



From Neural  
Activation to  
Symbolic  
Alignment

Alexander Mehler,  
Andy Lücking,  
Peter Menke

Dialogue  
Networks

Data

Classification

Conclusions

# From Neural Activation to Symbolic Alignment

A Network-Based Approach to the Formation of  
Dialog Lexica

Alexander Mehler    **Andy Lücking**    Peter Menke

Text Technology Group, Goethe-Universität Frankfurt am Main  
CRC 673 "Alignment in Communication", Bielefeld University

*International Joint Conference on Neural Networks*  
San Jose, California, July 31 – August 5, 2011



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## Egyptian Museum in San Jose invites public to Epagomenal festival July 16 and 17

Dress like an Egyptian and you can win a prize at the annual Egyptian Epagomenal Festival July 16 and 17 at the Rosicrucian Egyptian Museum. The two days of events feature special activities for adults, including lectures, while children can make cornhusk mummies, jewelry, senet game boards and shabtis, the small figures buried with pharaohs in their tombs.

Mary Gottschalk, Posted: 07/11/2011 07:31:43 PM



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Coherence – **by folklore**, and **in San Jose**



# Alignment in Communication

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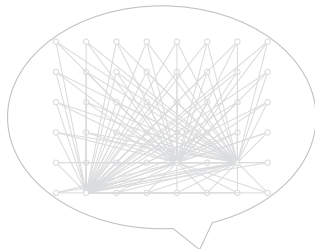
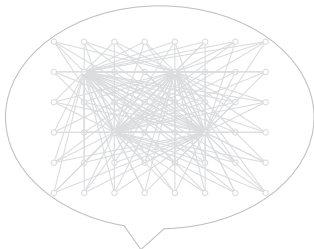
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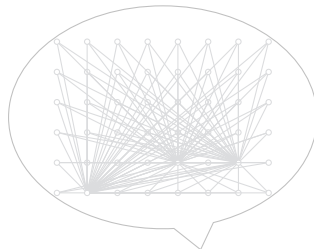
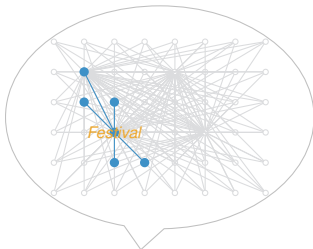
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) ) ) /Festival/





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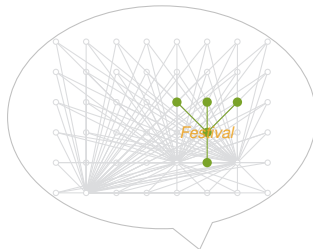
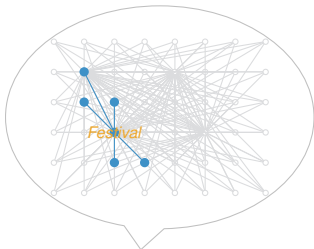
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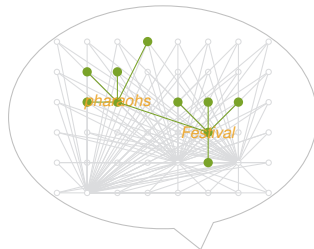
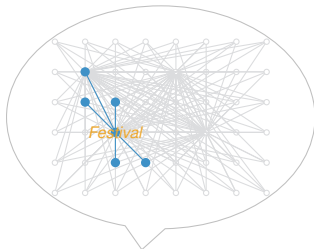
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/pharaohs/ ( ( (





