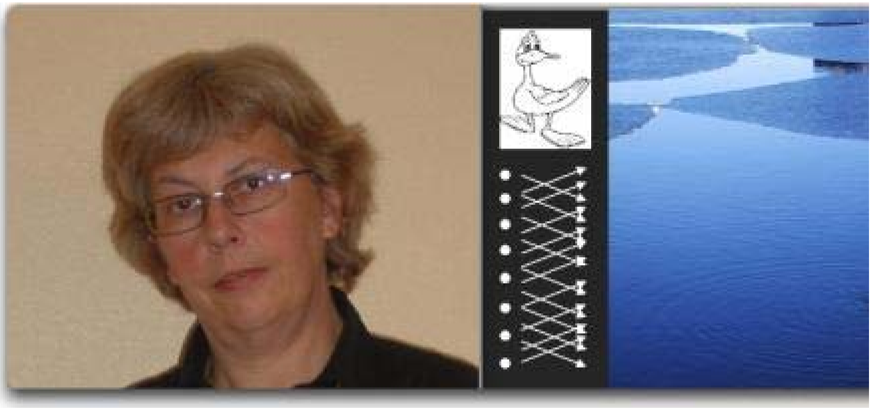
PHOCUS on reservoir computing

Thursday 25th February 2010



Reservoir computing illustrated by Hélène Paugam-Moisy Lyon University. Courtesy:http://www.lri.fr/~hpaugam/

Inspired by the fast processing of information in the human brain, a con European research institutions is developing a novel kind of computing. project "PHOCUS" started in January aims at designing photonic systei via light, to quickly perform complex computations including the rapid amounts of data, potentially consuming far less power than current supe

Recognising a friend's face in a crowd of people is a complex task for the bra only a fraction of a second. "It is one of the biggest unresolved questions in brain research, how the electrical discharges of billions of neurons are organised to deliver correct answers in such a short time," says Claudio Mirasso, (*right*) the project coordinator of the Universitat de les Illes Balears. "However, in recent years a paradigm has been developed in neuroscience that might lead to an answer," adds Mirasso.

Neuroscientists exploit an analogy between the human brain's response to external stimuli and the reaction of a liquid to external perturbations, such as into water.

From the waves generated by the impact, one can conclude where and when surface. Similarly, it could be possible to draw information about external sti transient responses of neural networks. These networks into which stimuli or referred to as 'reservoirs'.

However, the existing computer models of neural networks are difficult to tra
interactions among the model's elements have to be carefully re-adjusted for
The concept of reservoir computing avoids this problem by leaving the reserv
training only the readout of processed data.

"Preliminary experiments indicate that this is fa
training the reservoir itself," says **(left)** Jürgen
Potsdam-Institute for Climate Impact Research

So how does reservoir computing work? Like a
water surface, external stimuli or 'inputs' rema
reservoir for a certain time. This memory of the
combination with the emerging response of the
transforms the input into a large number of dyn
reservoir, thus creating a high-dimensional stat

The trick of reservoir computing is that the rese
different inputs are easier to identify in this hig
space than in the original, lower dimensional in
number of dimensions of the input space corresponding to the number of feat
recognise a known face, for example. It has been shown that the identificatio
dimensional state space can be used to classify different inputs.

Complex collective behaviour exhibited by coupled nonlinear dynamical syst
the reservoir's memory of the input and its emerging response, is at the core

The understanding of coupled complex systems' dynamics and in particular t
synchronization properties has been significantly advanced in recent years. P
played a key role in these studies and demonstrate the usefulness of complex

Scientific interactions between laser and nonlinear dynamics physicists, neur
brain researchers, led to the idea that photonic systems could be used to unde
eventually mimic some of the functionalities of the brain.

The realisation of reservoir computing using photonic systems offers great op
imposes even more challenges. Photonic systems allow for extremely fast pro
compatible with telecommunication technology. Integration of larger photoni
however, technologically challenging and expensive.

The *"Towards a PHOtonic liquid state machine based on delay-CoUpled Sys*
consortium has identified a new approach to realise the functionality of a con
only few photonic components. The basic idea is to use the generically occur
feedback and coupling of one or a few semiconductor lasers to generate a ver
state space. Ultimately, PHOCUS aims at photonic implementations of reserv
operating at high data rates. This would offer alternatives to supercomputers
clusters for specific tasks requiring reduced size and less power consumption

With a budget of €2,394,000 the PHOCUS consortium project, is being co-or

Universitat de les Illes Balears, Spain, with the partners the Consejo Superior de Investigaciones Cientificas, Spain, the Frankfurt Institute for Advanced Studies, Germany, the Université de Franche-Comte, France, the Universidad de Cantabria, Spain, the Potsdam Institute for Climate Impact Research, Germany, and the Vrije Universiteit Brussel, Belgium, and will run for three years.
