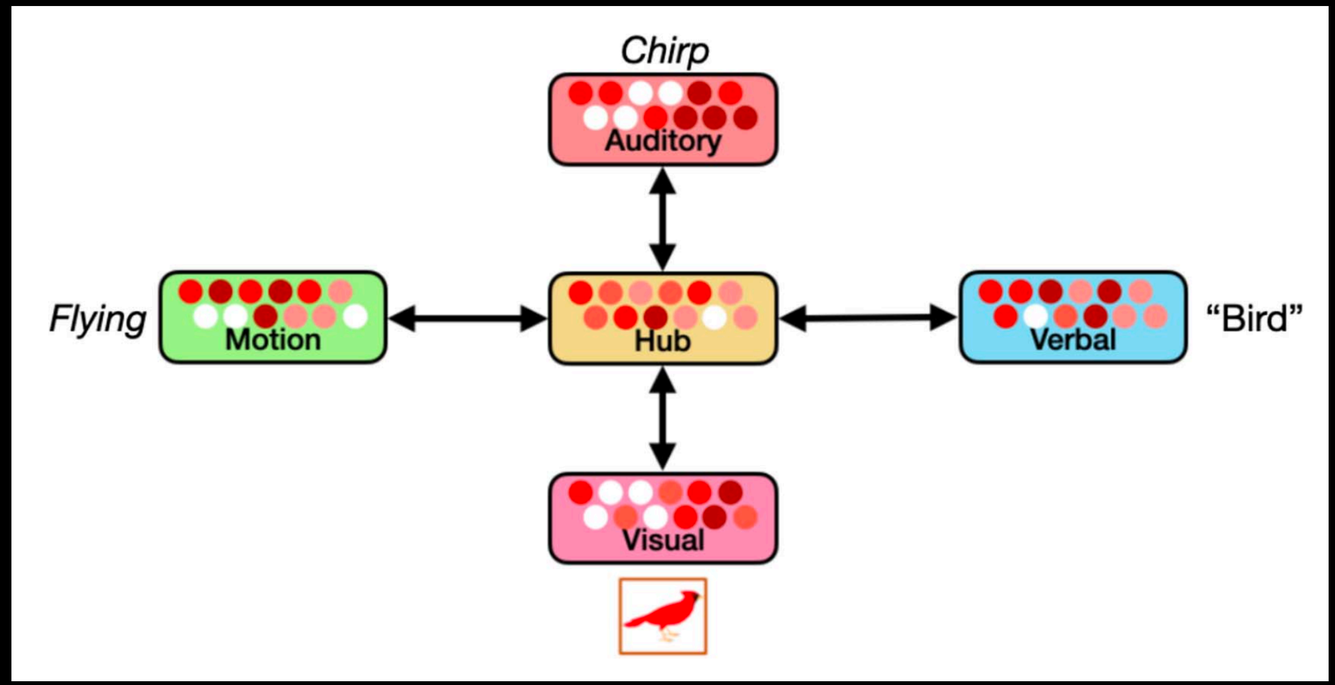
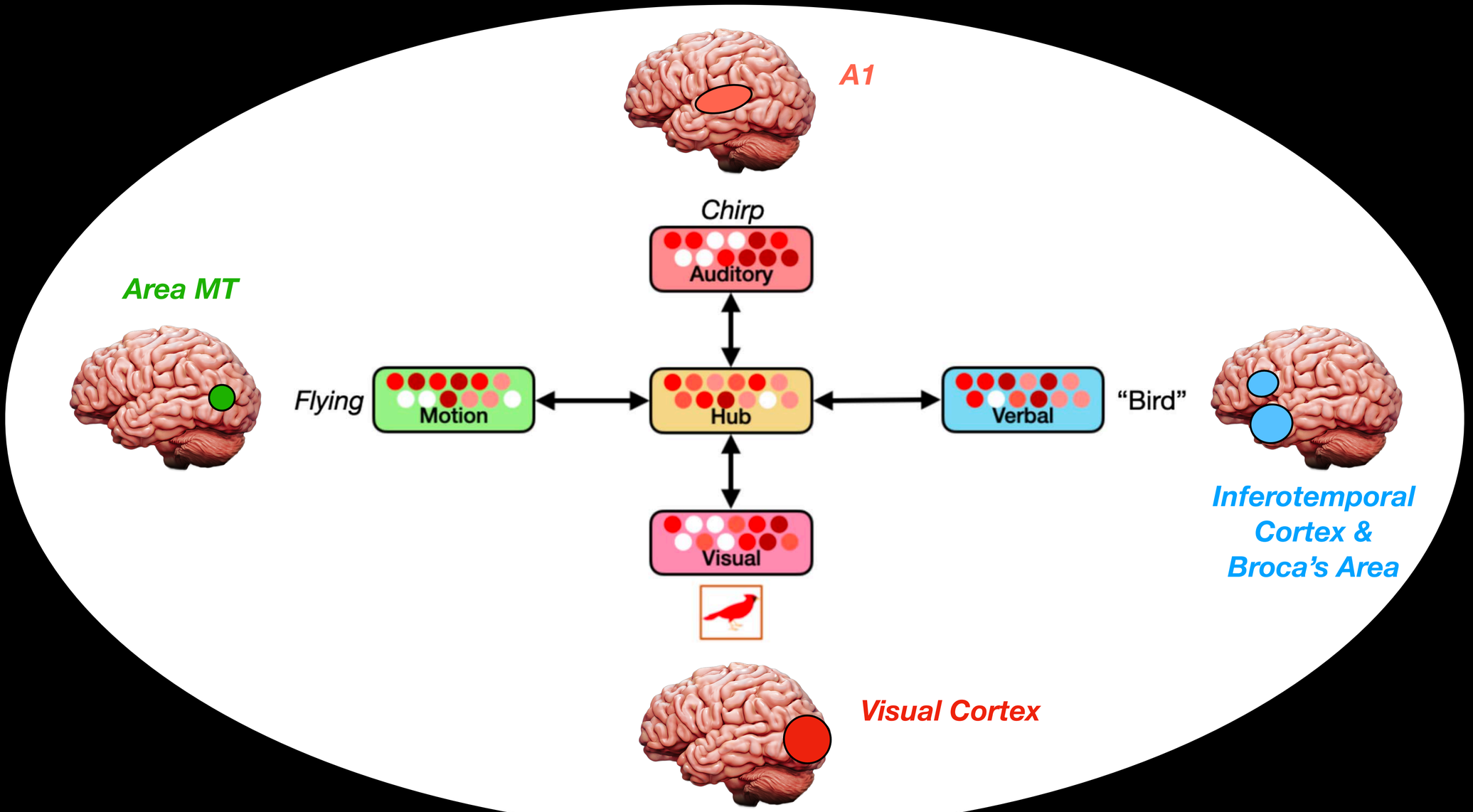
Language Processing II

The “Hub and Spokes” Framework

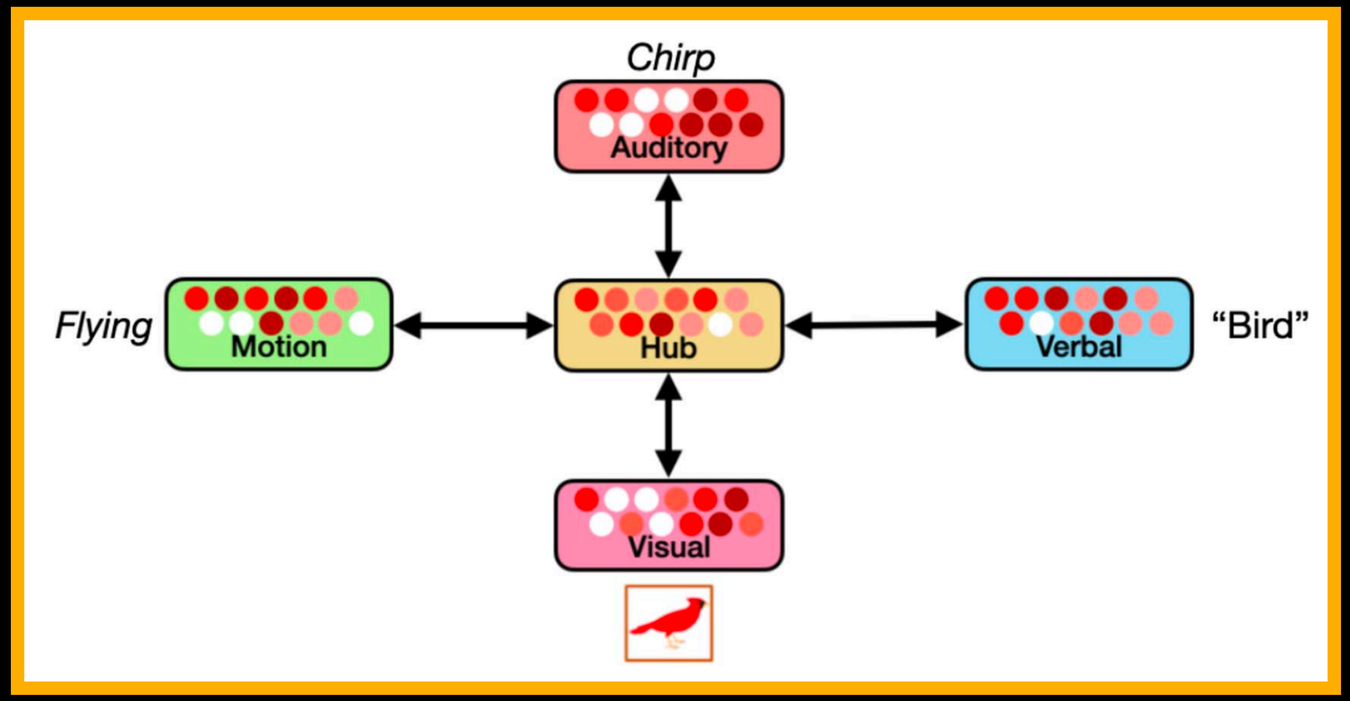
Rogers & McClelland (2004)



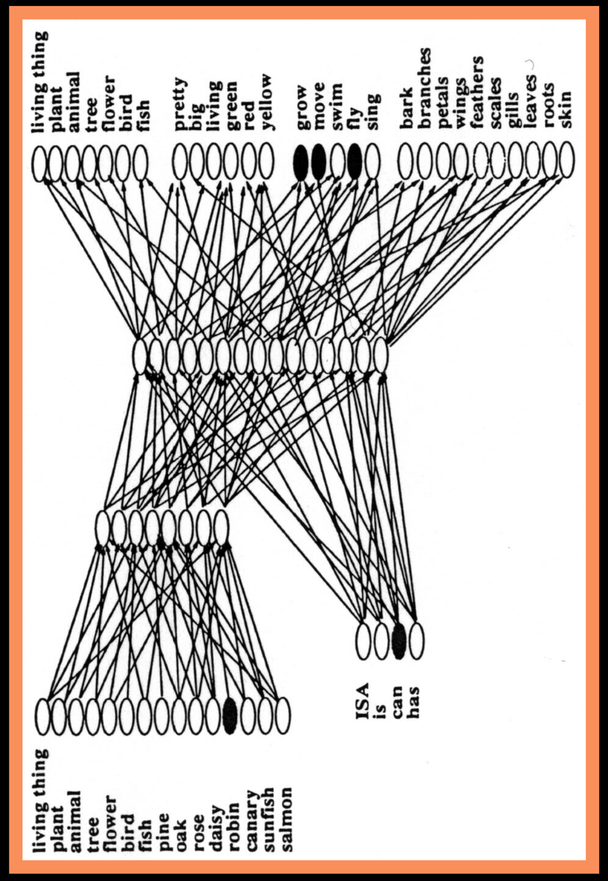
The "Hub and Spokes" Framework and the Brain