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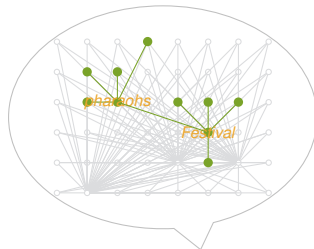
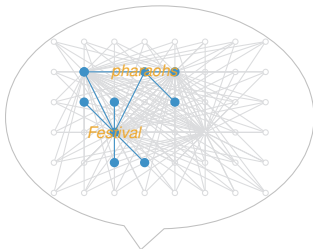
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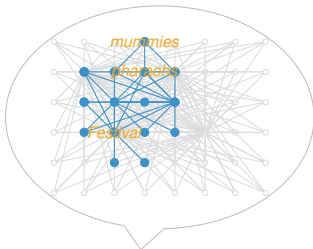
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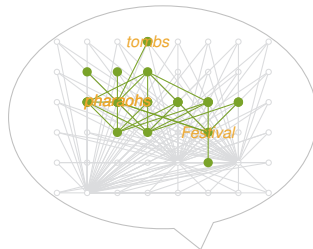
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# Interactive Alignment Model

Pickering and Garrod (2004)

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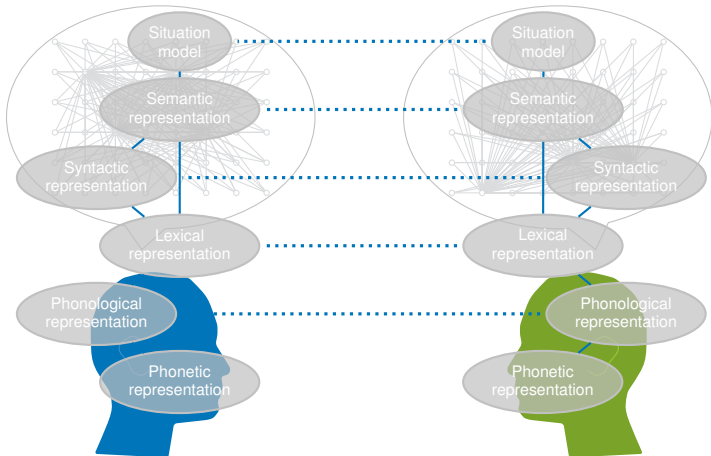
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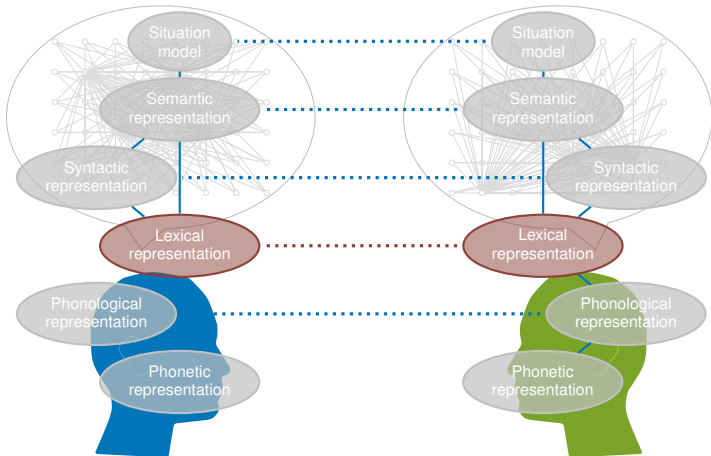
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# Features of Alignment

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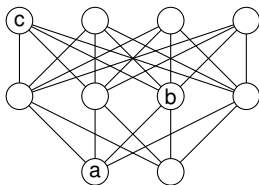
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## Alignment

- is operative on mental representations
- is non-intentional
- brings about routinized repetitive behavior
- different and differentiable from non-alignment





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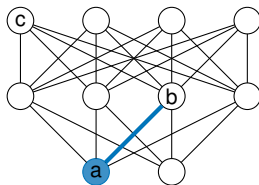
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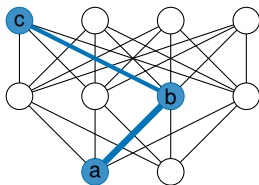
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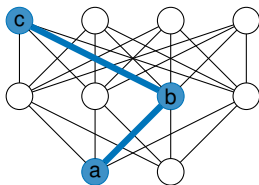
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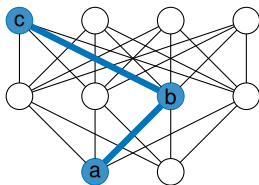
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- is operative on mental representations
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- different and differentiable from non-alignment ?







