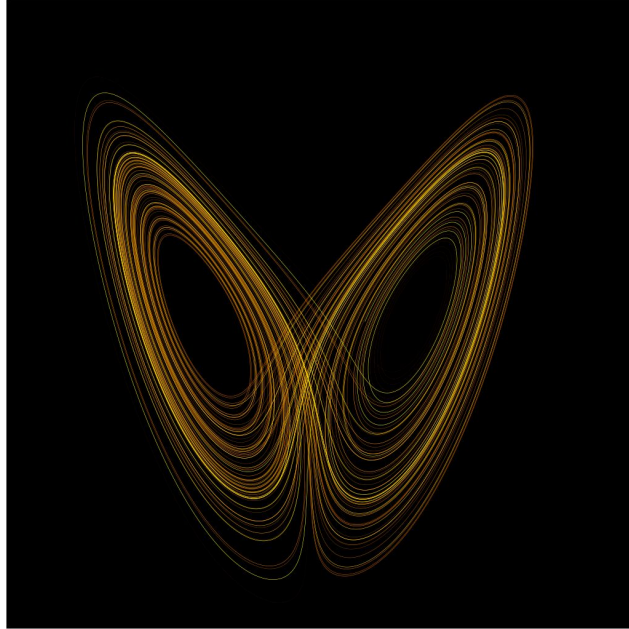# Computational Linguistics Seminar

LING 7710
Marten van Schijndel

# Topic

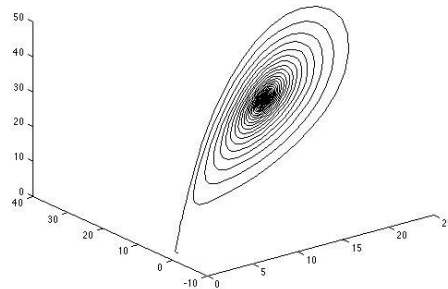Going to focus on "Emergent meaning" and "Dynamical systems"
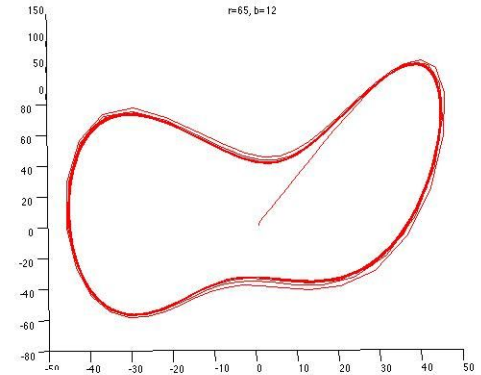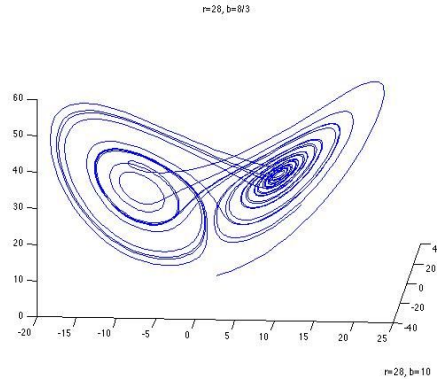
# Lorenz (Fetter, Hamilton) attractor

3 simple deterministic equations (x, y, z are variable)

$$\frac{\mathrm{d}x}{\mathrm{d}t} = \sigma(y - x),$$

$$\frac{\mathrm{d}y}{\mathrm{d}t} = x(\rho - z) - y,$$

$$\frac{\mathrm{d}z}{\mathrm{d}t} = xy - \beta z.$$



r=28, b=8/3



r=65, b=12



r=28, b=10

# Bottleneck principle



"bottleneck" hidden layer

Input layer

Output layer
(reconstruction
of input layer)