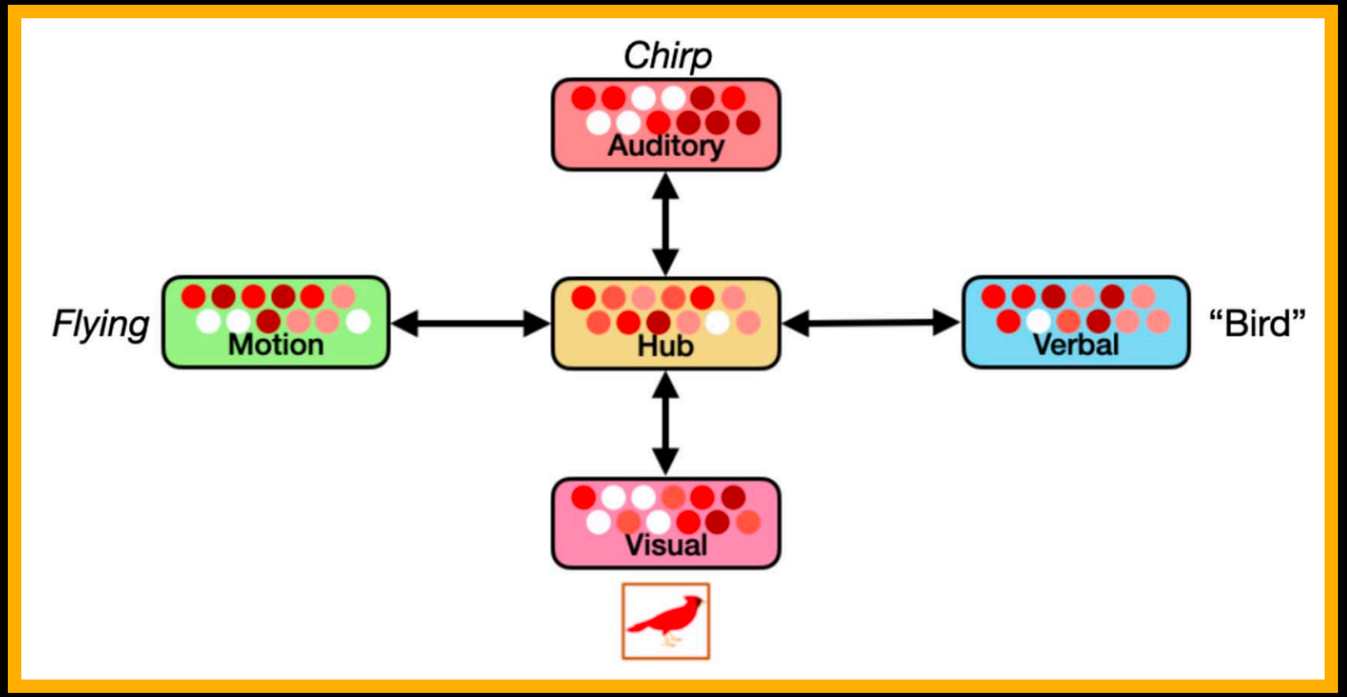


The “Hub and Spokes” Framework the Rumelhart Model

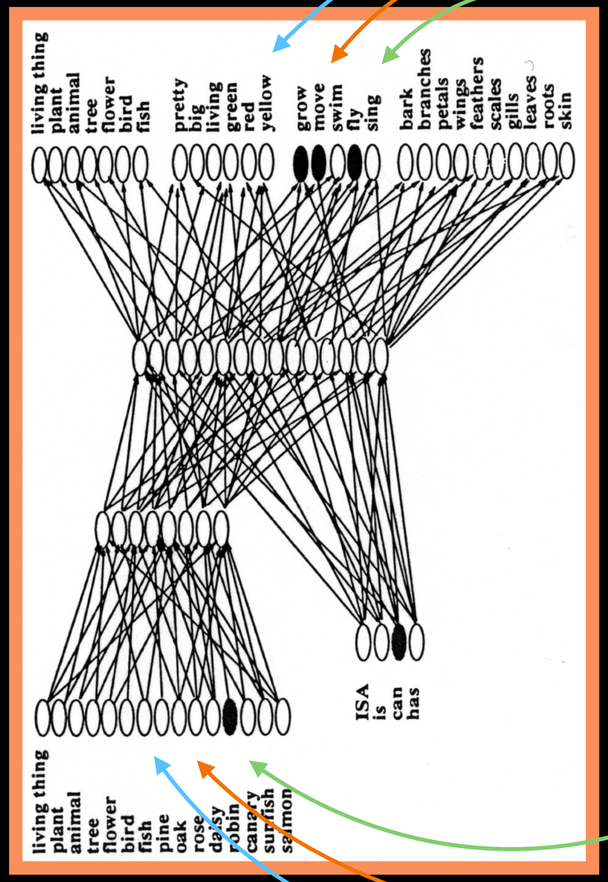


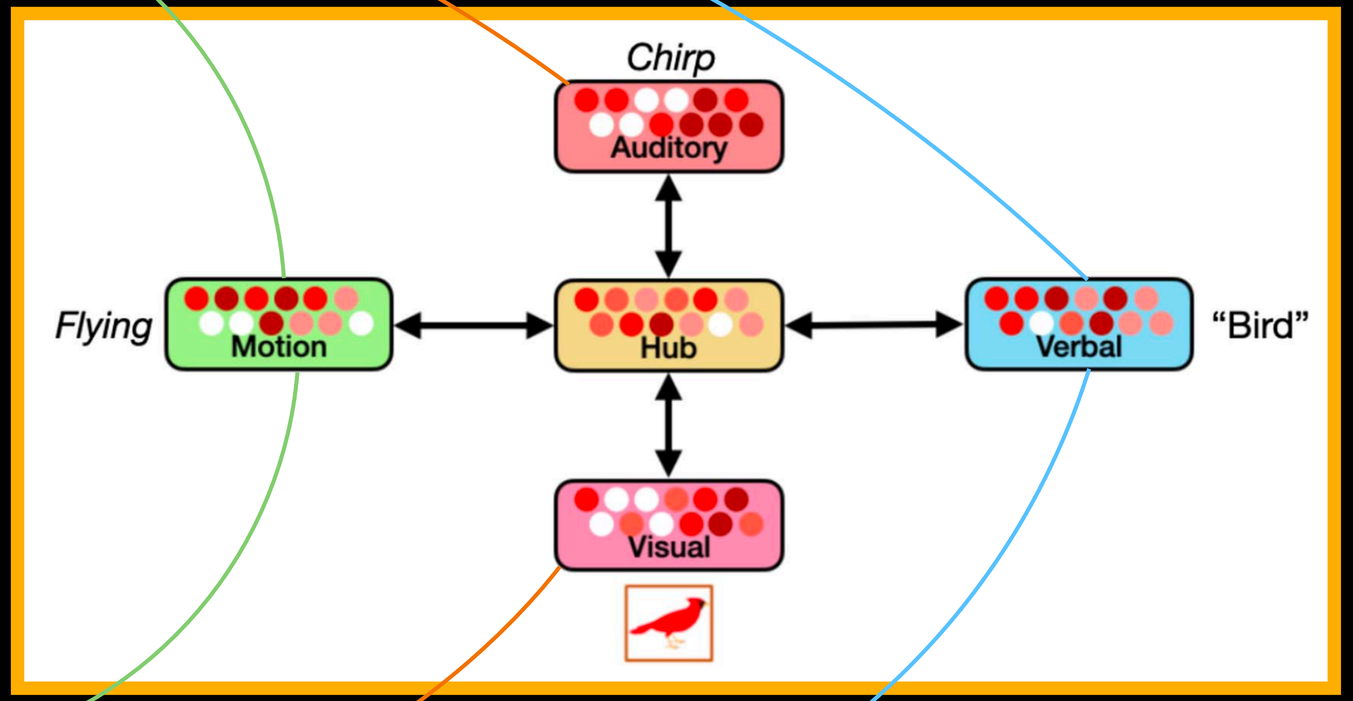
The “Hub and Spokes” Framework
the Rumelhart Model



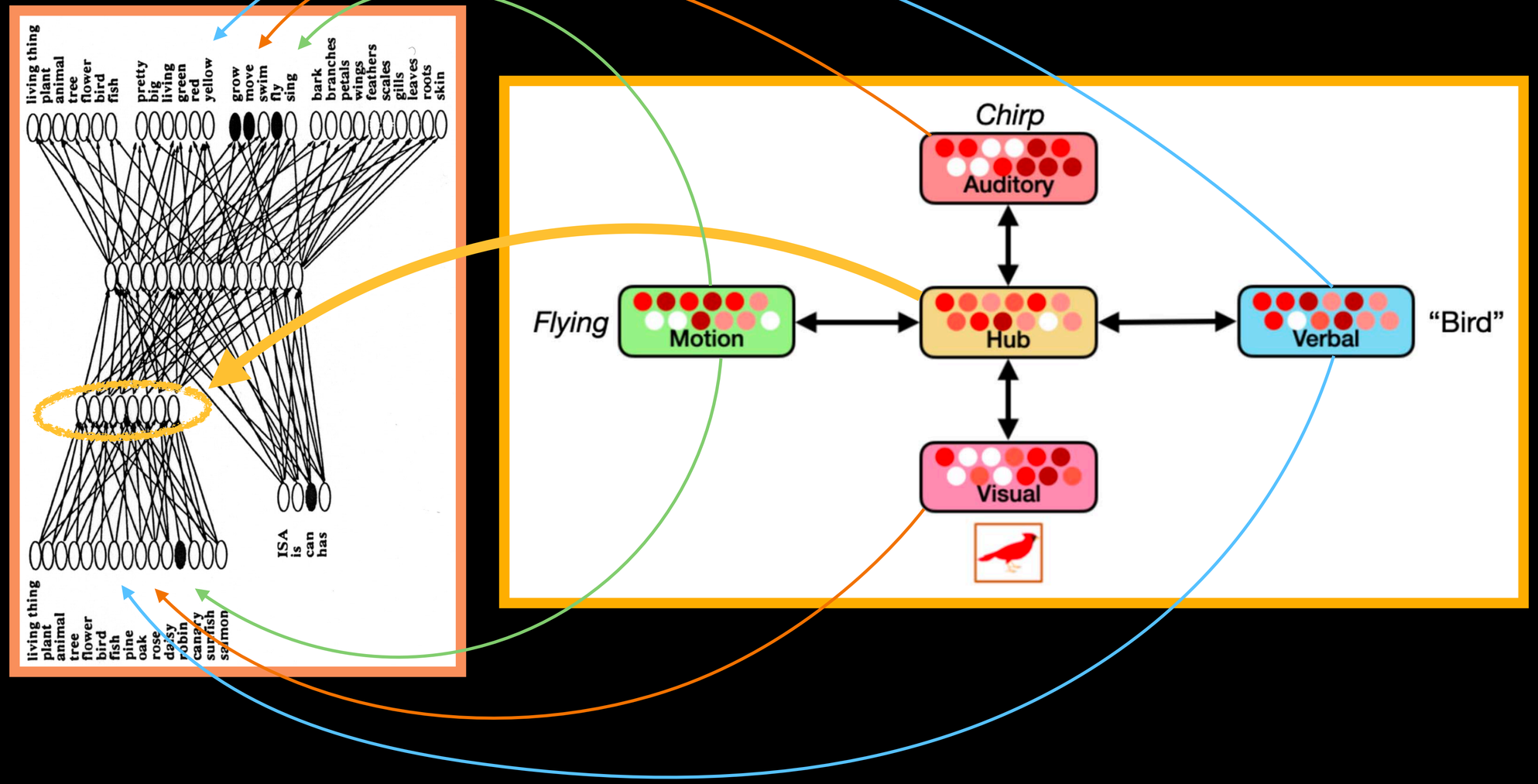


The “Hub and Spokes” Framework
the Rumelhart Model

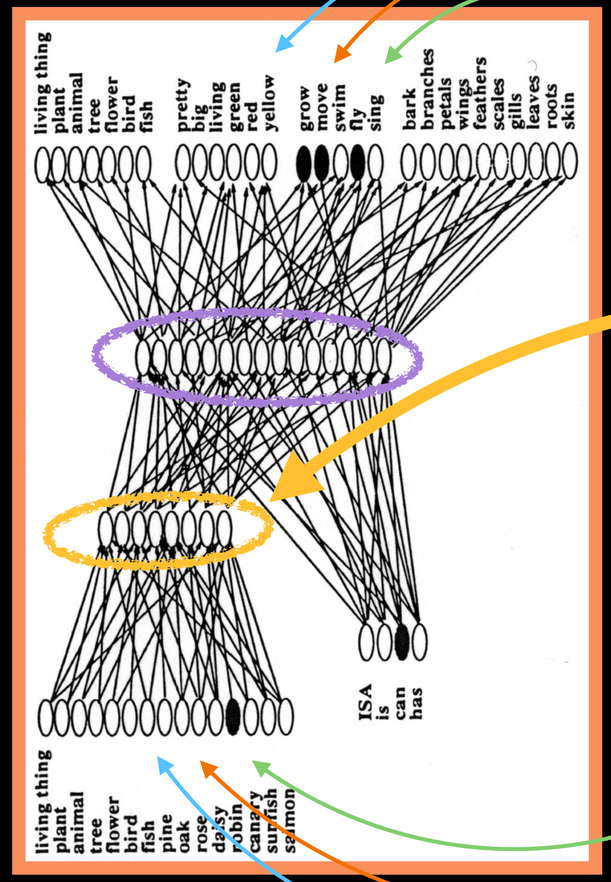


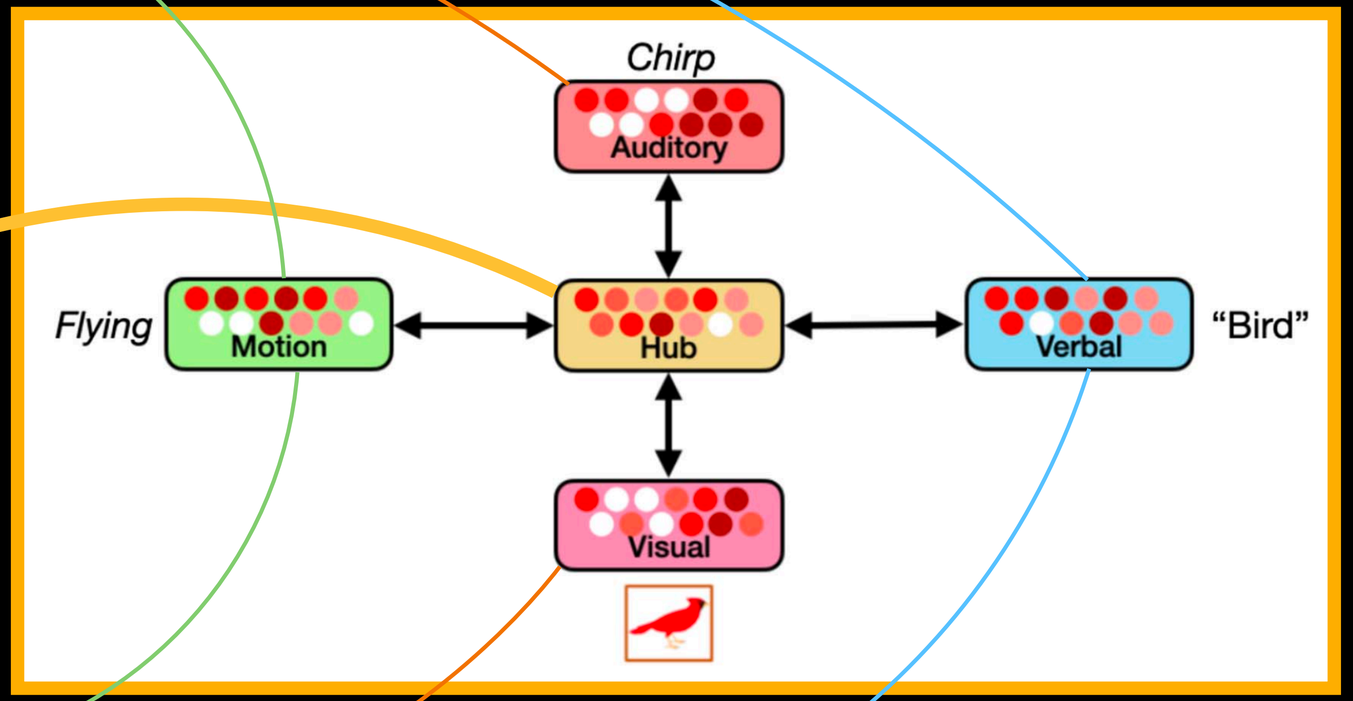


The “Hub and Spokes” Framework
the Rumelhart Model

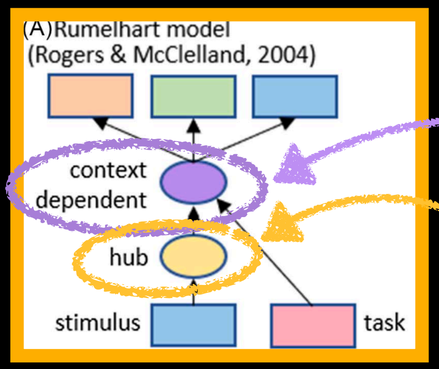


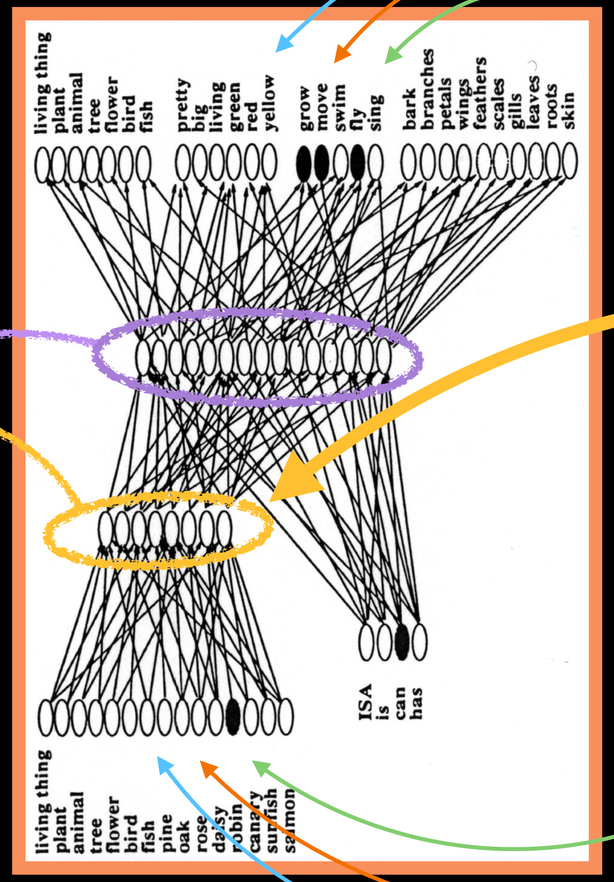
The “Hub and Spokes” Framework
the Rumelhart Model