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# Two-Level Time Aligned Network Series (TiTAN)

Mehler, Lücking, and Weiß (2010)

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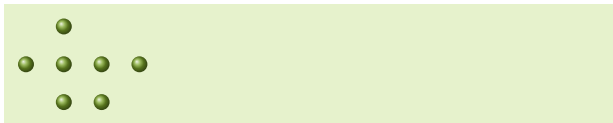
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$t$   
time line



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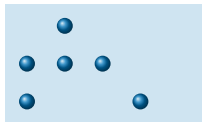
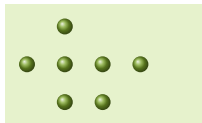
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$t$   
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Networking of dialogue  
lexica according to refer-  
ential use of lexical items



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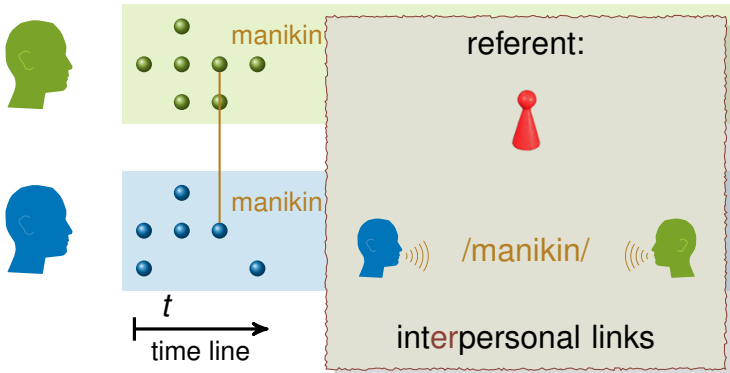
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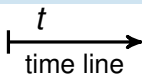
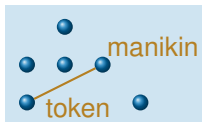
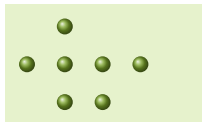
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referent:



/manikin/  
/token/

intrapersonal links



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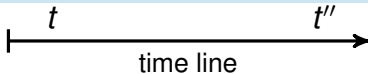
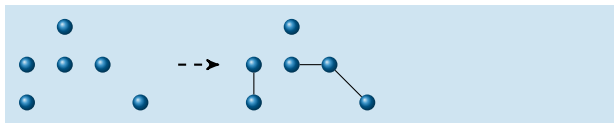
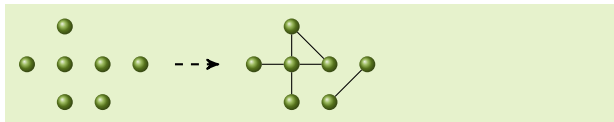
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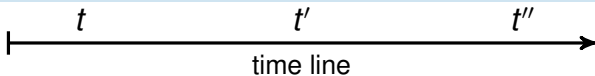
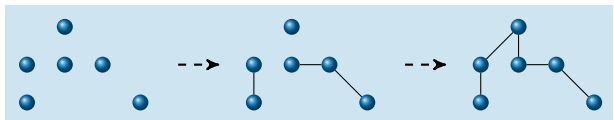
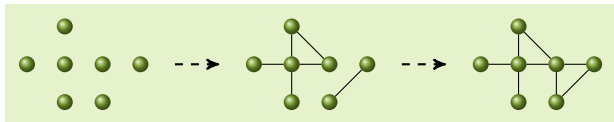
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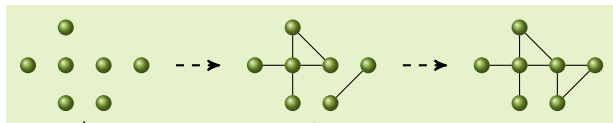
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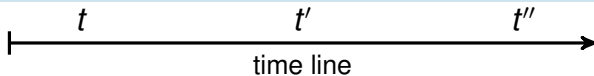
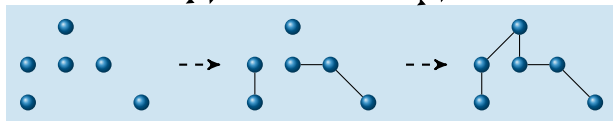
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turn taking