All layers are fully connected but not drawn
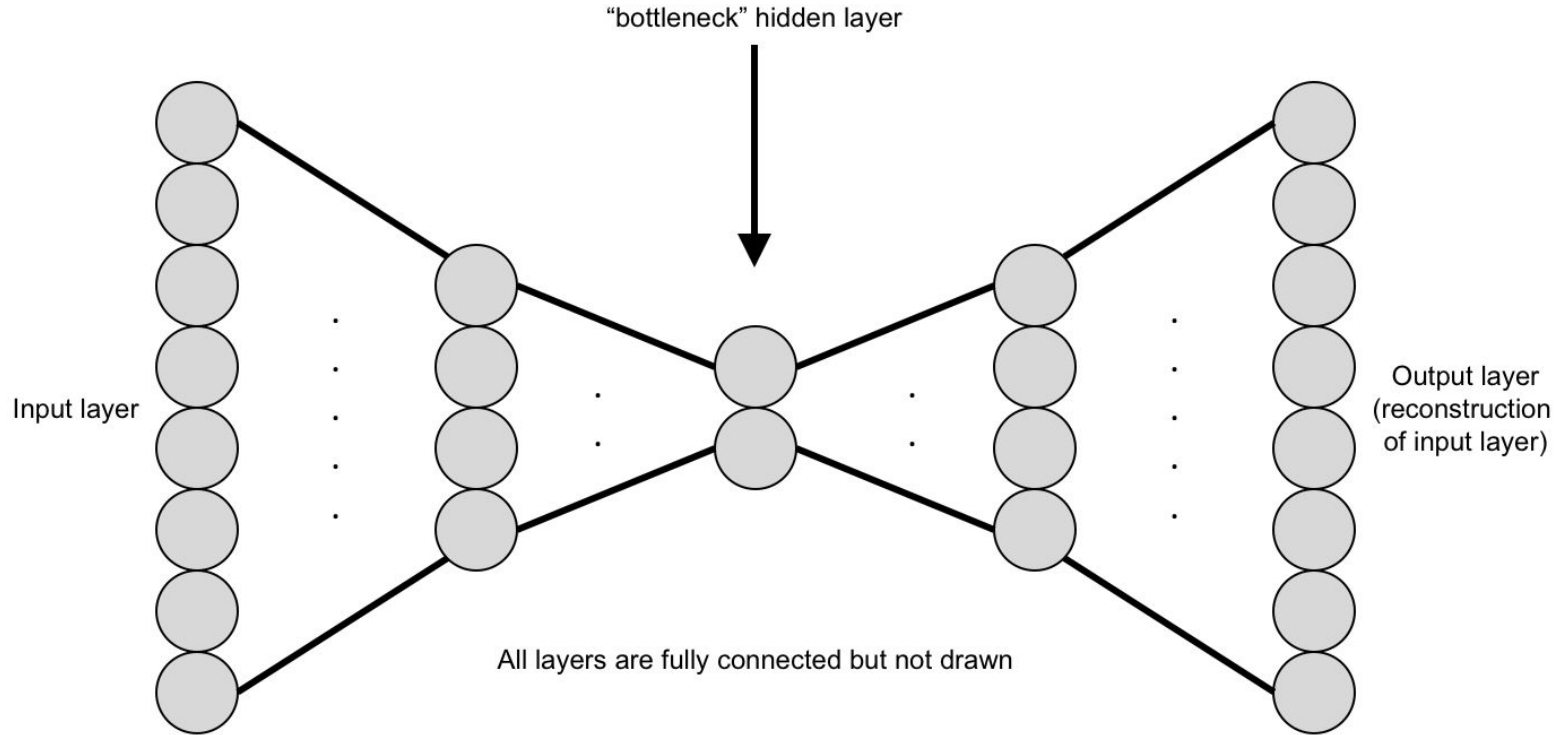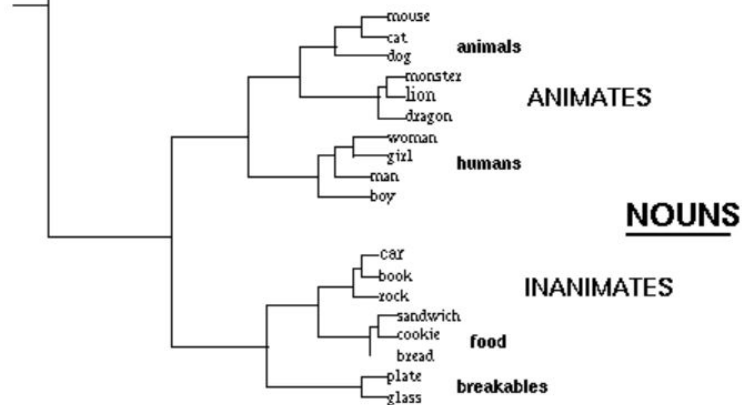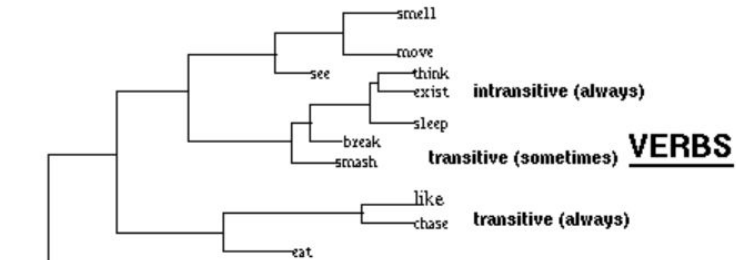
# Two views of "words" (Elman, 1995)