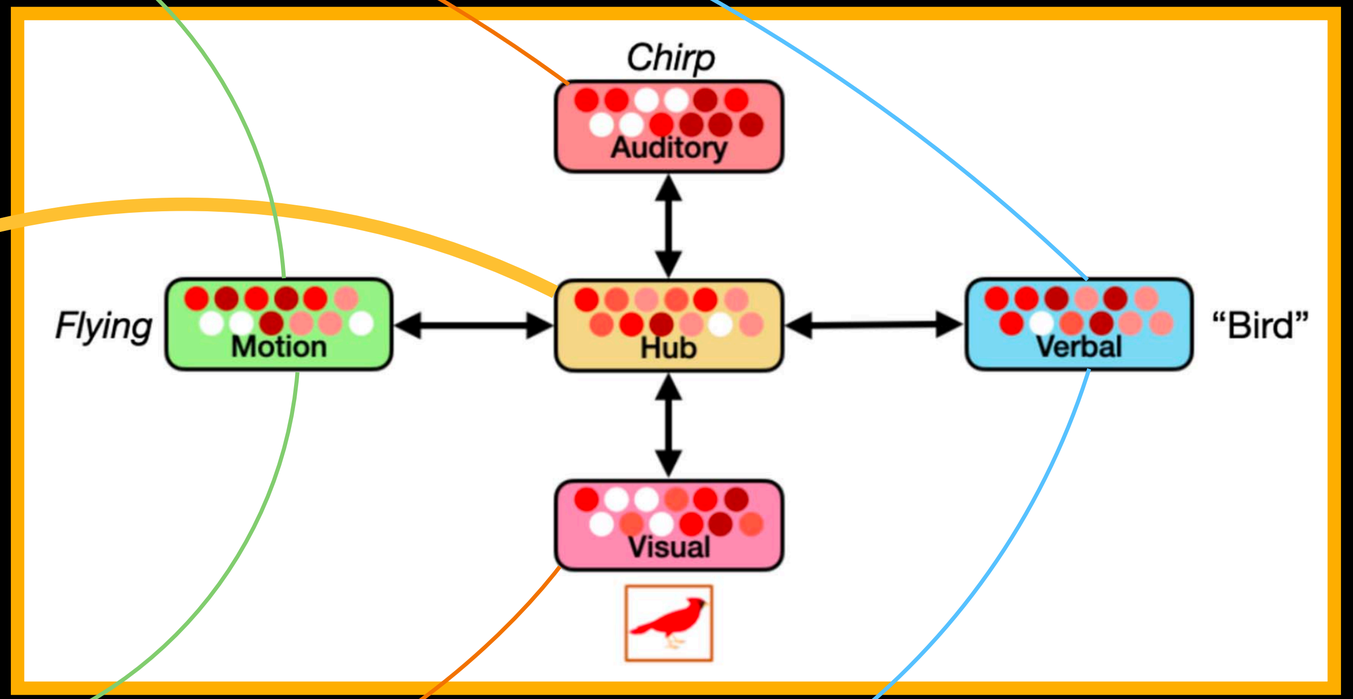




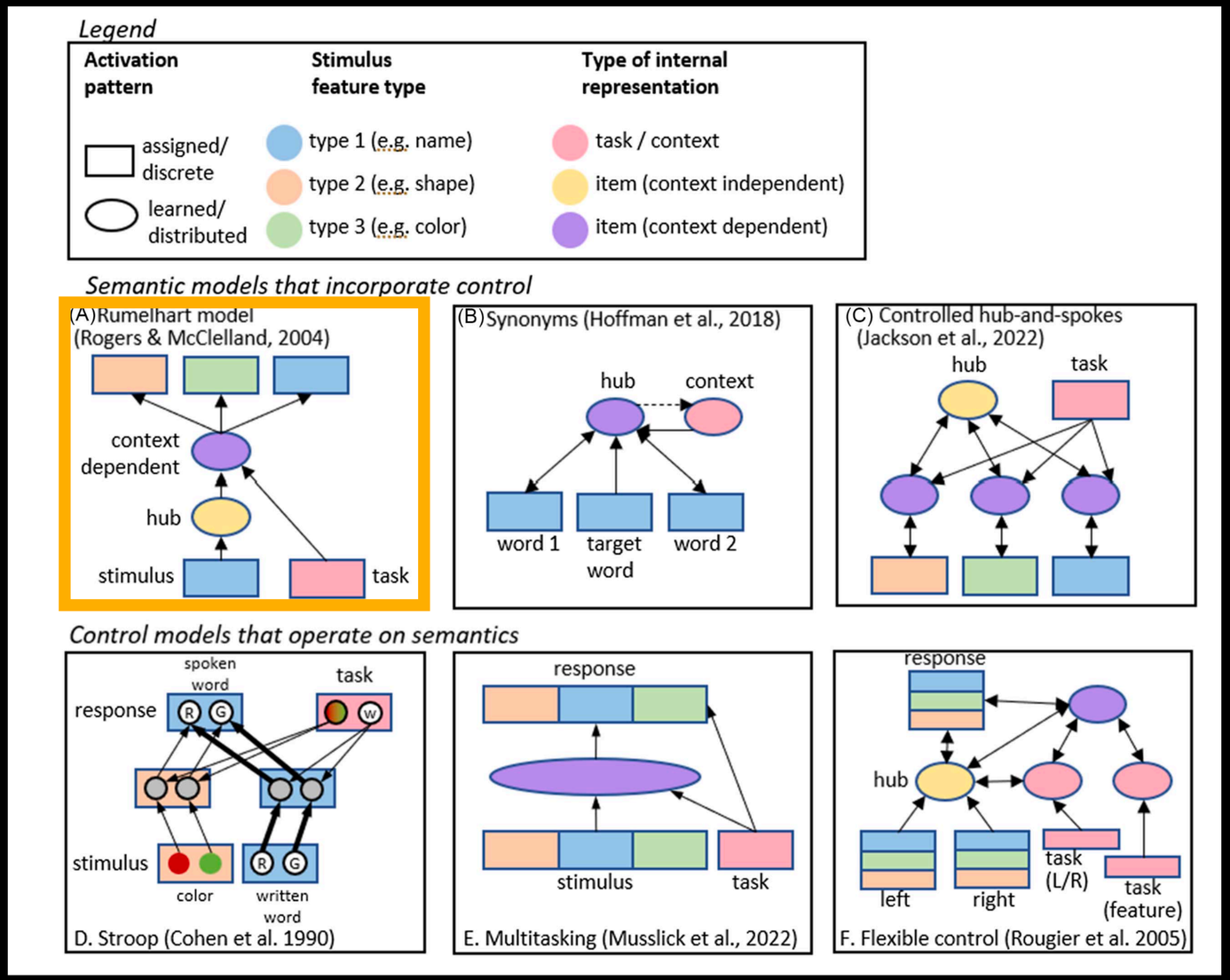
The “Hub and Spokes” Framework the Rumelhart Model





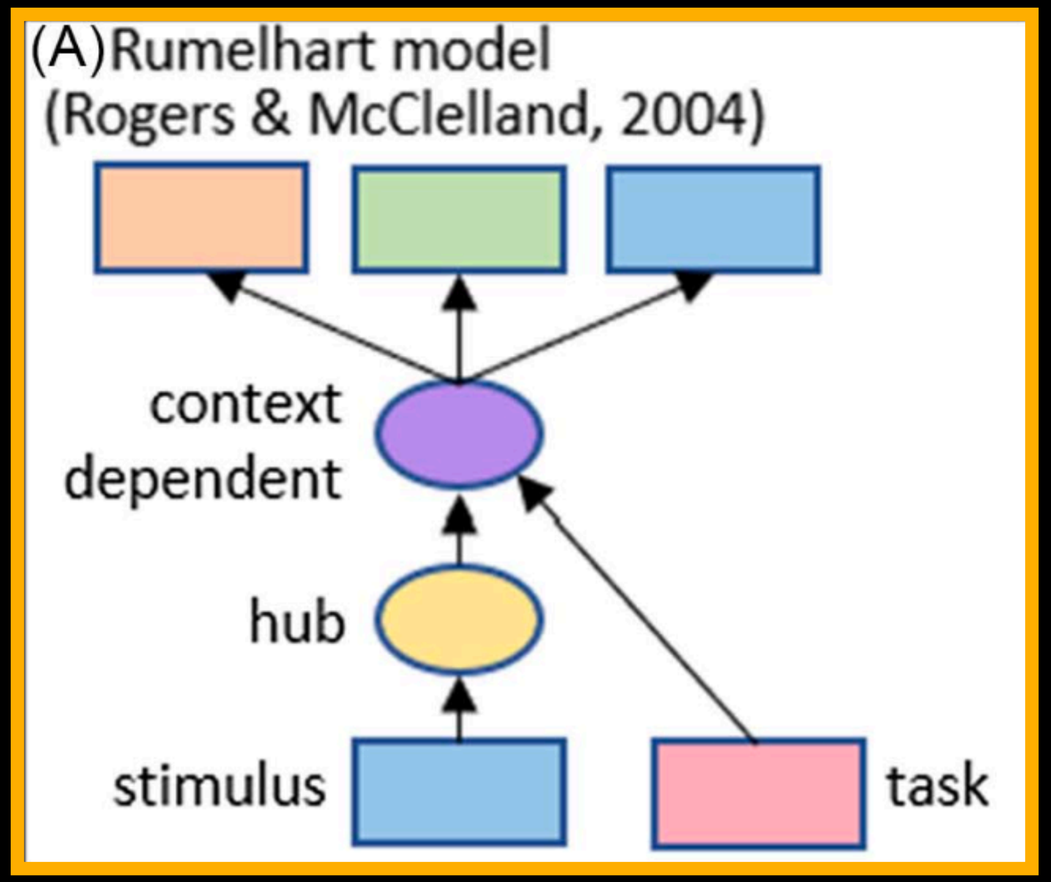


Models of Semantics and Context (Control)



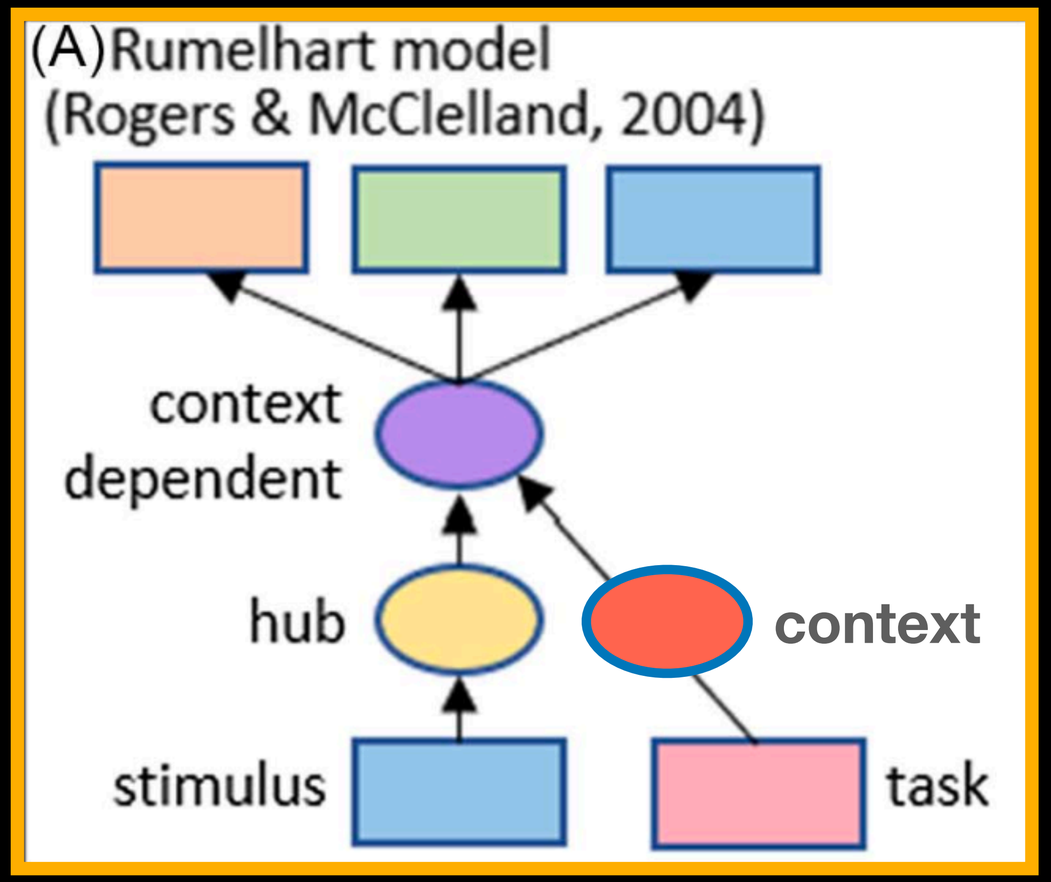
Integrate Semantics and Control (ISC) Model

Giallanza, Campbell, Cohen & Rogers (2024)



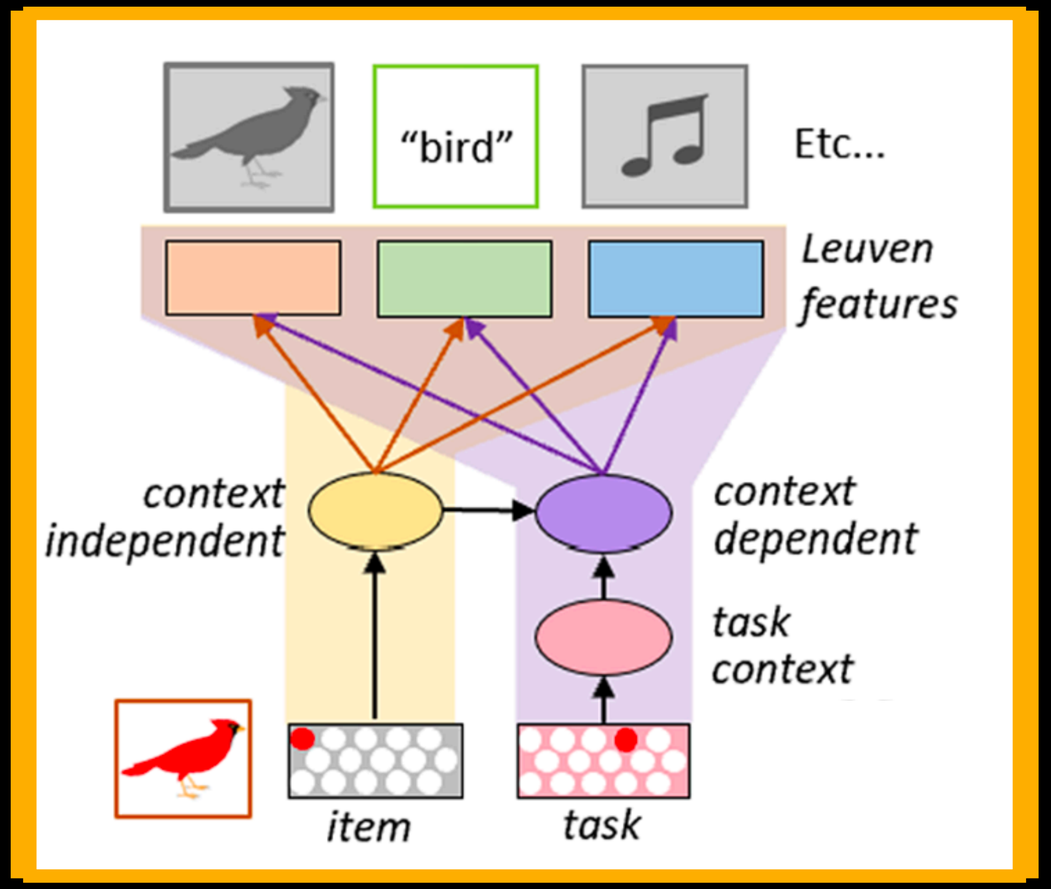
Integrate Semantics and Control (ISC) Model

Giallanza, Campbell, Cohen & Rogers (2024)



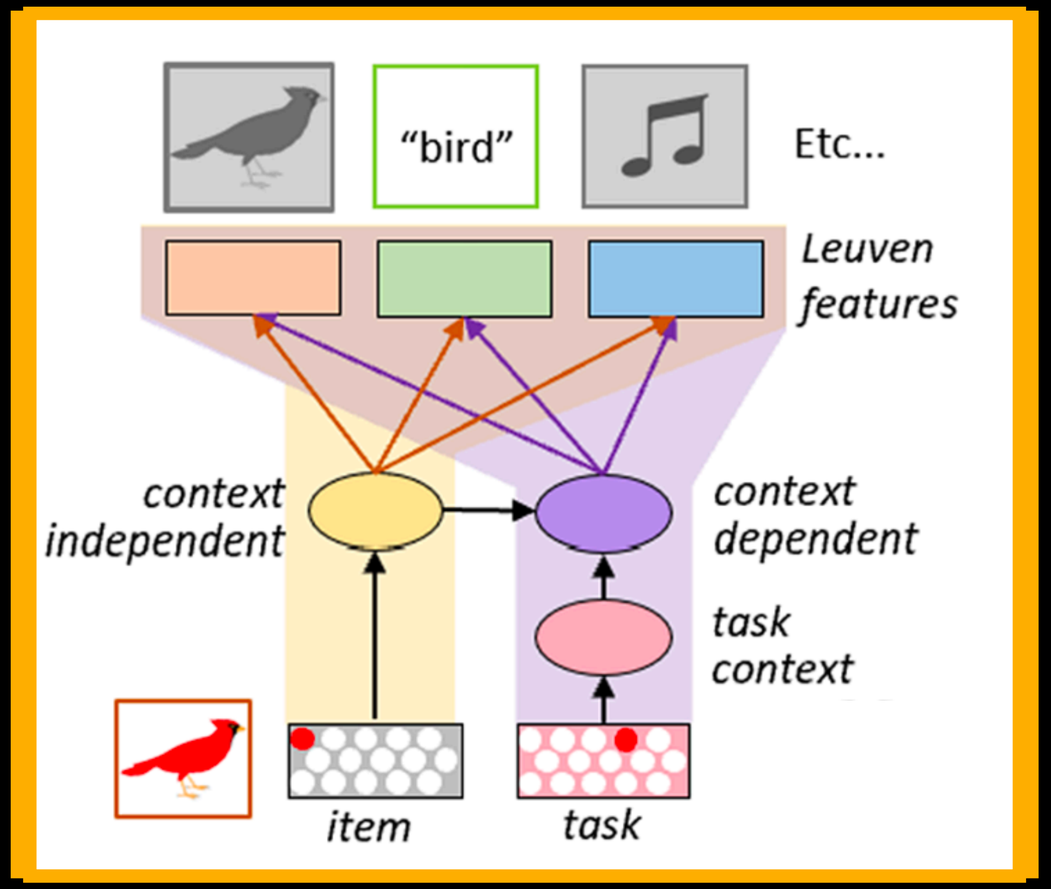
Integrate Semantics and Control (ISC) Model