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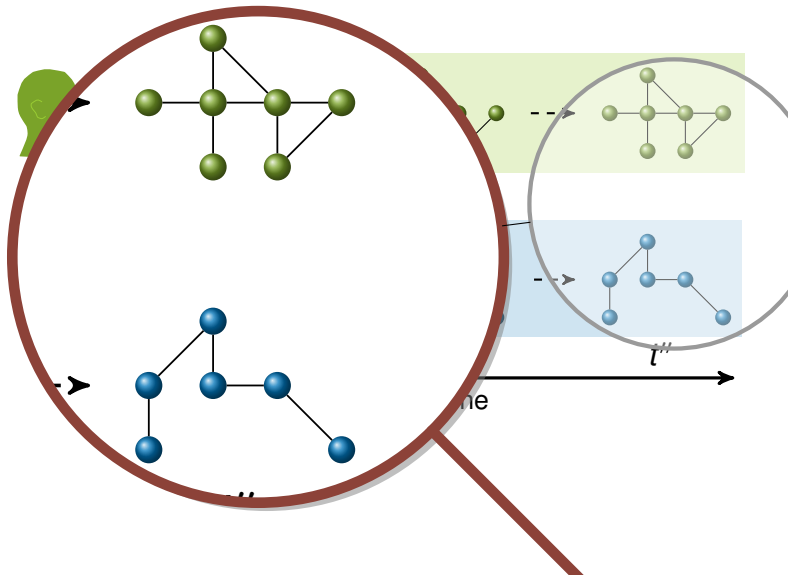
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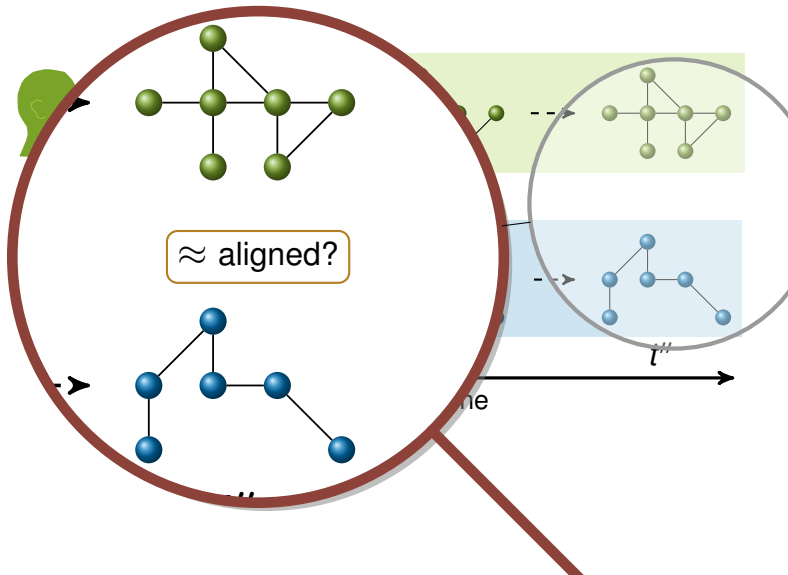
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# Graph Distance Measurement

Mehler, Lücking, and Weiß (2010)

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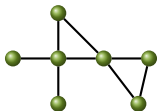
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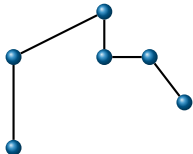
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$G_1$