1) "Words are objects of processing. … [They] must be accessed, recognized, and retrieved from permanent storage. Following this, the internal representations have to be inserted into a grammatical structure."

2) "Words are not the objects of processing as much as they are inputs which drive the processor in a more direct manner… as operators rather than as operands… [They] operate on the network's internal state and move it to another position in state space."

Elman (1995)
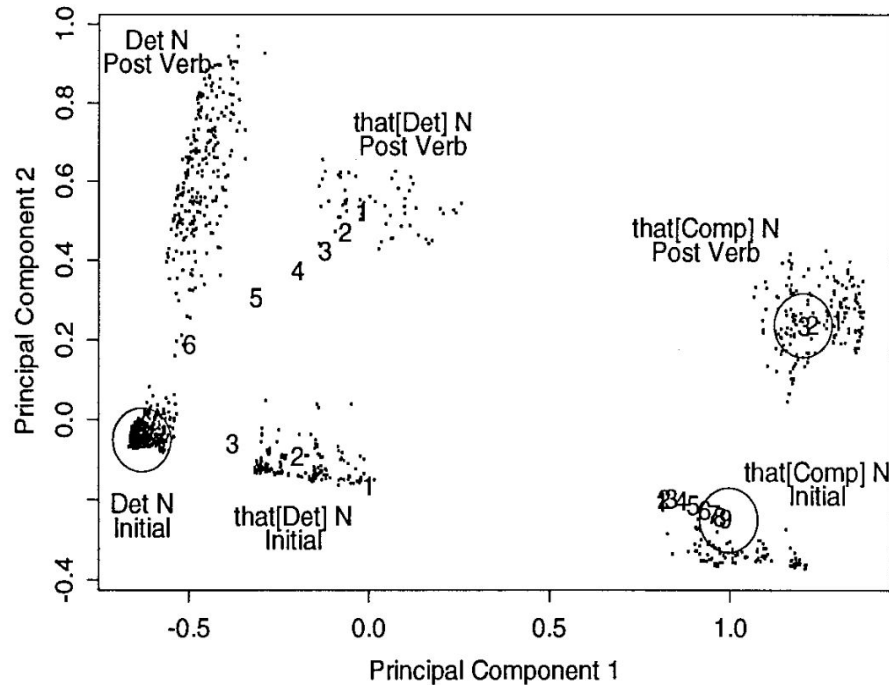
Tabor (1997)

# Elman on distributed semantics/syntax

What the network learns over time is what response it should make to different words, taking context into account. Because words have reliable and systematic effects on behavior, it is not surprising that all instances of a given word should result in states which are tightly clustered, or that grammatically or semantically related words should produce similar effects on the network. We might choose to think of the internal state that the network is in when it processes a word as representing that word (in context), but it is more accurate to think of that state as the result of processing the word, rather than as a representation of the word itself.

# Elman on Language as dynamical system

Instead of a dictionary-like lexicon, we have a state space partitioned into various regions.

Instead of symbolic rules and phrase structure trees, we have a dynamical system in which grammatical constructions are represented by trajectories through state space

# Some Implications

Ellipsis / Argument structure: A gives B to C

Did you give to charity? I gave last week.

Types vs Tokens: Binding vs subspaces

Priming mechanisms

# Structure of class

- Read papers
- Role playing discussion!
  (https://colinraffel.com/blog/role-playing-seminar.html)
- Concluding with 1 or 2 group projects that explore these topics
- Syllabus

# Scheduling

# Next time

Guest and Martin (2021)

Probably Tabor et al (2004)

Bring paper suggestions!