Giallanza, Campbell, Cohen & Rogers (2024)



Integrate Semantics and Control (ISC) Model

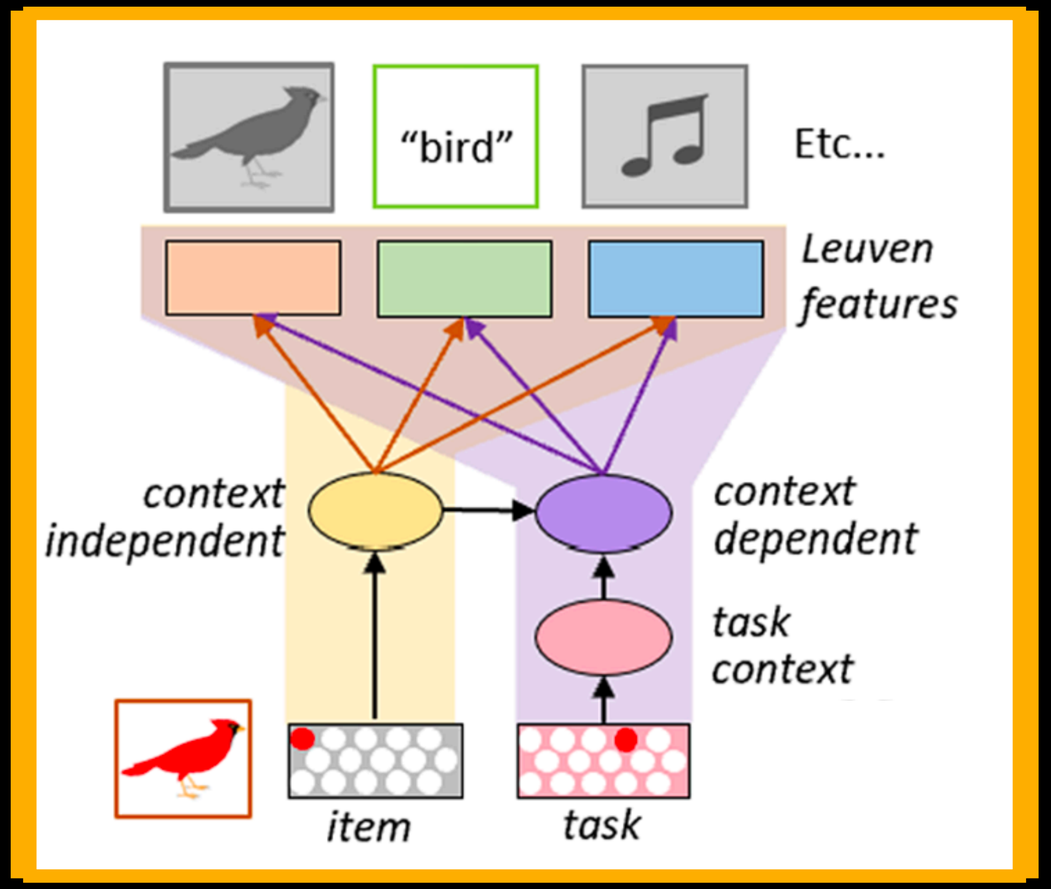
Giallanza, Campbell, Cohen & Rogers (2024)



"Categorize Item"

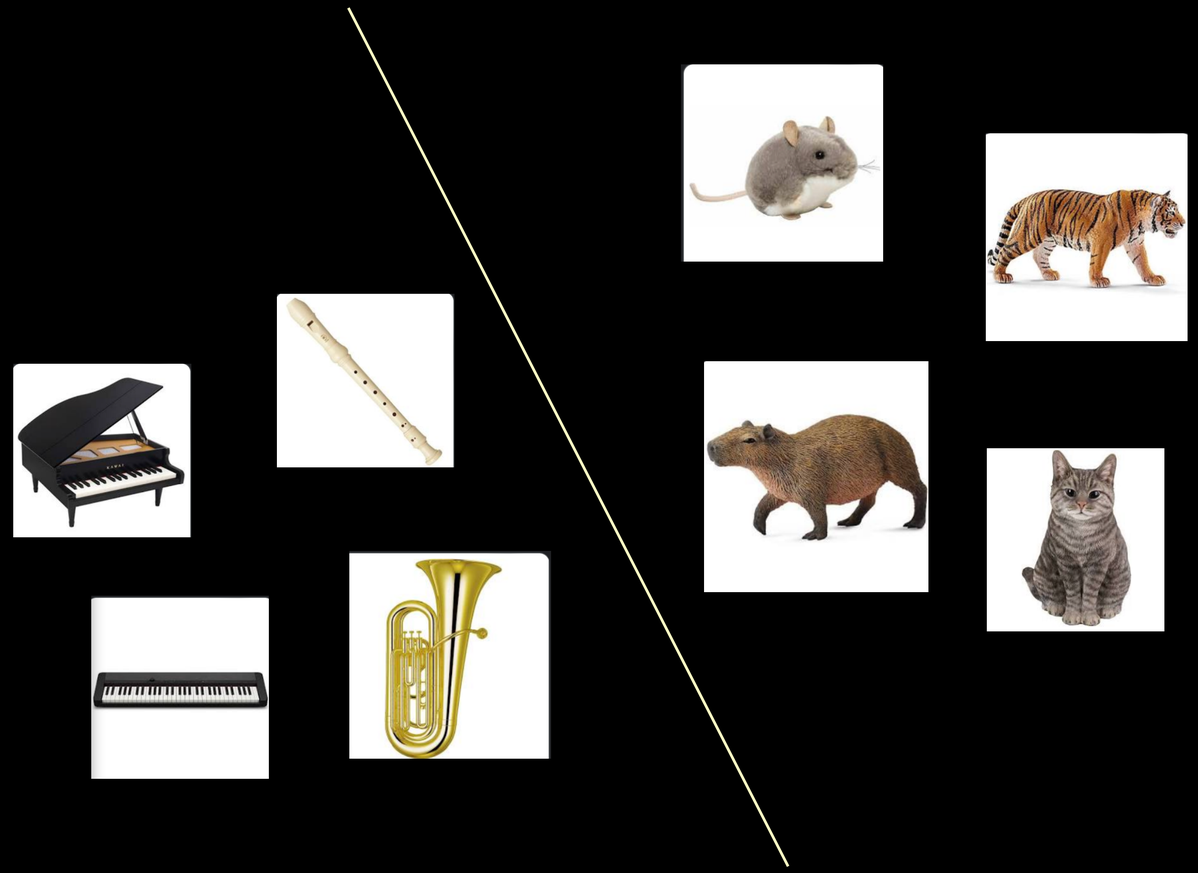
Integrate Semantics and Control (ISC) Model

Giallanza, Campbell, Cohen & Rogers (2024)



"Judge Its Size"

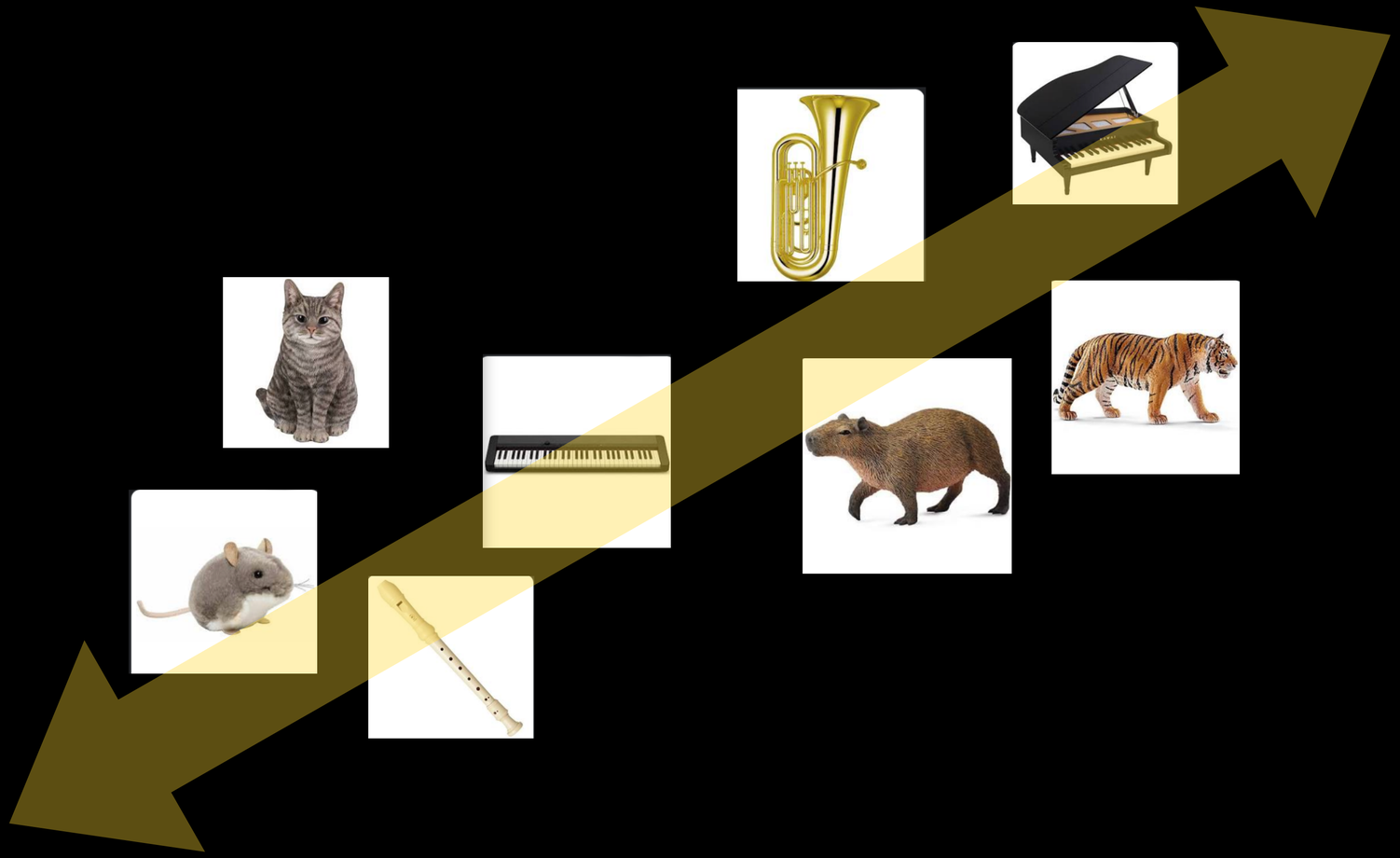
Contextual (Attentional) Control as the *Warping* of Semantic Structure



Categorize Item:

Animal or Instrument?

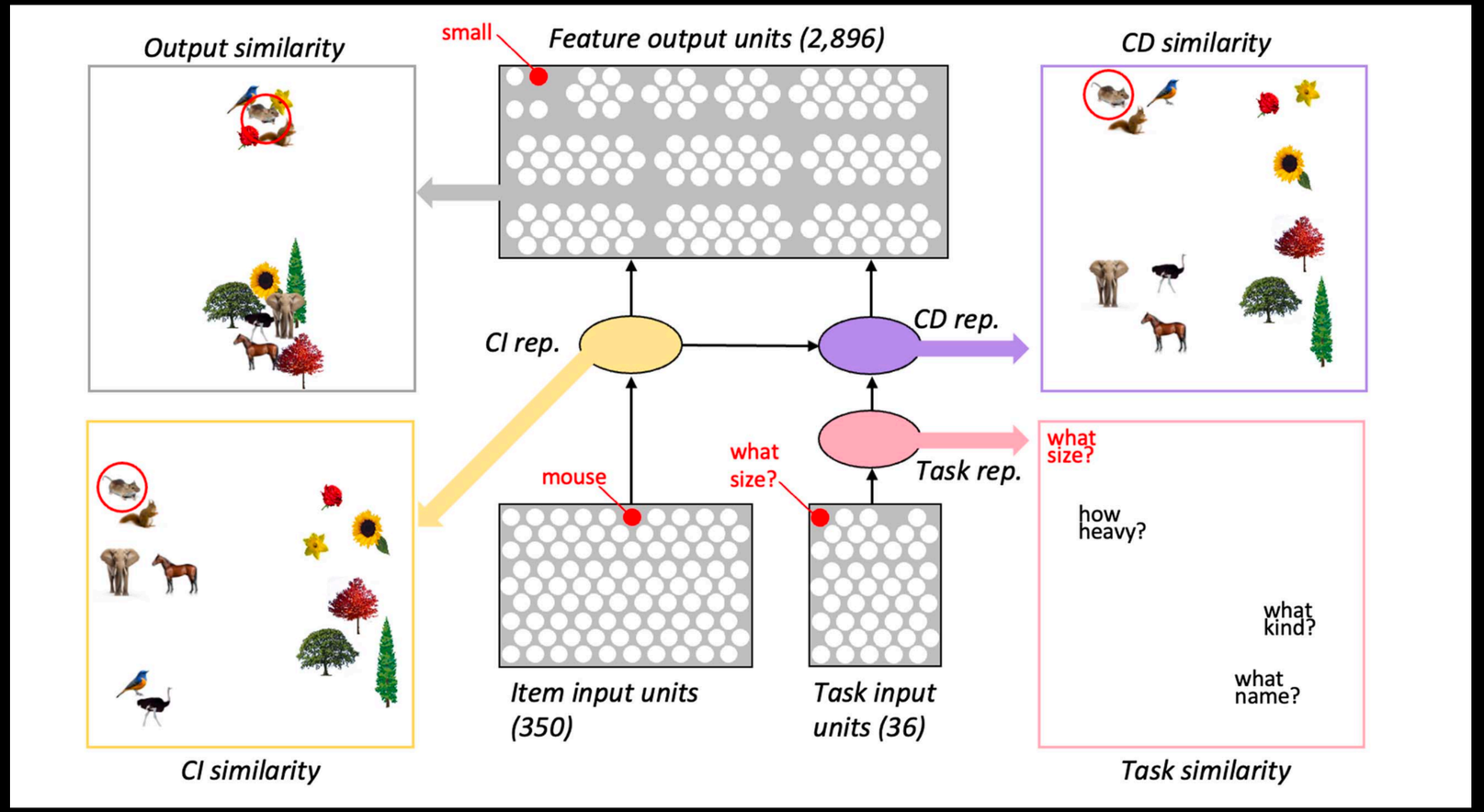
Contextual (Attentional) Control as the *Warping* of Semantic Structure