$G_2$



$$D(G_1, G_2)|_{(v,w)} = 1 - \frac{I(v; w)}{\max\{H(v), H(w)\}} \in [0, 1]$$



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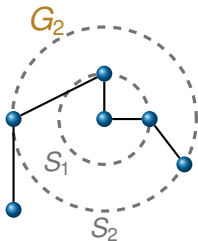
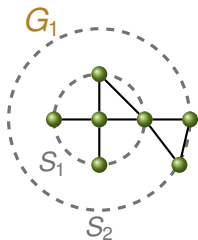
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$$D(G_1, G_2)|_{(v,w)} = 1 - \frac{I(v; w)}{\max\{H(v), H(w)\}} \in [0, 1]$$

$$I(v; w) = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \frac{|S_{i,j}(v, w)|}{n} \log_2 \frac{\frac{|S_{i,j}(v, w)|}{n}}{\frac{|S_i(v)|}{n} \cdot \frac{|S_j(w)|}{n}}$$

$$H(v) = - \sum_{i=0}^{n-1} \frac{|S_i(v)|}{n} \log_2 \frac{|S_i(v)|}{n}$$



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# Jigsaw Map Game

Weiß et al. (2008)

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## Experimental study on alignment of object naming

- controlled face-to-face dialogues
- task: cooperative, interchanging positioning of objects on a map



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## Critical objects to be Named and Located



clothespin



pencil



button

cuboids



brick or block

cone



manikin or token

round component



bowl or ball



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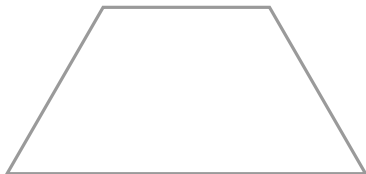
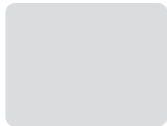
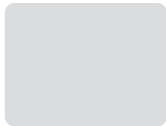
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## Playing the Game!







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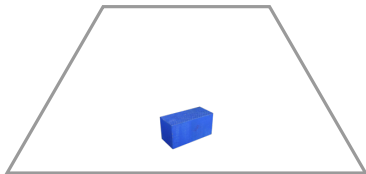
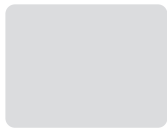
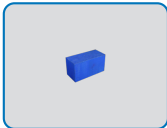
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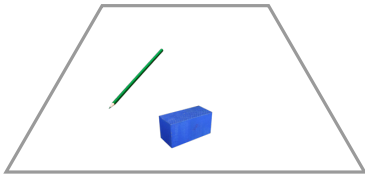
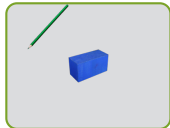
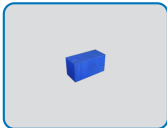
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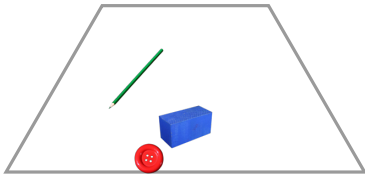
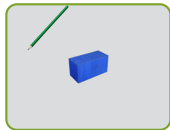
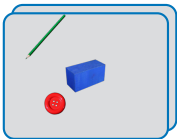
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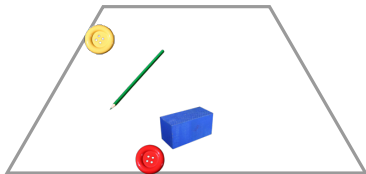
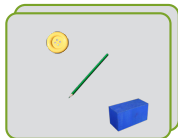
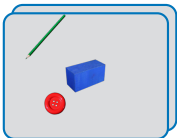
Dialogue  
Networks

Data

Classification

Conclusions

## Playing the Game!





# Jigsaw Map Game

Weiß et al. (2008)

From Neural  
Activation to  
Symbolic  
Alignment

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Andy Lücking,  
Peter Menke

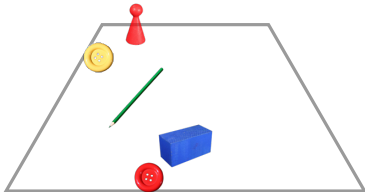
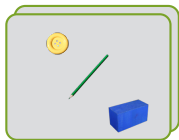
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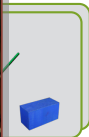
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Playi





# Some Facts and Figures

From Neural  
Activation to  
Symbolic  
Alignment

Alexander Mehler,  
Andy Lücking,  
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Dialogue  
Networks

