DAMOCO: MATLAB toolbox for multivariate data analysis, based on coupled oscillators approach
Example 1

January 16, 2011

1 Data and method

This example is implemented by the function `co_example1`; it uses the data file `co_vdp2.mat`. The data for this example are generated by a model of two bidirectionally coupled van der Pol oscillators:

$$\begin{aligned} \ddot{x}_1 - \mu(1-x_1^2)\dot{x}_1 + \omega_1^2 x = \varepsilon_1(\dot{x}_2 - \dot{x}_1) \ , \\ \ddot{x}_2 - \mu(1-x_2^2)\dot{x}_2 + \omega_2^2 x = \varepsilon_2(\dot{x}_1 - \dot{x}_2) \ . \end{aligned} \tag{1}$$

Parameters are: $\mu = 0.5$, $\omega_1 = 1.11$, $\omega_2 = 0.89$, and $\varepsilon_1 = \varepsilon_2 = 0.1$.
In this example, we use the high-level function, which computes everything, using default parameters. The Fourier-based technique is used, see manual and related publications for details. You need the matlab optimization toolbox to run this example.

2 Output and comments

```
Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the default value of the function tolerance, and
the problem appears regular as measured by the gradient.



Synchronization index from phases 0.22576
Directionality index -0.076845
```

Absence of synchrony is a requirement for the technique; it fails if the synchronization index is too high. As can be seen from the value of the synchronization index ≈ 0.23 and from Fig. (1), this requirement is fulfilled here.

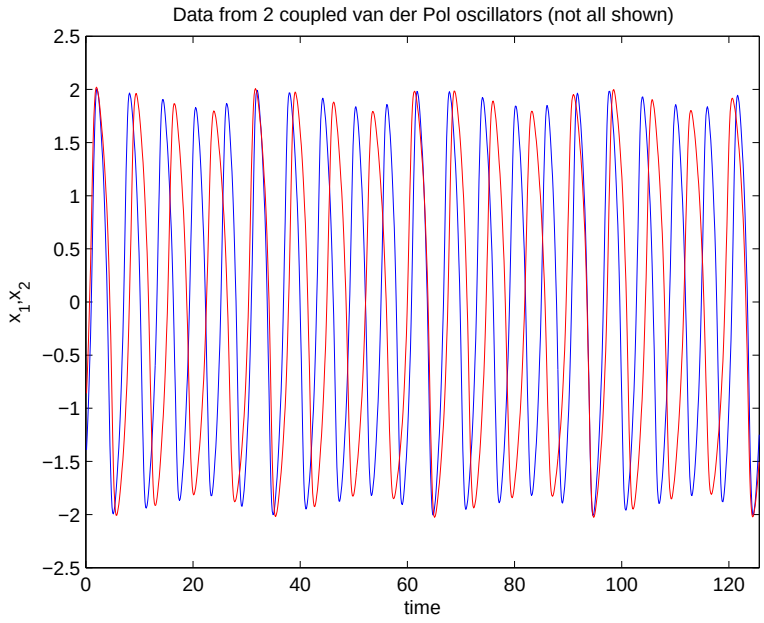

Figure 1: Data from coupled van der Pol oscillators.

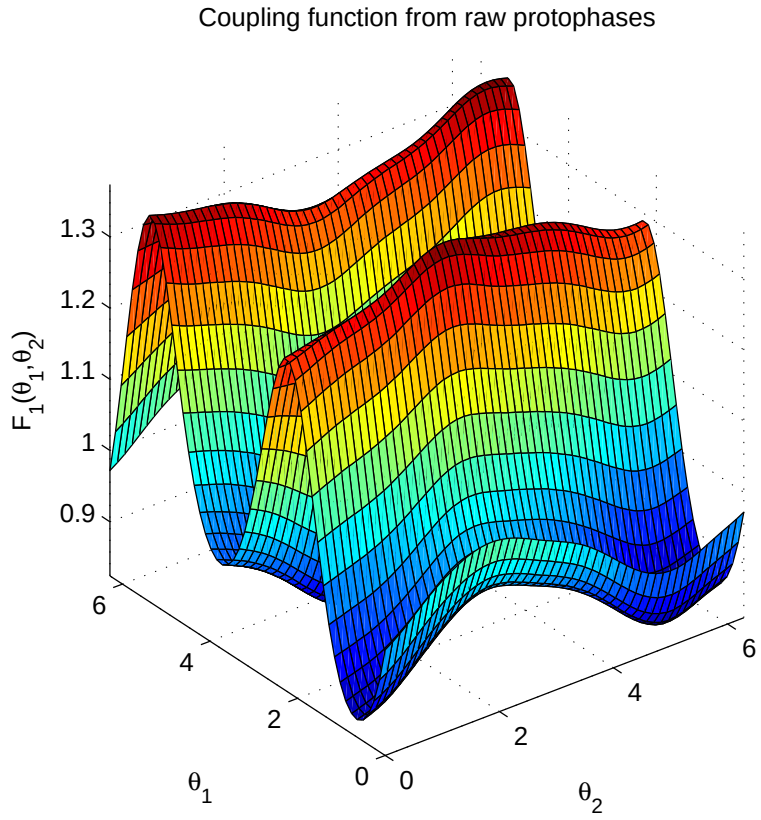

Figure 2: Coupling function constructed from protophases is dominated by the dependence on the own protophase θ_1.

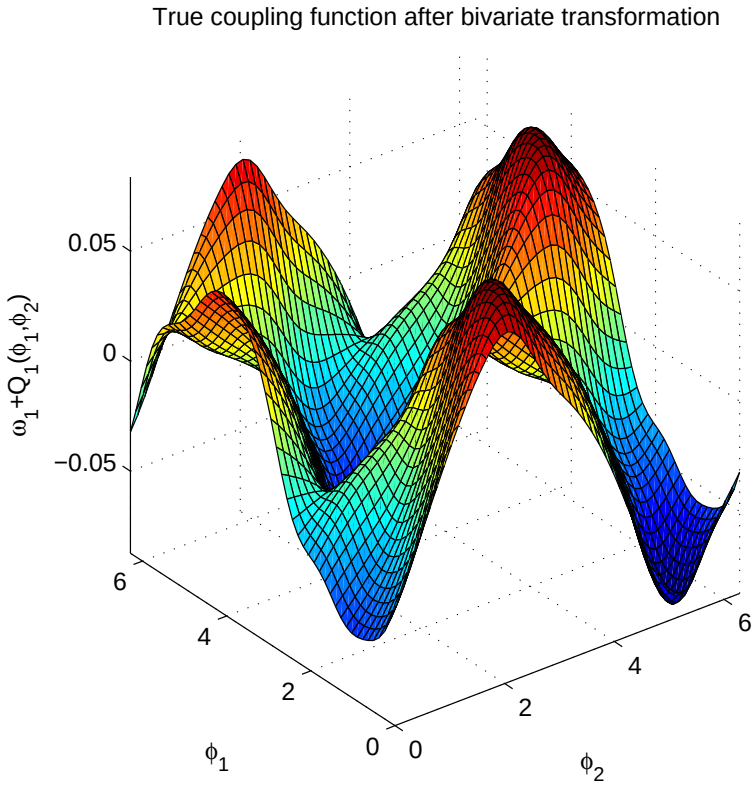

Figure 3: Coupling function, obtained after the transformation, correctly reveals the interaction.