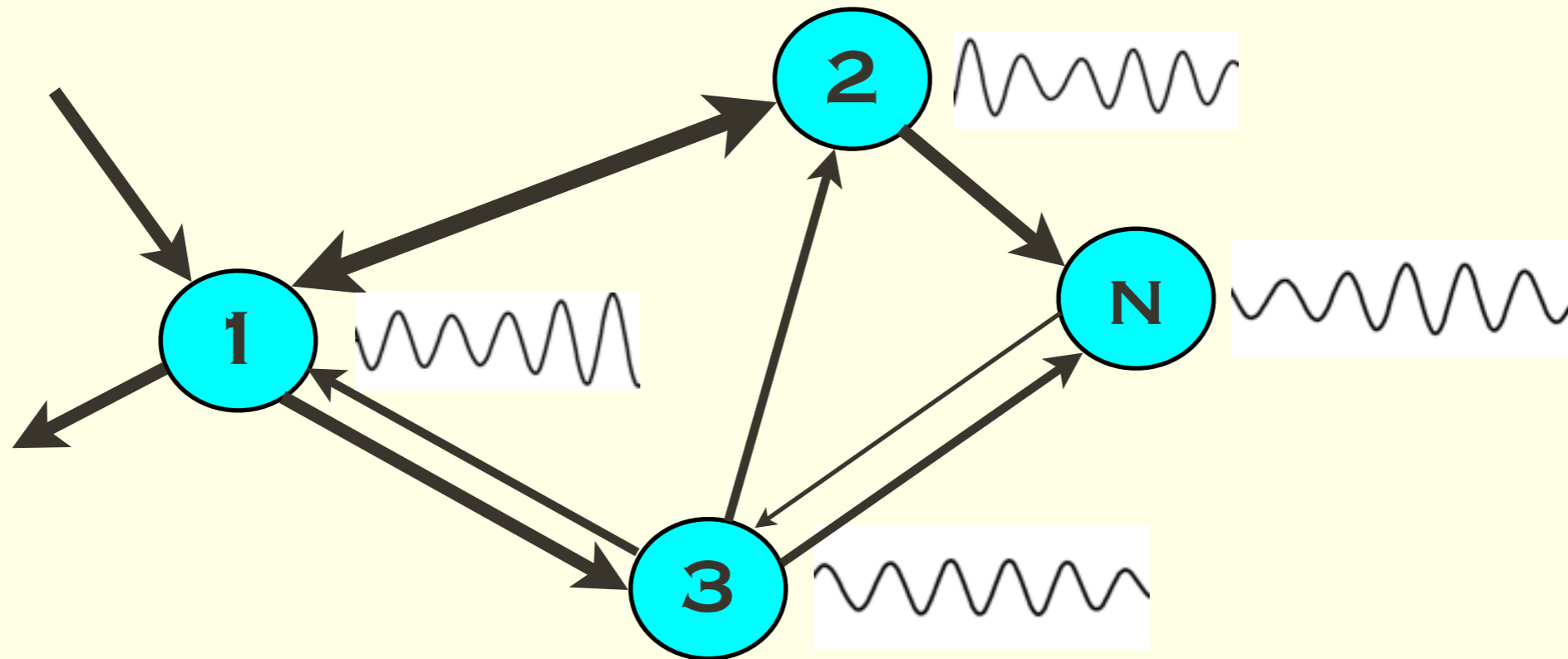
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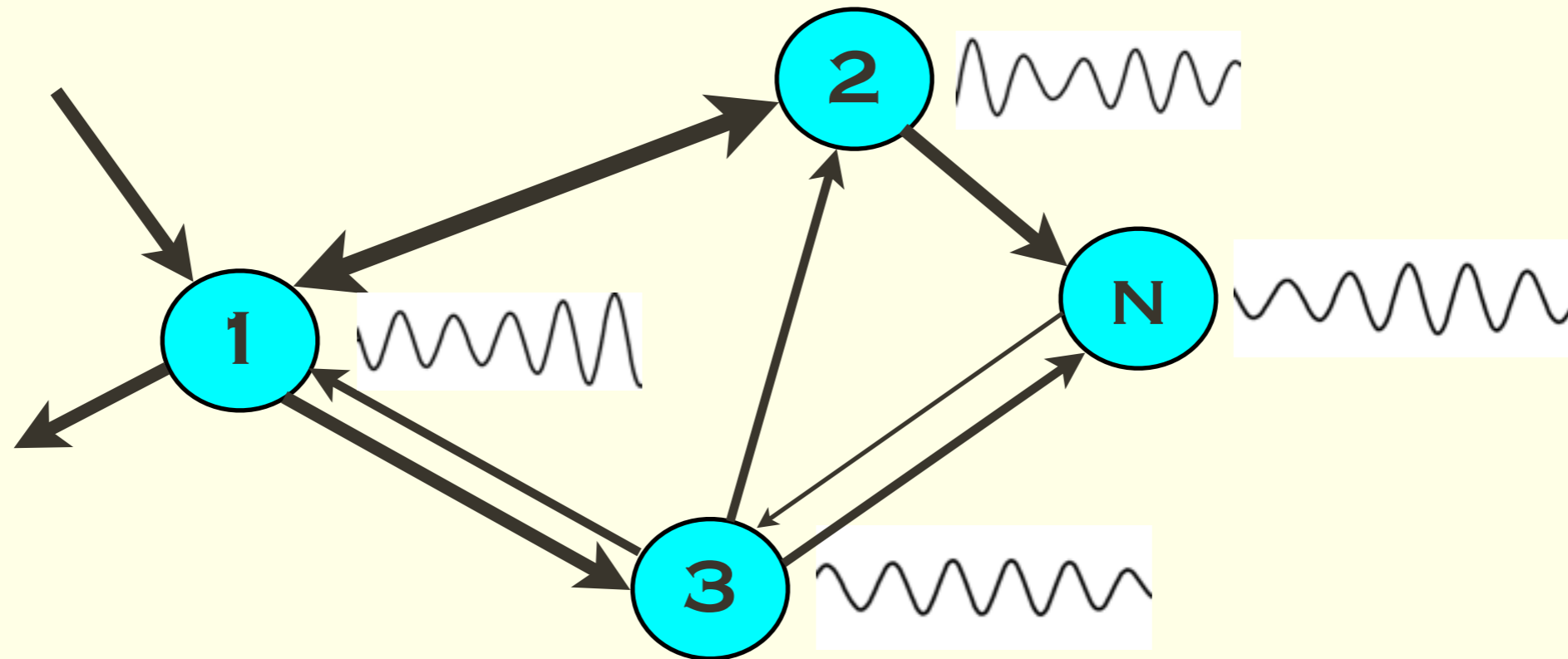
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# Formulation of the problem