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level	total number	average per dialog
words	93,120	1,501.935
turns	28,380	457.742
events	1,731	27.919
event phases	5,153	83.113
lexops	4,415	71.210
repairs	3,327	53.661



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- 1 Dialogue Networks
- 2 Data
- 3 Classification**
- 4 Conclusions





# Features of Alignment

From Neural  
Activation to  
Symbolic  
Alignment

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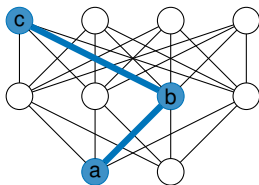
Data

Classification

Conclusions

## Alignment

- is operative on mental representations
- is non-intentional
- brings about routinized repetitive behavior
- different and differentiable from non-alignment





# Test Scenario

From Neural  
Activation to  
Symbolic  
Alignment

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■ 47 instances of  
alignment

■ 8 instances of  
non-alignment



# Test Scenario

From Neural  
Activation to  
Symbolic  
Alignment

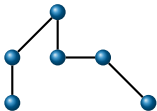
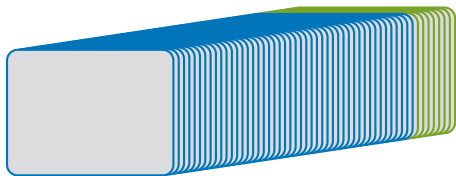
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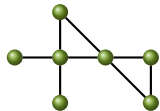
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Are aligned dialog  
instances distinguishable  
from non-aligned ones by  
TiTAN series modelling?





# Test Scenario

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Activation to  
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Alignment

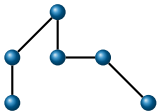
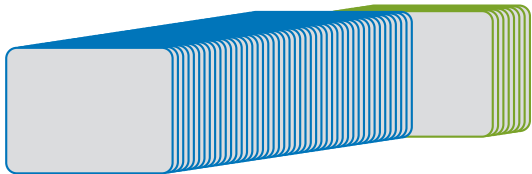
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Networks

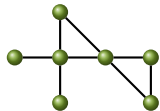
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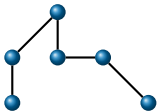
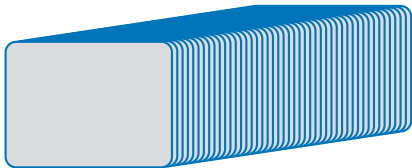
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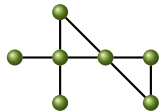
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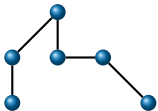
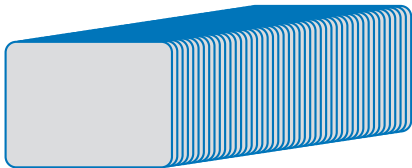
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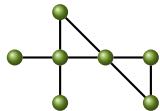
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# Experimentation

Quantitative Network Analysis (QNA) Mehler (2008)

From Neural  
Activation to  
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Peter Menke

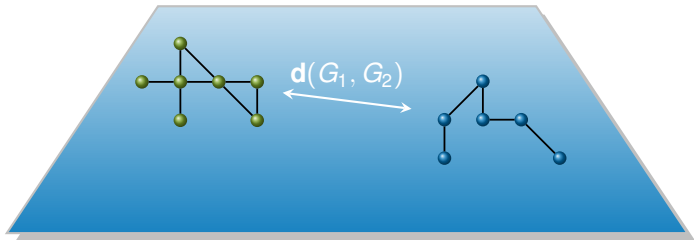
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*n*-dimensional space





# Experimentation

Quantitative Network Analysis (QNA) Mehler (2008)

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Procedure	F-score	Feature Selection
QNA[Mahalanobis,complete]	.92284	47 / 103
QNA[Mahalanobis,complete]	.90654	46 / 103
QNA[Mahalanobis,Ward]	.89578	49 / 103
QNA[correlation,complete]	.861	49 / 103
random baseline known-partition	.75073	
random baseline equi-partition	.61788	





# Results

From Neural  
Activation to  
Symbolic  
Alignment

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Classification

Conclusions

- QNA classifications outperform the random baselines
- QNA classification based on TITAN is feasible ( $\geq 90\%$ )
- No QNA classification separates the data perfectly

## Observation

In any case, multiple topological indices are needed

What is the relationship among the topological indices?