Judge its size

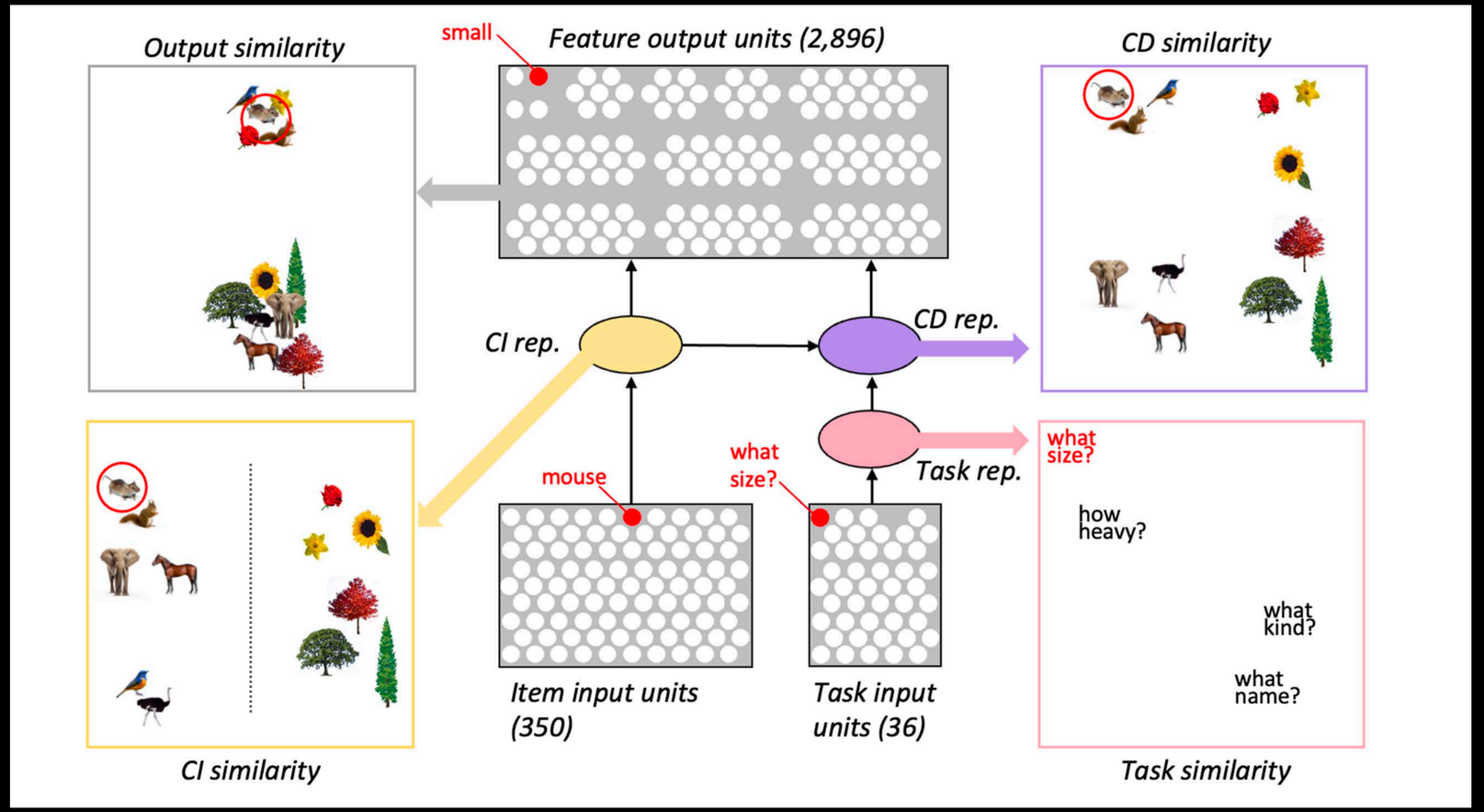
Bigger than a trash can?

Contextual (Attentional) Control as the *Warping* of Semantic Structure

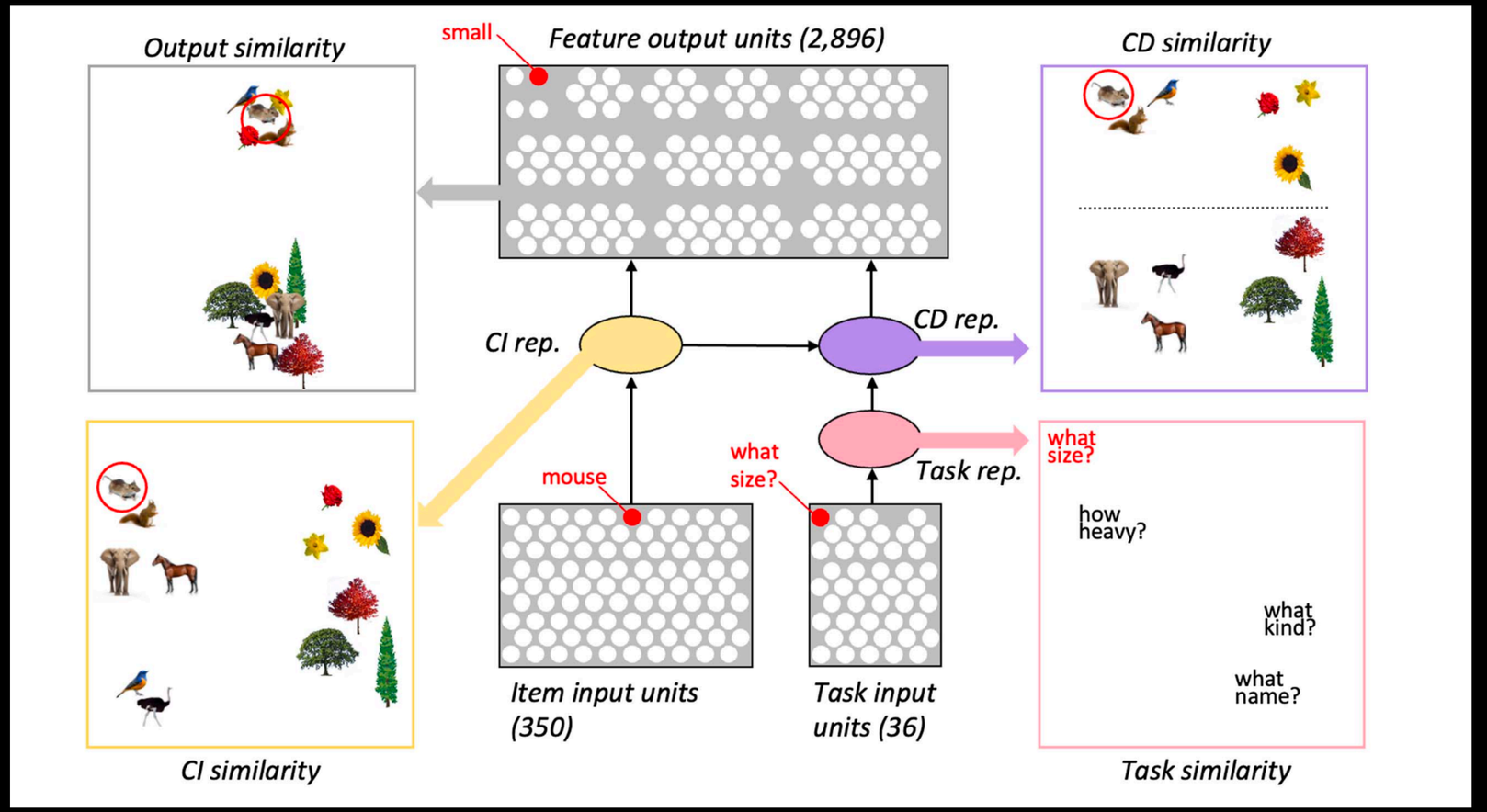


Contextual (Attentional) Control as the *Warping* of Semantic Structure

Category Biased: *Coherent covariation over all features*



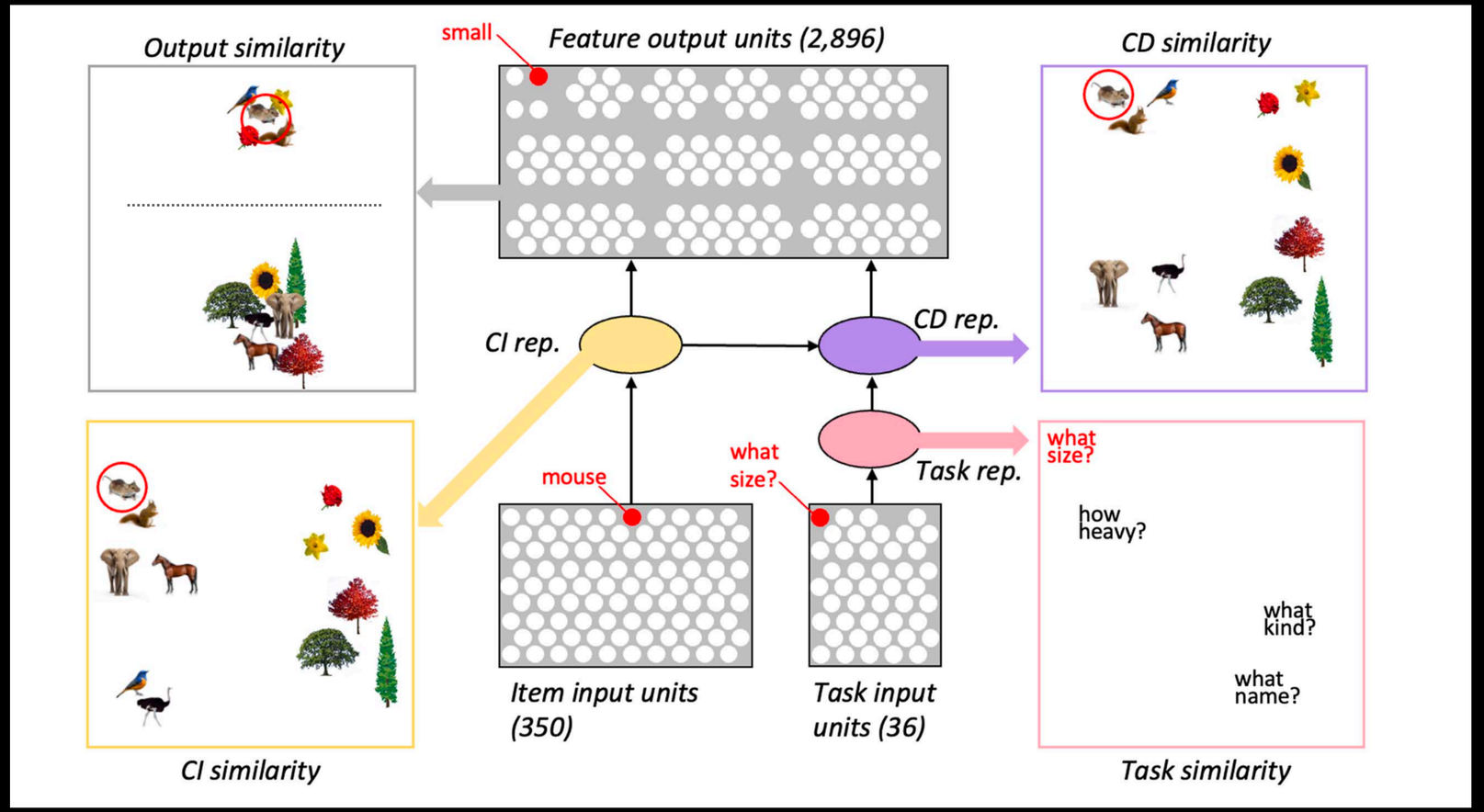
Contextual (Attentional) Control as the *Warping* of Semantic Structure



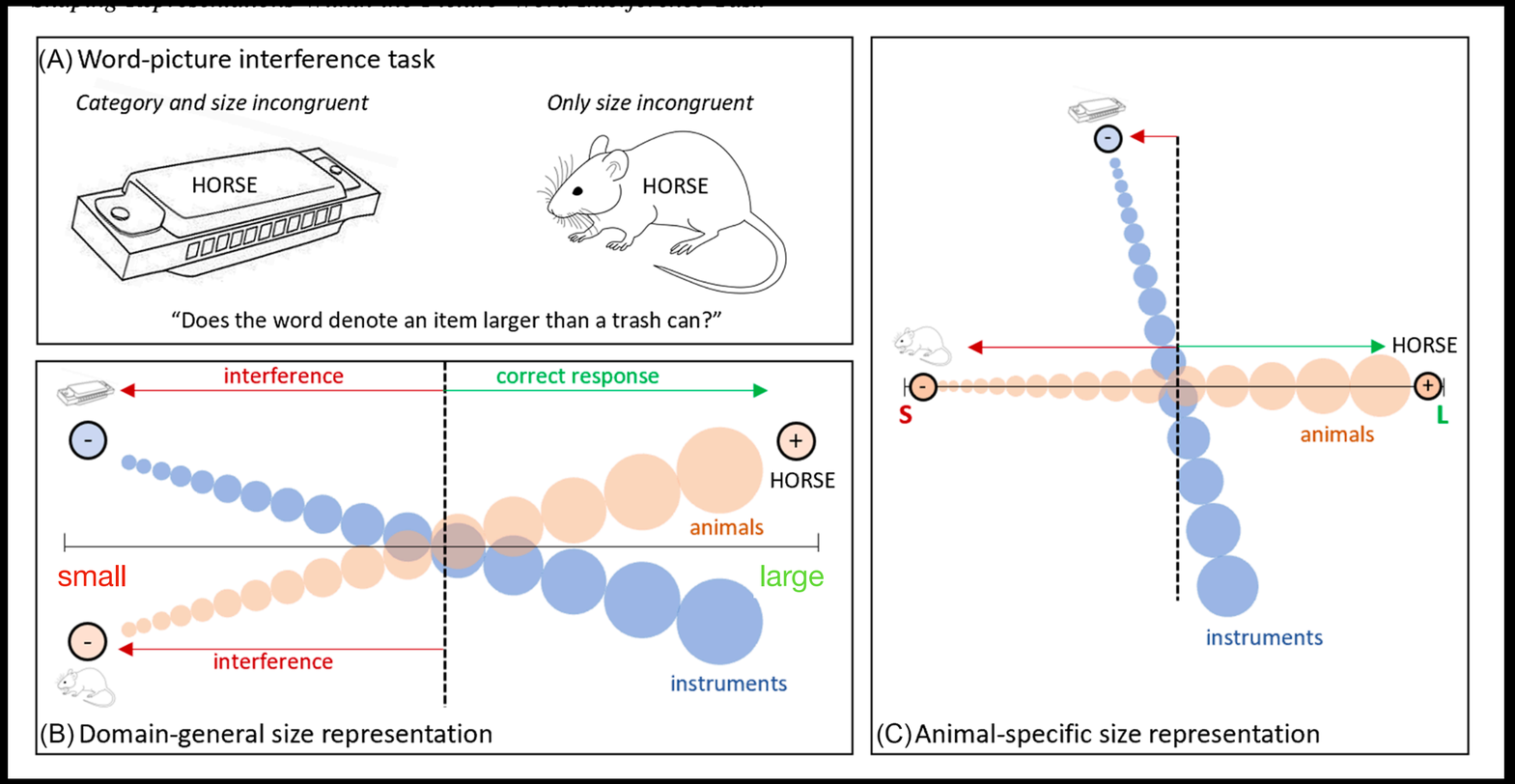
Context Warping: *Covariation based on size*

Contextual (Attentional) Control as the *Warping* of Semantic Structure

Output "Sharpening"



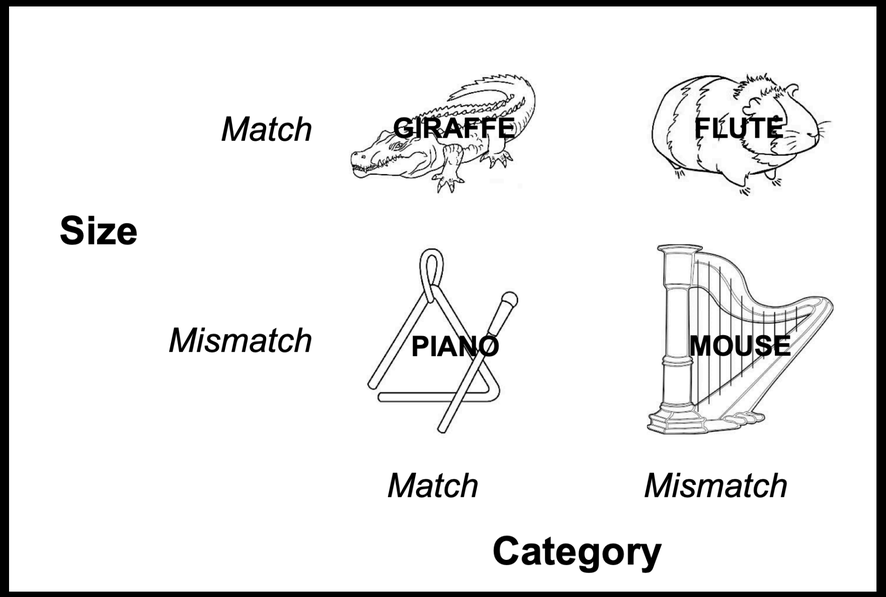
Contextual (Attentional) Control as the *Warping* of Semantic Structure



