DY 22 Networks

Zeit: Samstag 11:30–13:00 Raum: TU H2032

DY 22.1 Sa 11:30 TU H2032

Active Control of Bipedal Locomotion — •Joachim Hass[1,2], J. Michael Herrmann[1], and Theo Geisel[1,2] — [1]Georg-August-Universität Göttingen — [2]MPI für Strömungsforschung

Passive walking machines can be realized by multiple inverted pendula with the pivot switching at each step. At small descending slopes walking cycles exist which are barely stable, but practically stability requires – in addition to fine-tuned parameters – an active suppression of perturbations. We show that control methods based on multi-step optimization of a discretized controller or on adaptive feedback are both effective in stabilizing the gait while relying only on adjusting damping constants. The energy consumption necessary e.g. at uphill motion can be controlled by the same methods. While the former method requires extensive training, the latter one adapts quickly and is realizable as a biologically plausible tuning scheme of a central pattern generator. After adaptation the CPG is sensitive to repeated features of the stride and may function as the target of high-level control. In addition we describe implications for the analysis of human gait and the control of leg prostheses.

DY 22.2 Sa 11:45 TU H2032

Neural Networks for Gamma-Hadron-Separation — •Christoph Kolodziejski and Georg Reents — Institiut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg

The MAGIC-Telescope, an atmospheric imaging Cherenkov telescope in La Palma, gathers information in form of patterns of different types of particles. The interest is focused on the detection of gamma-rays. Compared to cosmic Cherenkov radiation signals they only constitute minor contributions, but look very alike. With the help of neural networks, a better separation than the currently used statistical algorithms is likely to be found. Different types of networks (e.g. Feed-Forward Multilayer Perceptrons, Pulsed Coupled Neural Nets) are analyzed to achieve this task.

DY 22.3 Sa 12:00 TU H2032

Synchronization in a net of FitzHugh-Nagumo neurons — •A. Skupin[1] and L. Schimansky-Geier[2] — [1]Hahn-Meitner-Institut Glienicker Str. 100 14109 Berlin — [2]Humboldt University Newtonstr. 15 12489 Berlin

While musing on Synchronization of clocks 100 years ago has led to Einsteins theory of relativity nowadays Synchronization plays an important role in different fields of science, specially in Statisical Physics, the other theory Einstein has instituted in his mirical year. In the last three decades Synchronization was detected as an important feature in neurophysiology, where different diseases like Parkinson disease can be explained by Synchronization of neurons. Thus motivated we study a net of FitzHugh-Nagumo neurons and its behaviour to an external stimulation and delay coupling. This will be compared with the Kuramoto model and a gaussian approximation.

DY 22.4 Sa 12:15 TU H2032

Der wechselseitige Einfluss von Struktur und Dynamik in einem Polymeren Netzwerk — •Michael Lang, Marcus Wacha, Dietmar Göritz und Stefan Kreitmeier — Fakultät für Physik, AG Polymerphysik, Universität Regensburg, 93040 Regensburg

Dynamische Computer-Simulationen von polymeren Netzwerken und Einzelkettensystemen ermöglichen es, den wechselseitigen Einfluss von Netzwerkstruktur und Dynamik zu analysieren. Bei der Entstehung eines Netzwerkes ist es die Dynamik der einzelnen Moleküle, die einen wesentlichen Einfluss auf die Kinetik der Reaktion und damit auf die Entstehung der Netzwerkstruktur besitzt: Moleküle mit einer erhöhten Beweglichkeit besitzen eine größere Reaktionsgeschwindigkeit, da im gleichen Zeitintervall eine größere Anzahl von möglichen Reaktionspartnern erreicht werden kann. Aus der Statistik der Netzwerkbildung kann so eine Aussage über die Zusammensetzung der Netzwerkstruktur gewonnen werden. Diese Struktur ist es aber, die im Netzwerk wiederum die Dynamik der einzelnen Moleküle bestimmt. Dies wird exemplarisch anhand von Einzelkettensimulationen und Deformationen von Netzwerken gezeigt.

DY 22.5 Sa 12:30 TU H2032

Network properties of meteorological stations in the river Elbe basin quantified by phase synchronization — •Diego Rybski[1], Shlomo Havlin[2] und Armin Bunde[1] — [1]Institut für Theoretische Physik III, Universität Gießen, Germany — [2]Minerva Center and Department of Physics, Bar-Ilan University, Ramat-Gan, Israel

We study the phase synchronization of 317 daily precipitation records from meteorological stations located in the river Elbe basin by calculating for each pair (i, j) of records the synchronization index $\rho(i, j)$ based on the Shanon entropy, see, e.g., [1] and references therein. By shifting the time series relative to each other we determine the time delay that yields the maximum index $\rho_{max}(i, j)$. We find that $\rho_{max}(i, j)$ decays logarithmically with the distance d_{ij} between both sites. In order to study the network structure of phase synchronized sites, we determine the best fit $\overline{\rho_{max}}(d)$ of $\rho_{max}(d_{ij})$ and use the deviations $\Delta_{ij} = \rho_{max}(i, j) - \overline{\rho_{max}}(d)$ as nontrivial indicators of the bond strength between both sites. We consider those sites (i, j) as connected where the relative synchronization index Δ_{ij} exceeds a certain threshold value Δ_0, and discuss the network properties as a function of Δ_0. We show that they are distinctively different from the corresponding randomized system.

[1] D. Rybski, S. Havlin, A. Bunde, Physica A 320 (2003) 601.

DY 22.6 Sa 12:45 TU H2032

Arbitrarily Long Spike Patterns in Heterogenous Neural Networks — •Raoul-Martin Memmesheimer, Marc Timme, and Theo Geisel — Max-Planck-Institut für Strömungsforschung, D-37073 Göttingen

Patterns of precisely timed spikes are believed to be functional correlates of stimuli and as such considered key elements of brain computation [1]. A central question of theoretical neuroscience is thus how spike patterns can emerge in the dynamics of neural networks. Here we show that prescribed periodic spike patterns of arbitrary length can be stored as the attractors of heterogenous networks of neural oscillators with delayed inhibitory interactions [2, 3], generalizing [4]. We analyze the impact of specific coupling heterogeneity on the precise timings of individual spikes.

[1] M. Abeles, *Science* **304**:523 (2004).
[2] R.E. Mirollo, S.H. Strogatz, *SIAM J. Appl. Math.* **50**:1645 (1990).
[3] U. Ernst, K. Pawelzik, T. Geisel, *Phys. Rev. Lett.* **74**:1570 (1995).
[4] M. Denker, M. Timme, M. Diesmann, F. Wolf, T. Geisel, *Phys. Rev. Lett.* **92**:074103 (2004).