# Results

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- QNA classification based on TITAN is feasible ( $\geq 90\%$ )
- No QNA classification separates the data perfectly

## Observation

In any case, multiple topological indices are needed

What is the relationship among the topological indices?



# Correlations

From Neural  
Activation to  
Symbolic  
Alignment

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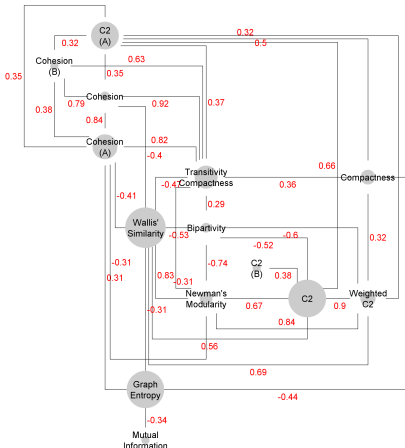
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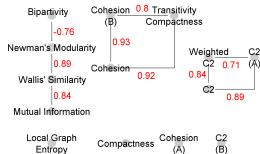
Classification

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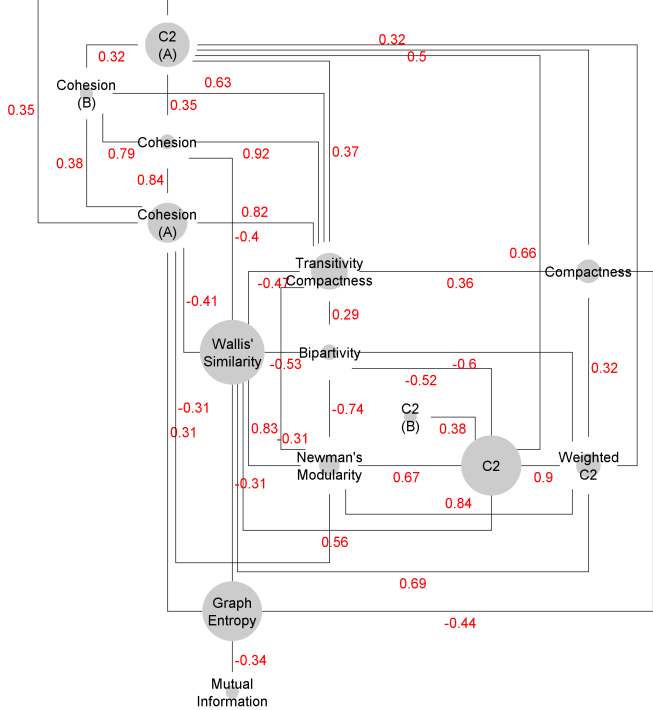
## Alignment Dialogs



## Non-Alignment Dialogs



No meaningful  
outcome due to few  
non-alignment  
instances





# From JMG to SaGA

From Neural  
Activation to  
Symbolic  
Alignment

Alexander Mehler,  
Andy Lücking,  
Peter Menke

Dialogue  
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Classification

Conclusions

JMG dialogues are

- strictly task-oriented
- highly regimented
- communicatively symmetric

Is classification also feasible on more free dialogues?



# Application: Route Directions

Mehler, Lücking, and Menke (2011)

From Neural  
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# Summary

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Conclusions

A network model of dialog that

- has a neural interpretation
- accounts for structure formation (alignment)
- provides a test bed for exploring relationships between topological indices



Alignment in  
Communication

SFB 673

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[www.linguistic-networks.net](http://www.linguistic-networks.net)





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Alexander Mehler,  
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Peter Menke

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# References II

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Activation to  
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Andy Lücking,  
Peter Menke

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Alexander Mehler

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