Semantic Attention Task

Task

Verbally report size of object denoted by the word



Findings

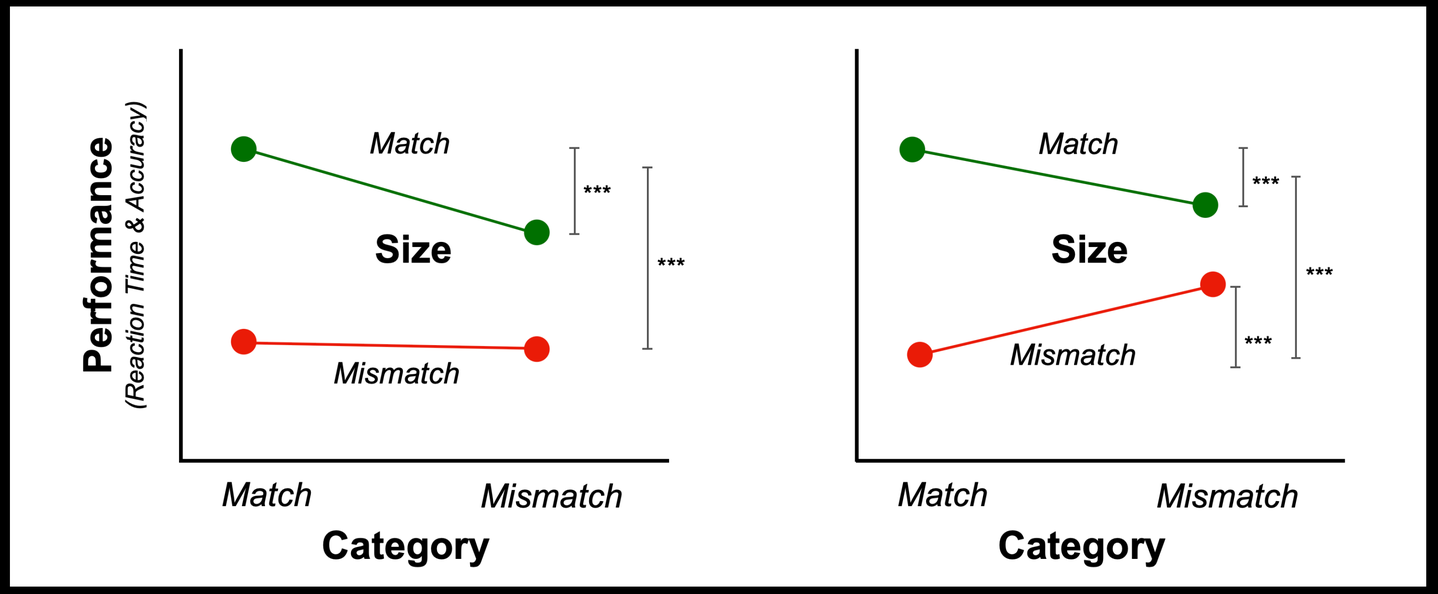
Semantic distraction interacts with context

Interleaved (no control)

"Size"

Blocked (control)

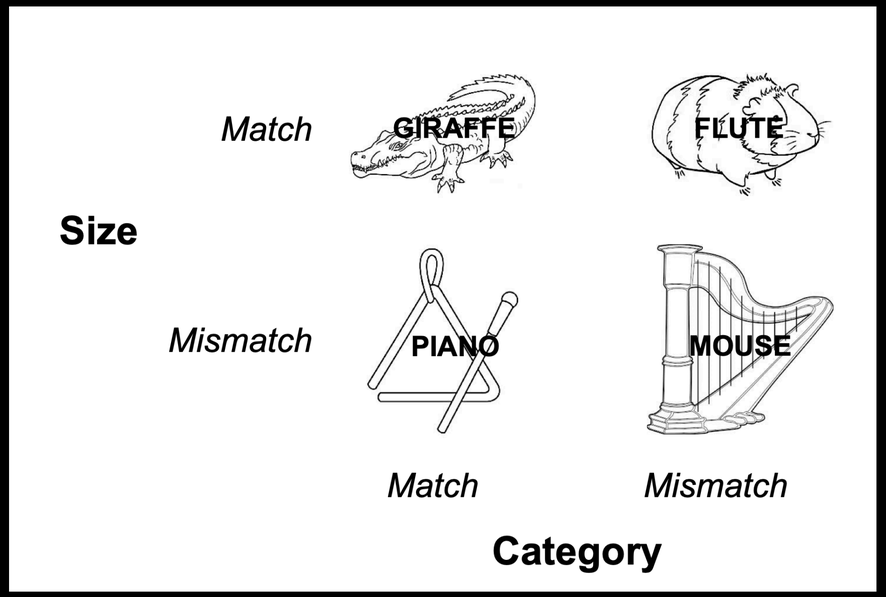
"Animal Size" vs. "Instrument Size"



Semantic Attention Task

Task

Verbally report size of object denoted by the word



Effect:

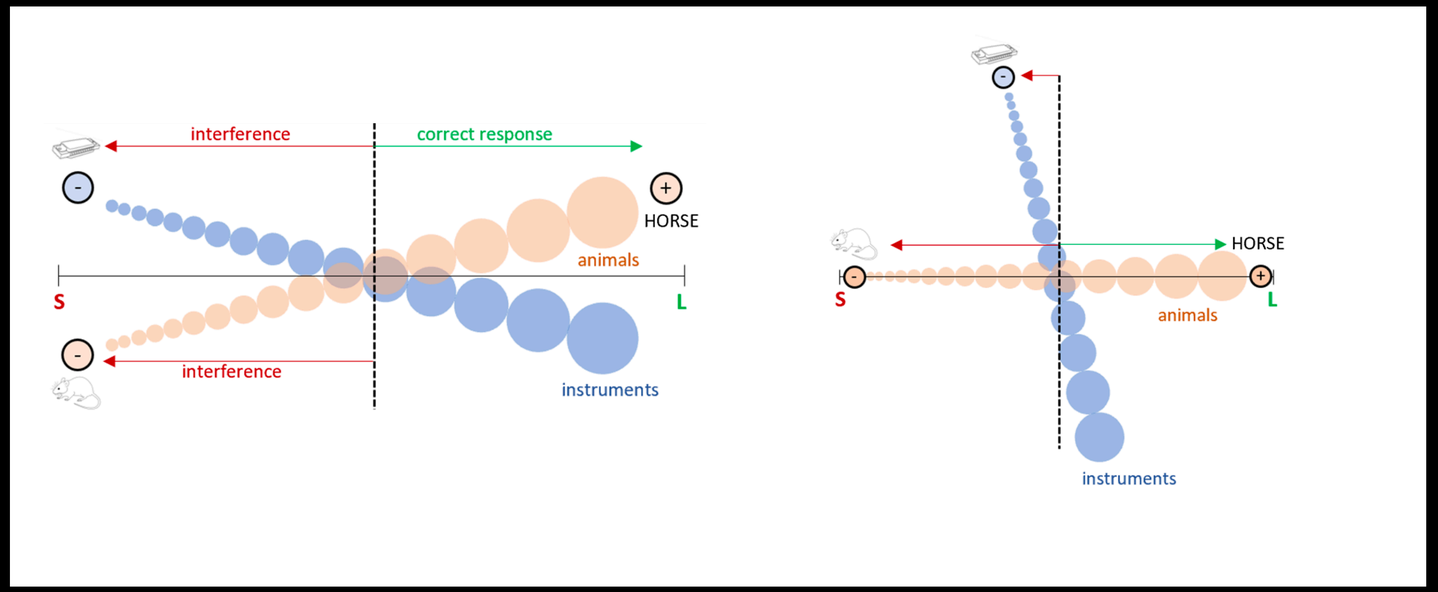
Stable context (blocked) warps semantic space

Interleaved (no control)

"Size"

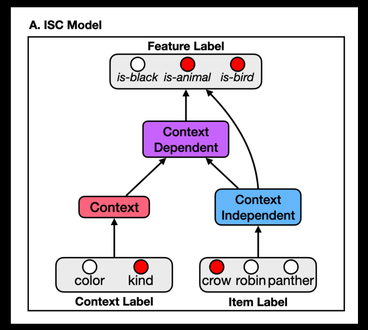
Blocked (control)

"Animal Size" vs. "Instrument Size"



Integrated Semantics and Control — Context *Inference* (ISC-CI)

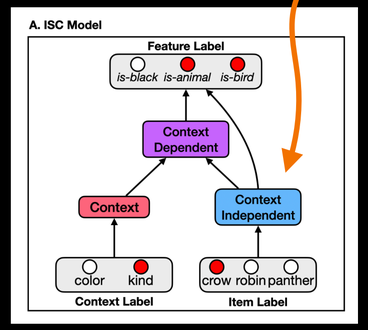
Giallanza, Campbell, Rogers & Cohen (under review)



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

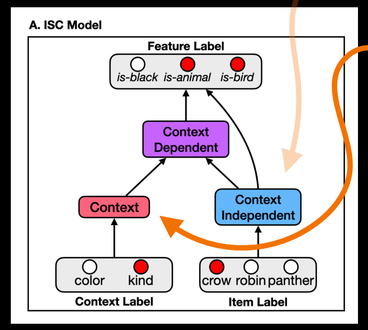
- **ISC model**
  - **semantic knowledge reflects the effects of statistical learning:** ***coherent covariation***



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

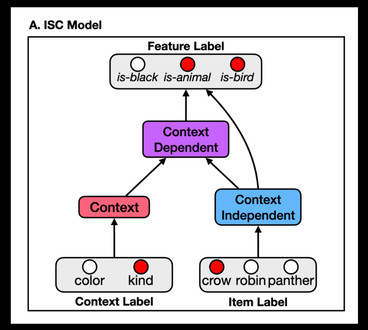
- **ISC model**
  - semantic knowledge reflects the effects of statistical learning: *coherent covariation*
  - **shaped in use by the influence of *context representations* that reflect explicit instructions, implicit behavior demands, and the other stimuli present or recently present in the environment**



Integrated Semantics and Control — Context *Inference* (ISC-CI)

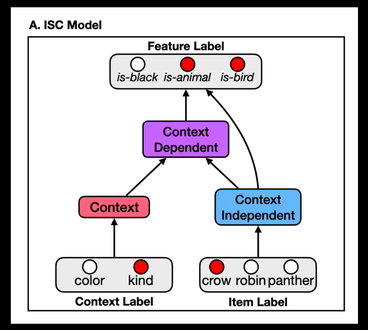
Giallanza, Campbell, Rogers & Cohen (under review)

- **ISC model**
  - semantic knowledge reflects the effects of statistical learning: *coherent covariation*
  - shaped in use by the influence of *context representations* that reflect explicit instructions, implicit behavior demands, and the other stimuli present or recently present in the environment
  - **context representations are themselves subject to the same mechanisms statistical learning, spanning multiple levels of abstraction, and driven by the statistics of *behavioral affordances* together with those of perception**



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)



- **ISC model**
  - semantic knowledge reflects the effects of statistical learning: *coherent covariation*
  - shaped in use by the influence of *context representations* that reflect explicit instructions, implicit behavior demands, and the other stimuli present or recently present in the environment
  - context representations are themselves subject to the same mechanisms statistical learning, spanning multiple levels of abstraction, and driven by the statistics of *behavioral affordances* together with those of perception
- **Still, many effects remain to be explained…**

Human Semantic Anomalies / Idiosyncrasies

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - Order effects: asymetric similarity judgements

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**

    How similar is a donkey to a horse?

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**

    How similar is a donkey to a horse? *Similar*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**

    How similar is a donkey to a horse? *Similar*

    How similar is a horse to a donkey?

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**

    How similar is a donkey to a horse? *Similar*

    How similar is a horse to a donkey? *Less so*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba
  - **Triangle inequality effects: violations of transitive inference**

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba
  - **Triangle inequality effects: violations of transitive inference**
    [Nurse : Patient] :: [Mother : Child]

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba
  - **Triangle inequality effects: violations of transitive inference**
    [Nurse : Patient] :: [Mother : Child]
    [Mother : Child] :: [Frog : Tadpole]

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments:**
  - **Order effects: asymetric similarity judgements**
    How similar is a donkey to a horse? *Similar*
    How similar is a horse to a donkey? *Less so*
  - **Multialternative effects: reversal of simiarlity judgments**
    Which is Jamaica most similar to: England, Poland or Cuba
    Which is Jamaica most similar to: England, Russia or Cuba
  - **Triangle inequality effects: violations of transitive inference**
    [Nurse : Patient] :: [Mother : Child]
    [Mother : Child] :: [Frog : Tadpole]
    [Nurse : Patient] :: [Frog : Tadpole]

Human Semantic Anomalies / Idiosyncrasies

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or {crows} → robins

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**

    {crows} → ravens or {crows} → robins

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or {crows} → robins
  - **Conclusion typicality:**
    {crows, ravens} → robins or {crows, ravens} → penguins

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or {crows} → robins
  - **Conclusion typicality:**
    {crows, ravens} → robins or {crows, ravens} → penguins

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity**
    {crows, robins} → sparrows or *{crows} → sparrows*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity** *(support spans query)*
    {crows, robins} → sparrows or *{crows} → sparrows*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity** *(support spans query)*
    {crows, robins} → sparrows or *{crows} → sparrows*
  - **In-category non-monotonicity**
    {brown bears, grizzly bears} → buffalo or *{brown bears} → buffalo*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity** *(support spans query)*
    {crows, robins} → sparrows or *{crows} → sparrows*
  - **In-category non-monotonicity** *(support is narrower than query)*
    {brown bears, grizzly bears} → buffalo or *{brown bears} → buffalo*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity** *(support spans query)*
    {crows, robins} → sparrows or *{crows} → sparrows*
  - **In-category non-monotonicity** *(support is narrower than query)*
    {brown bears, grizzly bears} → buffalo or *{brown bears} → buffalo*
  - **Cross-category non-monotonicity**
    {flies, orangutans} → bees or *{flies} → bees*

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*:

  Given each of the following sets, which is more likely to be a member of the category:

  - **Premise-conclusion similarity:**
    {crows} → ravens or *{crows} → robins*
  - **Conclusion typicality:**
    {crows, ravens} → robins or *{crows, ravens} → penguins*
  - **Premise diversity:**
    {crows, robins} → sparrows or *{crows, ravens} → sparrows*
  - **In-category monotonicity** *(support spans query)*
    {crows, robins} → sparrows or *{crows} → sparrows*
  - **In-category non-monotonicity** *(support is narrower than query)*
    {brown bears, grizzly bears} → buffalo or *{brown bears} → buffalo*
  - **Cross-category non-monotonicity** *(support is broader than query)*
    {flies, orangutans} → bees or *{flies} → bees*

Human Semantic Anomalies / Idiosyncrasies

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories:**

  - **Metric Theories:** ***parametric distances*** of representations in a high dimension vector space
    (Smith, Shobin, Rips, 1974; Miklov, 2013 - e.g. ‚Word2Vec, ~ISC)

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories:**

  - **Metric Theories:** ***parametric distances*** of representations in a high dimension vector space
    (Smith, Shobin, Rips, 1974; Miklov, 2013 - e.g. ‚Word2Vec, ~ISC)

  - **Feature Contrast / Coverage Theories:** ***discrete (set theoretic) intersection*** / overlap
    (Tversky, 1977; Osherson et al., 1990)

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories:**

  - **Metric Theories:** ***parametric distances*** of representations in a high dimension vector space
    (Smith, Shobin, Rips, 1974; Miklov, 2013 - e.g. ,Word2Vec, ~ISC)

  - **Feature Contrast / Coverage Theories:** ***discrete (set theoretic) intersection*** / overlap
    (Tversky, 1977; Osherson et al., 1990)

  - **Bayesian Inference Theories**: likelihood relative to prior
    (Xu & Tenenbaum, 2007; Griffiths et al., 2010)

Human Semantic Anomalies / Idiosyncrasies

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories**
- **Context**
  - ***Warping of semantic space*** **to change distances among items as a function of context**