- **Data:** we have oscillatory signals coming from several *weakly coupled self-sustained oscillators*
- **Our goal:** to say as much as possible about the systems and their interaction
- **Particular problem:** to reconstruct *directional connectivity*

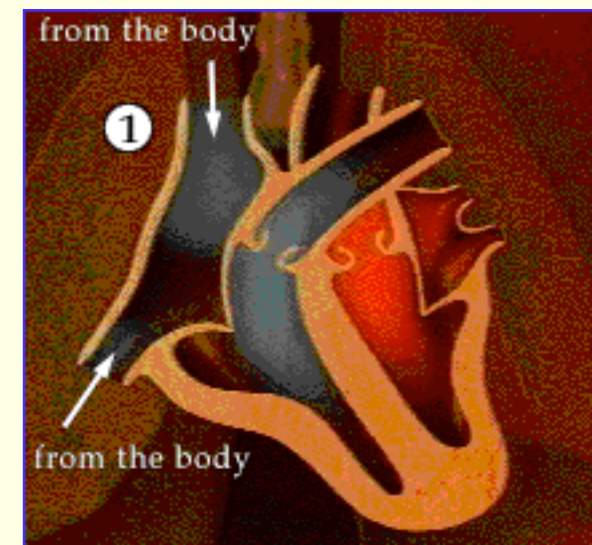
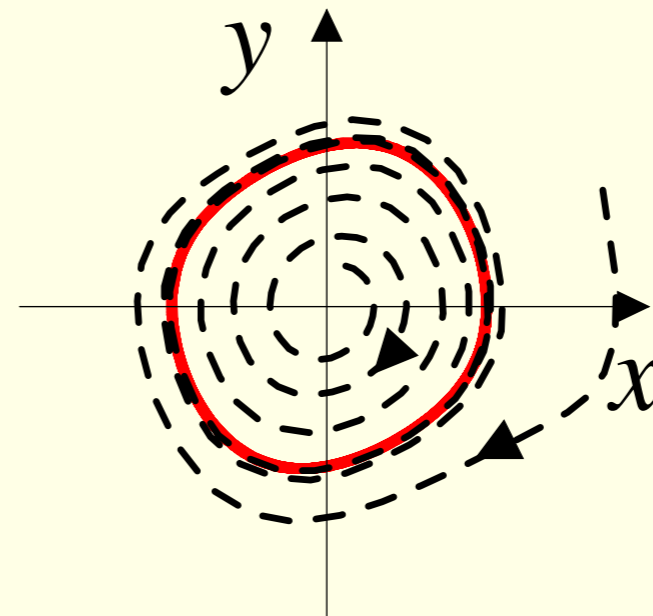
# General problem



- **Data:** we have oscillatory signals coming from several *weakly coupled self-sustained oscillators*

Active oscillators, systems  
generating endogenous rhythms

Dissipative nonlinear systems,  
limit cycle in the phase space



**Our approach: we quantify the  
interaction  
by reconstructing the model of  
phase dynamics from data**

Key idea: invariant (with respect to observables)  
model reconstruction

# Invariance of the reconstruction: an illustration



Suppose we analyze interaction of cardiovascular and respiratory systems



Suppose we measure respiratory flow, electrocardiogram, and arterial pulse

We quantify interaction using either respiratory flow and ECG or respiratory flow and arterial pulse

**Notice:** electrocardiogram and arterial pulse are different observables of the **same** system:  
hence, they should yield similar results!!

# Assumptions

- All nodes are *self-sustained oscillators*
- We measure outputs of all nodes
- The coupling is not too strong (each limit cycle is disturbed, but not destroyed)

# Problems

- To quantify the strength of synchrony (of interaction) between the nodes
- To quantify the **directional** interaction between the nodes
- To reveal the delay in coupling
- To recover autonomous frequencies