# Die Fliege im Honigtopf – BrainScaleS-2 aus Heidelberg

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Messung aus Novak und Wheeler (1988).



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## BrainScaleS-2 – Überblick



- Hybrides neuromorphes System, 65 nm CMOS
- 1000 × schneller als die Biologie
- 512 AdEx Neuronen
- 512 × 256 Synapsen
- Zwei Mikroprozessoren mit Vektorbefehlssatz

## Blitzschnelle Klassifizierung mit biologischen Modellen



Kriener, Göltz und Petrovici (2022)



Cramer, Stradmann u. a. (2022)

7210414459069015 94166740740131 941664550740147573217 762697349734973217 9162697349921673147 916269734992613247 85662069731976767485 85166206546015156021 216518185514425014 18181850364201439

Göltz u. a. (2021) und Cramer, Billaudelle u. a. (2022)

Am Beispiel handgeschriebener Zahlen:

- 85 000 erkannte Bilder pro Sekunde
- Energieverbrauch: 2.4 μJ pro Bild

## Blitzschnelle Klassifizierung mit biologischen Modellen

| 844683233472506481480645731750006750406061899644426344110189780356844173284818411177777451149811261417643684901   | 163183436763(021                        |
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| 13/14/11/123/0204308011134500043080001325034/14493512/F+04/123/14474705717449394050970197833  | 770//////////////////////////////////// |
| 35708773637074037085308574874848470242556798030347750108663+34477014864101486415774574148060  | 4270/44/434/9552                        |
| 407058678967896759416704950489596857918647512648735457711547643246841841542092752403(94121790474729528474   | * 5 3 7 6 8 4 9 8 / 5 6 5 4 7 6         |
| 1304848818048011433875648475528142472932964020066218973533236545864016236910220270446783620286702884048631  | 562650734/313343                        |
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| \\$YC7\$34637(\$2)1\$000///236979796039225##5\$82\$028/118845\484439441656\34\$1829097\364/665420/1\$182323737/22   | 5519100182704044                        |
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|   | 1646240013511105                        |
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|   |   |

#### Künstliche Netzwerke erkennen Vorhofflimmern







- Klassifizierung von 2-Kanal EKGs
  - Sinusrhythmus
  - Vorhofflimmern
- 276 µs pro Patient
- 5.6 W Systemleistung

Experiment aus Stradmann u. a. (2021)

# Honigbienen im Geschwindigkeitsrausch



## Robotik?



## Robotik? - schwierig!



# Ausblick: Heraus aus dem Honigtopf!





# Ausblick: Heraus aus dem Honigtopf!







## Ausblick: Heraus aus dem Honigtopf!





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