Human Semantic Anomalies / Idiosyncrasies

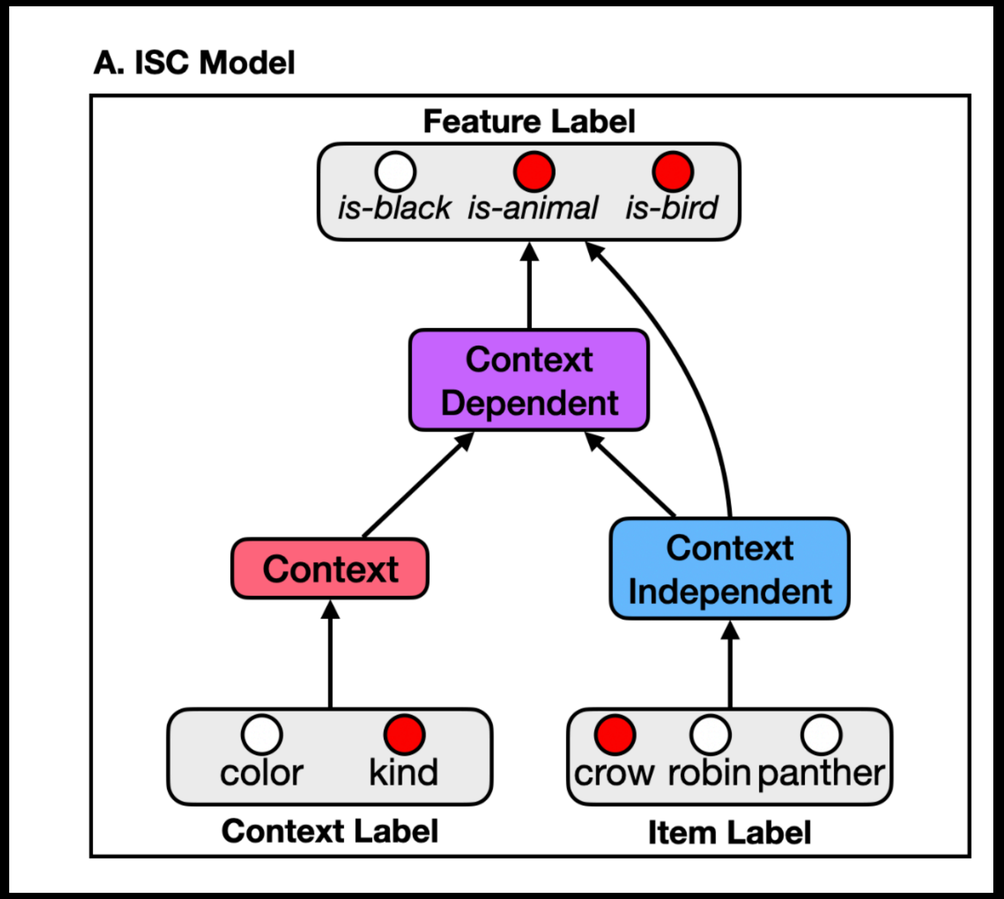
- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories**
- **Context**
  - ***Warping of semantic space*** **to change distances among items as a function of context**
  - ***But:***
    - **To what extent can context effects arise as *emergent property* of statistical learning of *continuous representations?***

Human Semantic Anomalies / Idiosyncrasies

- **Similarity Judgments**
- **Category Judgements** *(Inductive Inference)*
- **Theories**
- **Context**
  - ***Warping of semantic space*** **to change distances among items as a function of context**
  - ***But:***
    - **To what extent can context effects arise as *emergent property* of statistical learning of *continuous representations?***
    - **How do people *infer* this *“on the fly?”***

Integrated Semantics and Control — Context *Inference* (ISC-CI)

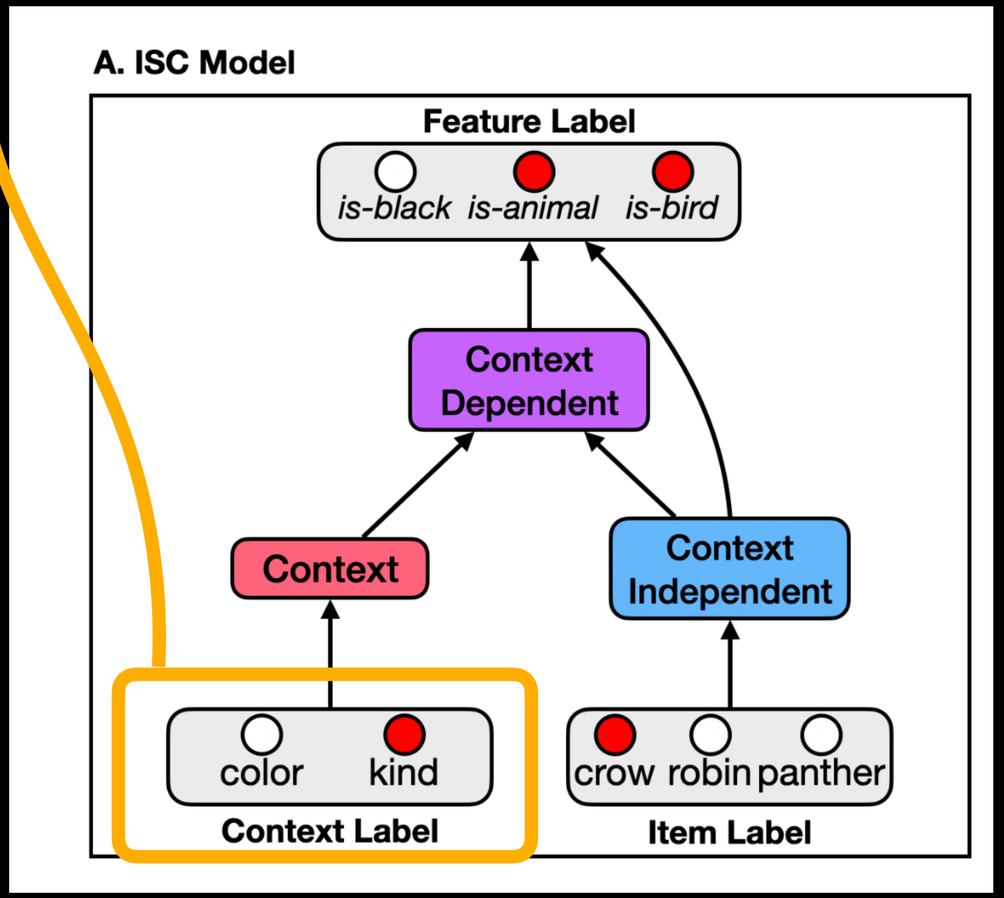
Giallanza, Campbell, Rogers & Cohen (under review)



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

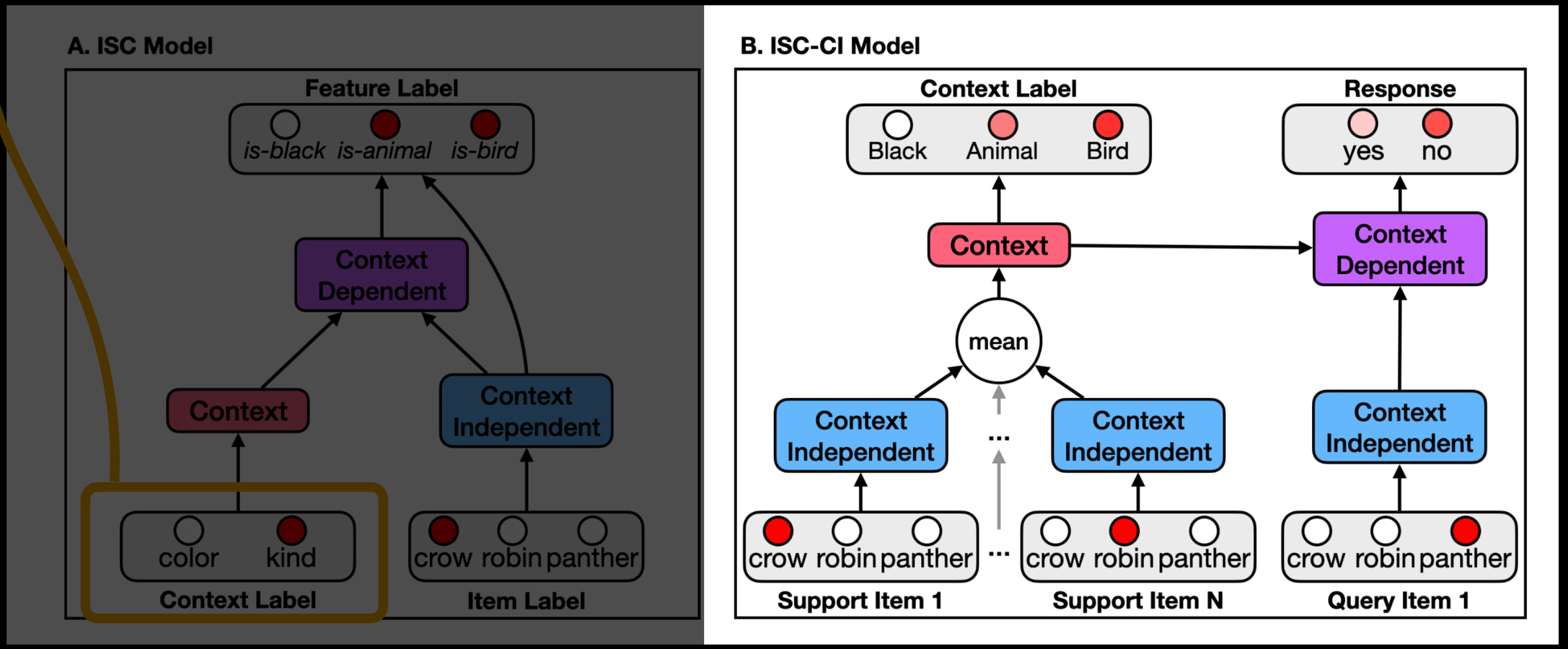
Context



Integrated Semantics and Control — Context *Inference* (ISC-CI)

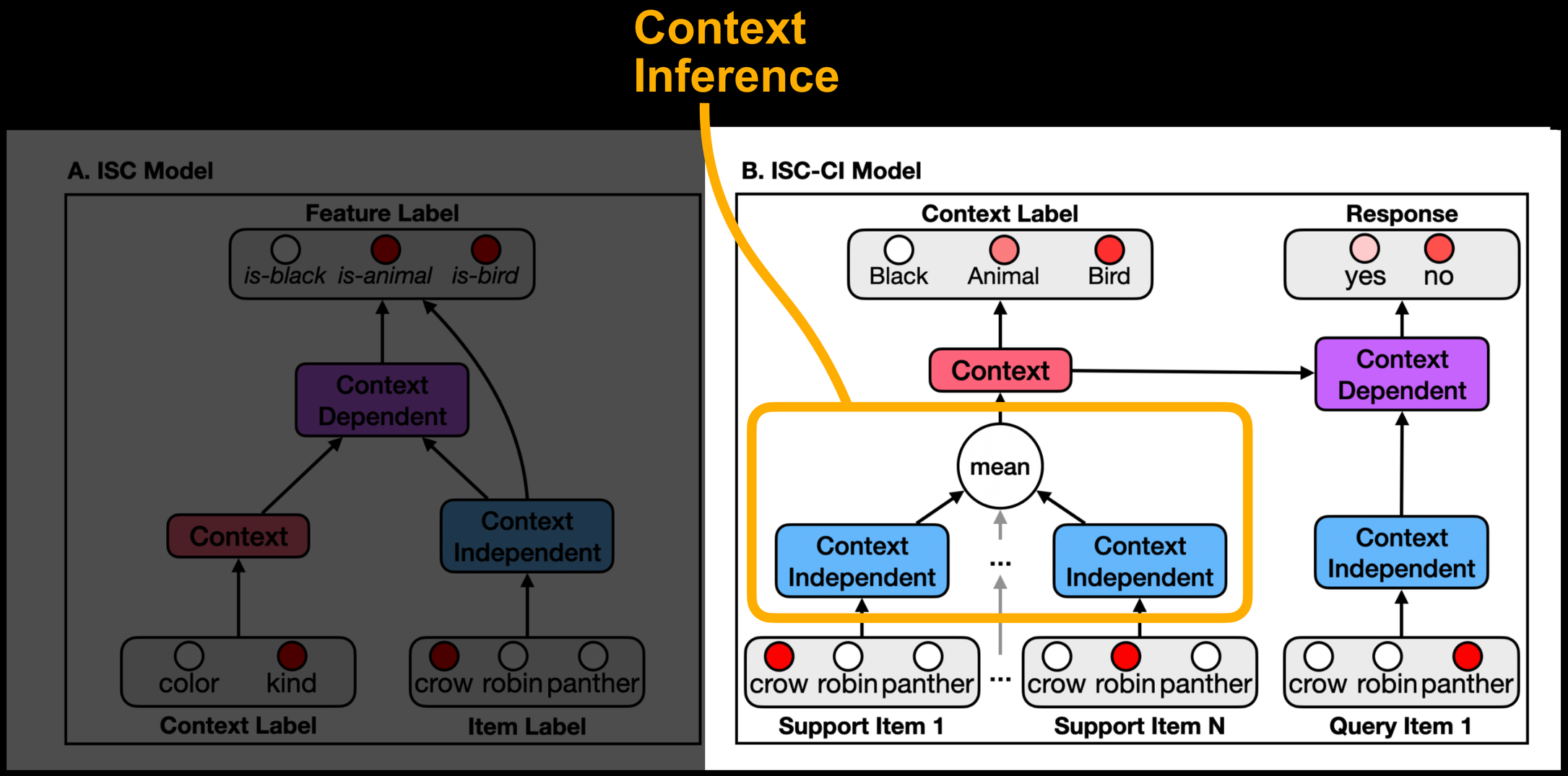
Giallanza, Campbell, Rogers & Cohen (under review)

Context



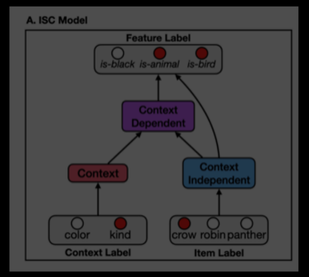
Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)



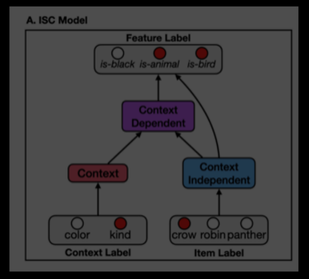
Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

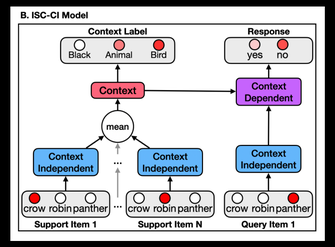


Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)



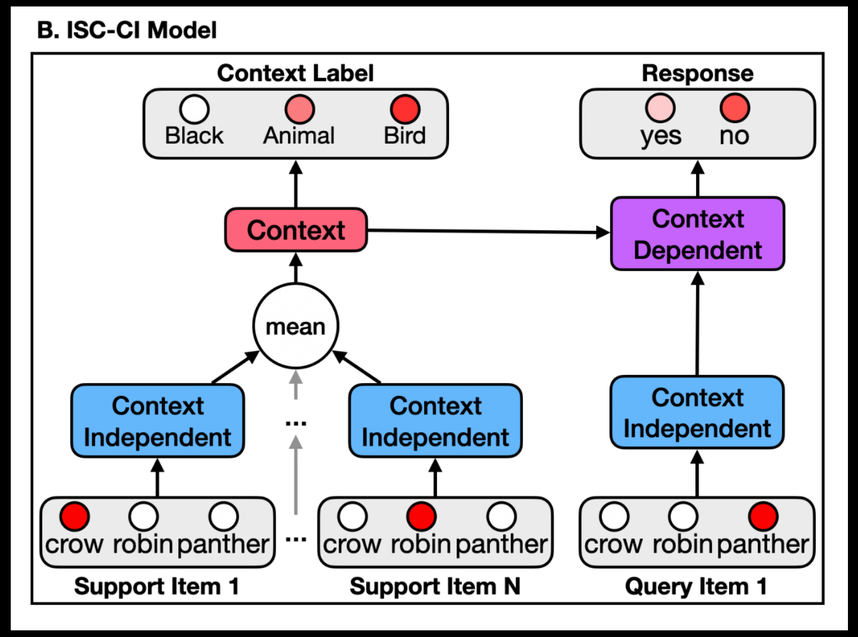
- **ISC-CI:**



  - objects occurring together in a given context tend to share properties relevant to that context: ***temporal autocorrelation***
  - these co-occurrence statistics are learned over the course of ***development***
  - **this implicit knowledge provides a basis for inferring, from a few examples of objects encountered in a new context, both which features are relevant in that context and what other objects are likely to occur in that context**

Integrated Semantics and Control — Context *Inference* (ISC-CI)

