How does Our Visual System Achieve Shift and Size Invariance?

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Biointelligence Lab
Tae Jun Kim
Index

- Questions
- Neurobiological Constraints
- Two computational approaches
- Models
- Other Models
- Solution
- Conclusion
- References
QUESTIONS
Questions

• How can Routing Circuits have a Feature Hierarchy?

• How can Dynamic Routing Circuits be Fast Enough?

• How can Invariant Feature Networks Process Where-Information?
NEUROBIOLOGICAL CONSTRAINTS
Neurobiological Constraints

- Two pathways
- Layered structure
- Feedback connections
- Feature hierarchy
- Invariance hierarchy
- Fast recognition
- Attention
- Learning
Ventral pathway & Dorsal pathway

Impression, The Sunrise: soleil levant (1872), Oscar-Claude Monet
Layered structure (cont.)

Modeling visual recognition from neurobiological constraints (1994), Oram and Perrett
Layered structure (cont.)

How Does Our Visual System Achieve Shift and Size Invariance? (2003), Laurenz Wiskott
Layered structure

Modeling visual recognition from neurobiological constraints (1994), Oram and Perrett
TWO COMPUTATIONAL APPROACHES
Two Computational Approaches

Normalization
- + Where-information is made explicit
- - Recognition requires normalization
- + Minimal information loss
- - No processing towards recognition

Invariant Features
- - Where-information may be difficult to extract
- + Recognition does not require knowing where the object is
- - Usually information is lost
- + Processing towards recognition
MODELS
Dynamic Routing Circuit Model (cont.)

How Does Our Visual System Achieve Shift and Size Invariance? (2003), Laurenz Wiskott
Dynamic Routing Circuit Model

A Neurobiological Model of Visual Attention and Invariant Pattern Recognition Based on Dynamic Routing of Information (1993), Bruno A. Olshausen
How Does Our Visual System Achieve Shift and Size Invariance? (2003), Laurenz Wiskott
Invariant Feature Networks

How Does Our Visual System Achieve Shift and Size Invariance? (2003), Laurenz Wiskott
SOLUTION
Questions

• How can Routing Circuits have a Feature Hierarchy?

• How can Dynamic Routing Circuits be Fast Enough?

• How can Invariant Feature Networks Process Where-Information?
Solution

• Combine two mechanisms
Combination of an invariant feature network and a dynamic routing circuit

How Does Our Visual System Achieve Shift and Size Invariance? (2003), Laurenz Wiskott
OTHER MODELS
Other Models

- JIM
- Combination of the log polar
- Fourier transform
- R-transform
- Dynamic link matching
JIM (John and Irv’s model)

Dynamic Binding in a Neural Network for Shape Recognition (1992), John E. Hummel and Irving Biederman
CONCLUSION
Conclusion
REFERENCES
References

• Modeling visual recognition from neurobiological constraints(1994), Oram and Perrett

• How Does Our Visual System Achieve Shift and Size Invariance?(2003), Laurenz Wiskott

• A Neurobiological Model of Visual Attention and Invariant Pattern Recognition Based on Dynamic Routing of Information(1993), Bruno A. Oishausen

• Dynamic Binding in a Neural Network for Shape Recognition(1992), John E. Hummel and Irving Biederman
Thank You!