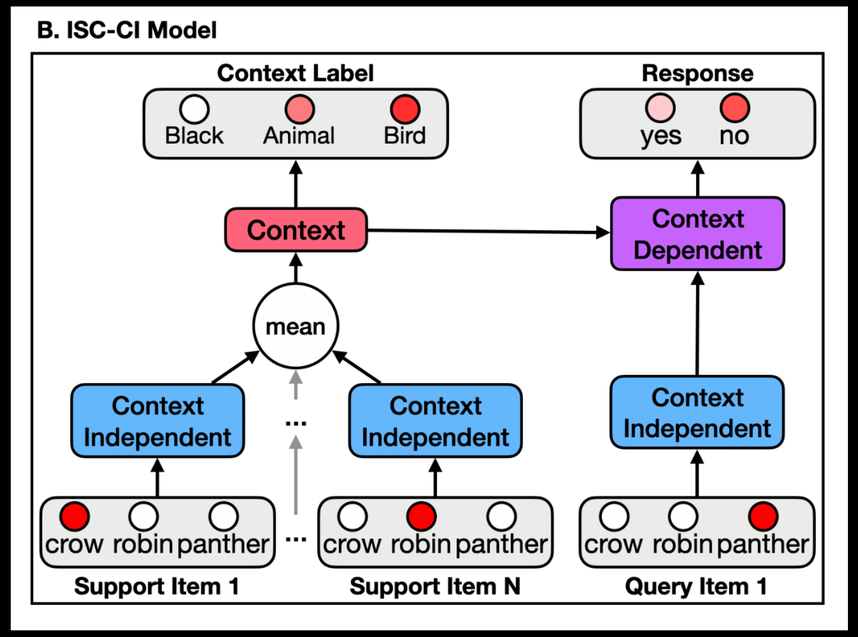
Giallanza, Campbell, Rogers & Cohen (under review)



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

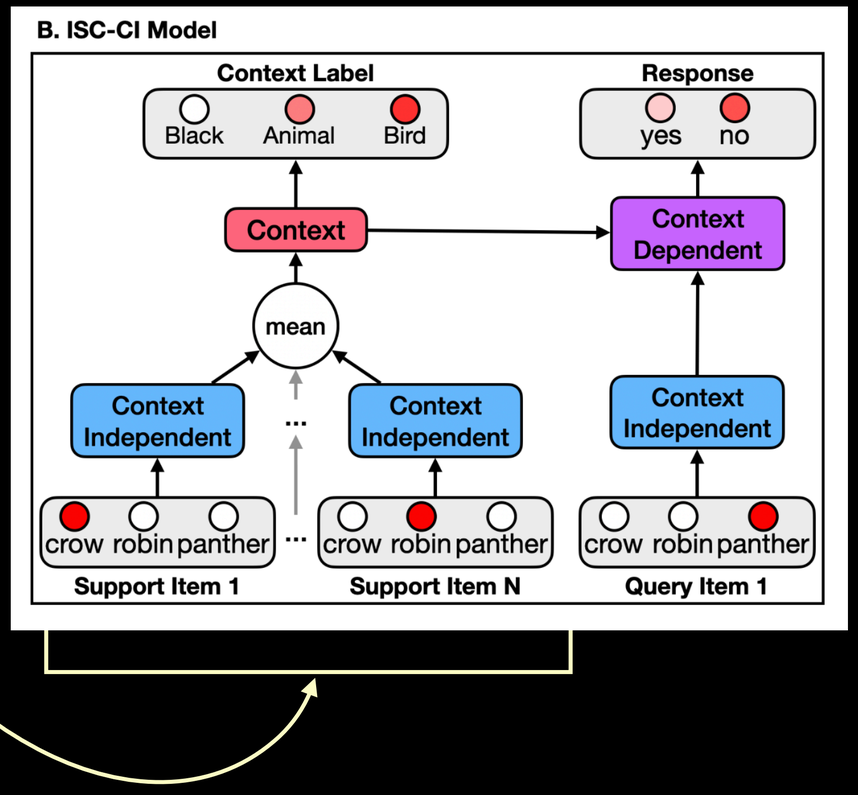
- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

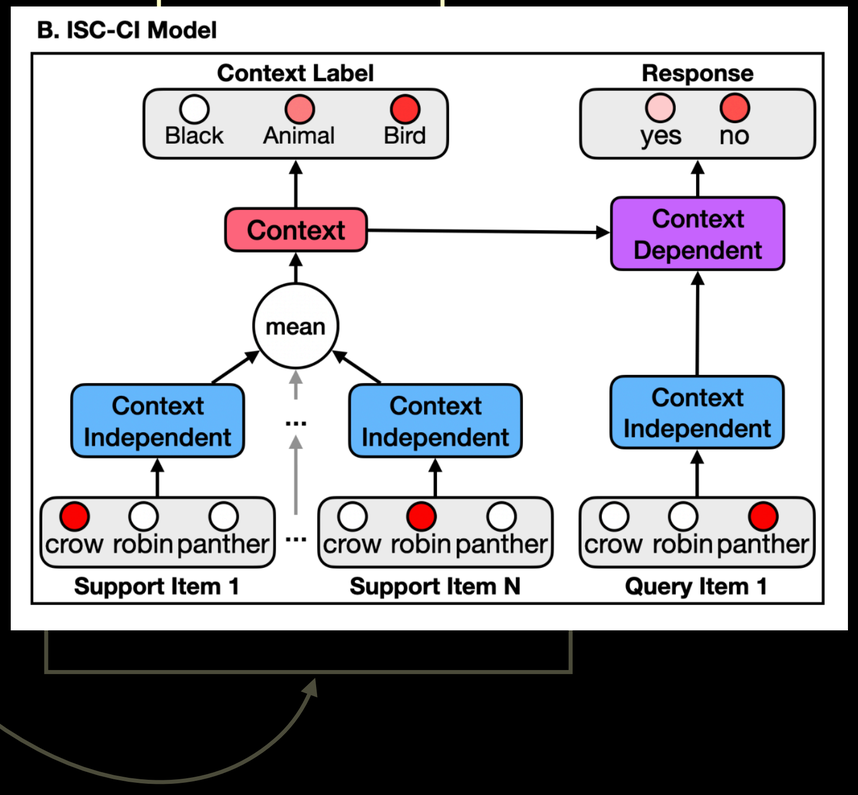
- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **“Episodes” of 2 items sharing a single feature**



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

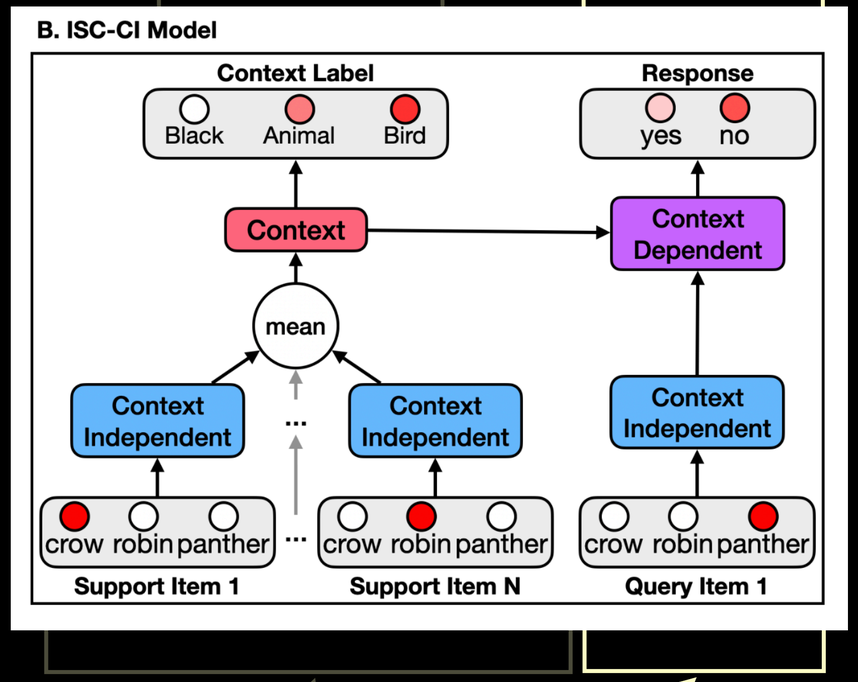
- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **“Episodes” of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)



Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **“Episodes” of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)
  - **Predict which additional objects also likely to occur in that context**
    {crow, robin, sparrow…} → raven, ~jaguar



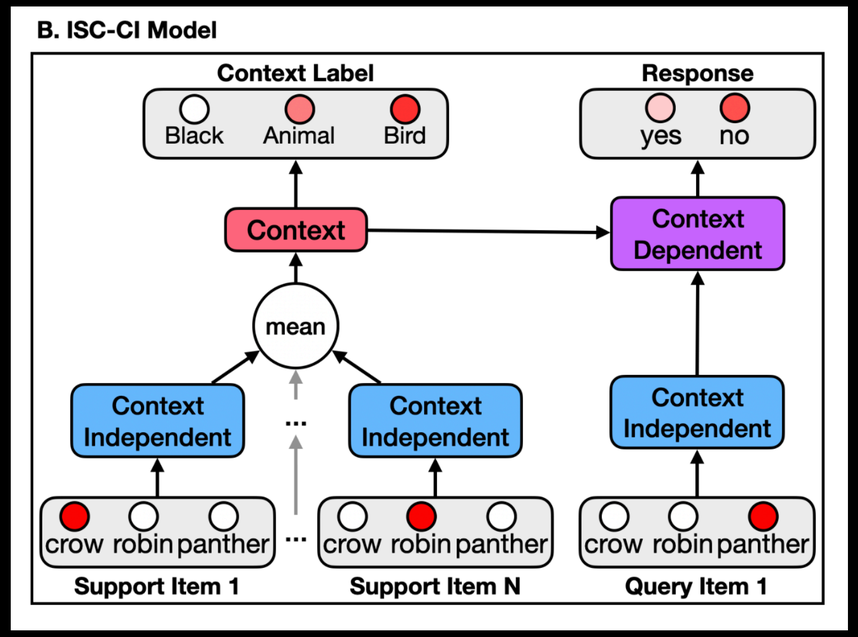
Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **"Episodes" of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)
  - **Predict which additional objects also likely to occur in that context**
    {crow, robin, sparrow…} → raven, ~jaguar
- **Testing**
  - **Tasks:**

    Similarity Judgements

    Category Inference

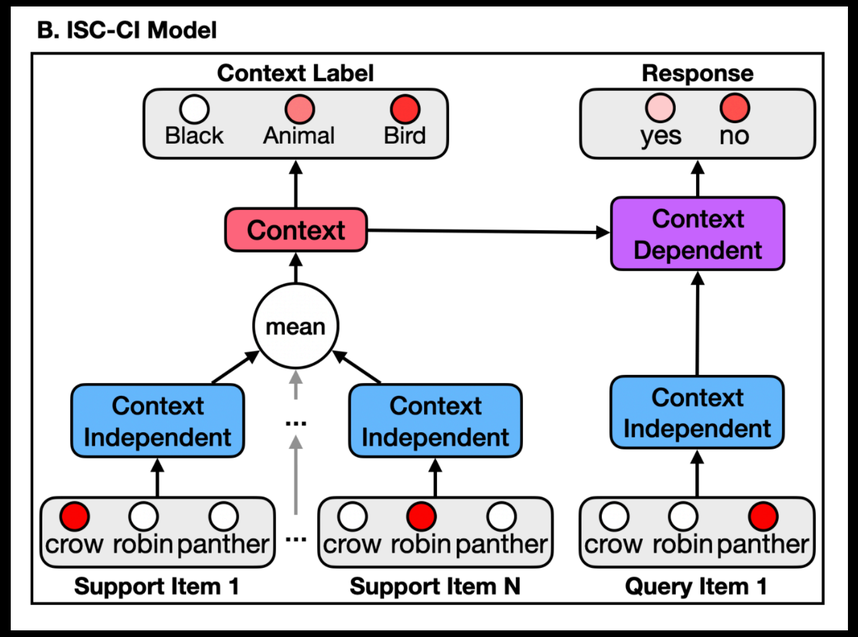


Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **"Episodes" of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)
  - **Predict which additional objects also likely to occur in that context**
    {crow, robin, sparrow…} → raven, ~jaguar
- **Testing**
  - **Tasks:**
    Similarity Judgements
    Category Inference
  - **Format:**

Argument (context):		Conclusion (stimulus)
{support set}	→	*{query set}*
example members:		member of the category?
{crow, robin}	→	*sparrow?*



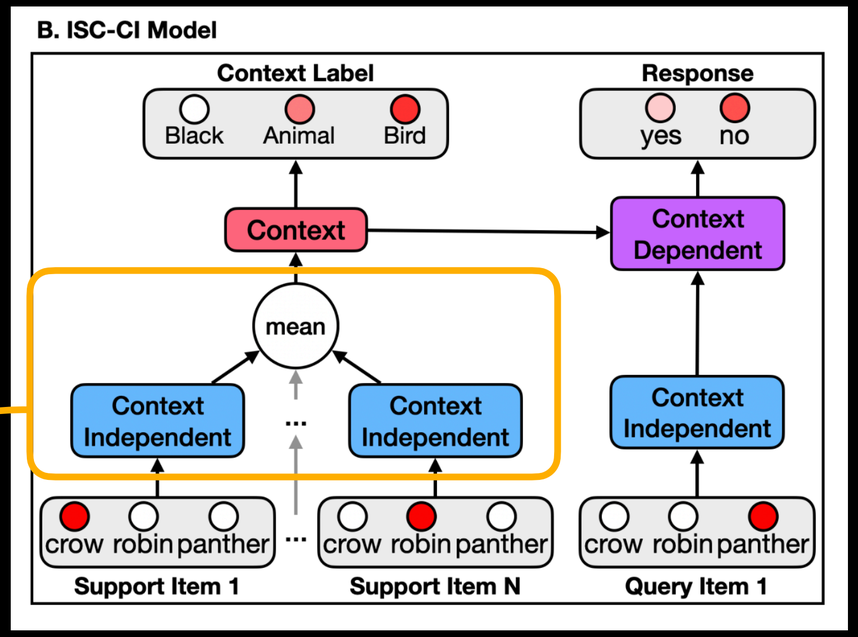
Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **"Episodes" of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)
  - **Predict which additional objects also likely to occur in that context**
    {crow, robin, sparrow…} → raven, ~jaguar
- **Testing**
  - **Tasks:**
    Similarity Judgements
    Category Inference
  - **Format:**

Argument (context):		Conclusion (stimulus)
{support set}	→	*{query set}*
example members:		member of the category?
{crow, robin}	→	*sparrow?*

Integration



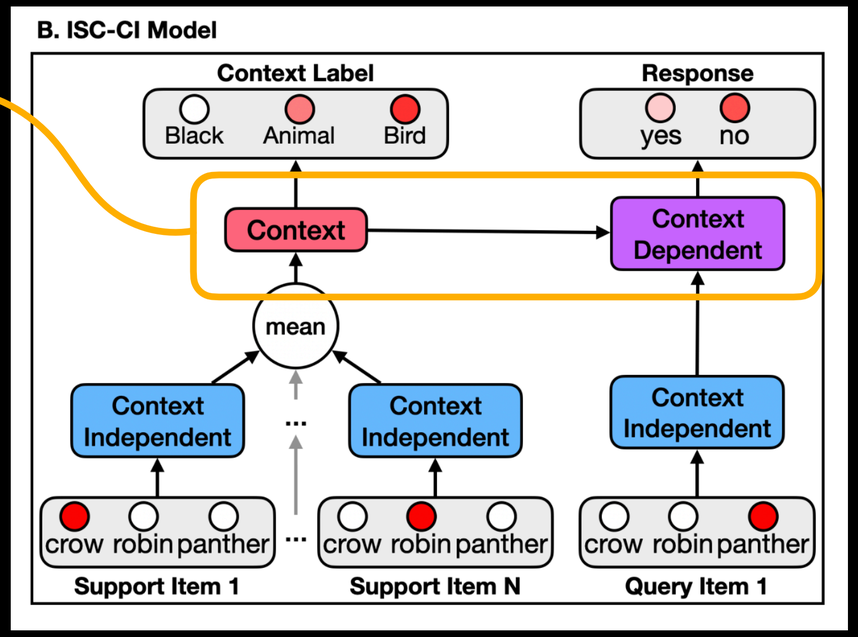
Integrated Semantics and Control — Context *Inference* (ISC-CI)

Giallanza, Campbell, Rogers & Cohen (under review)

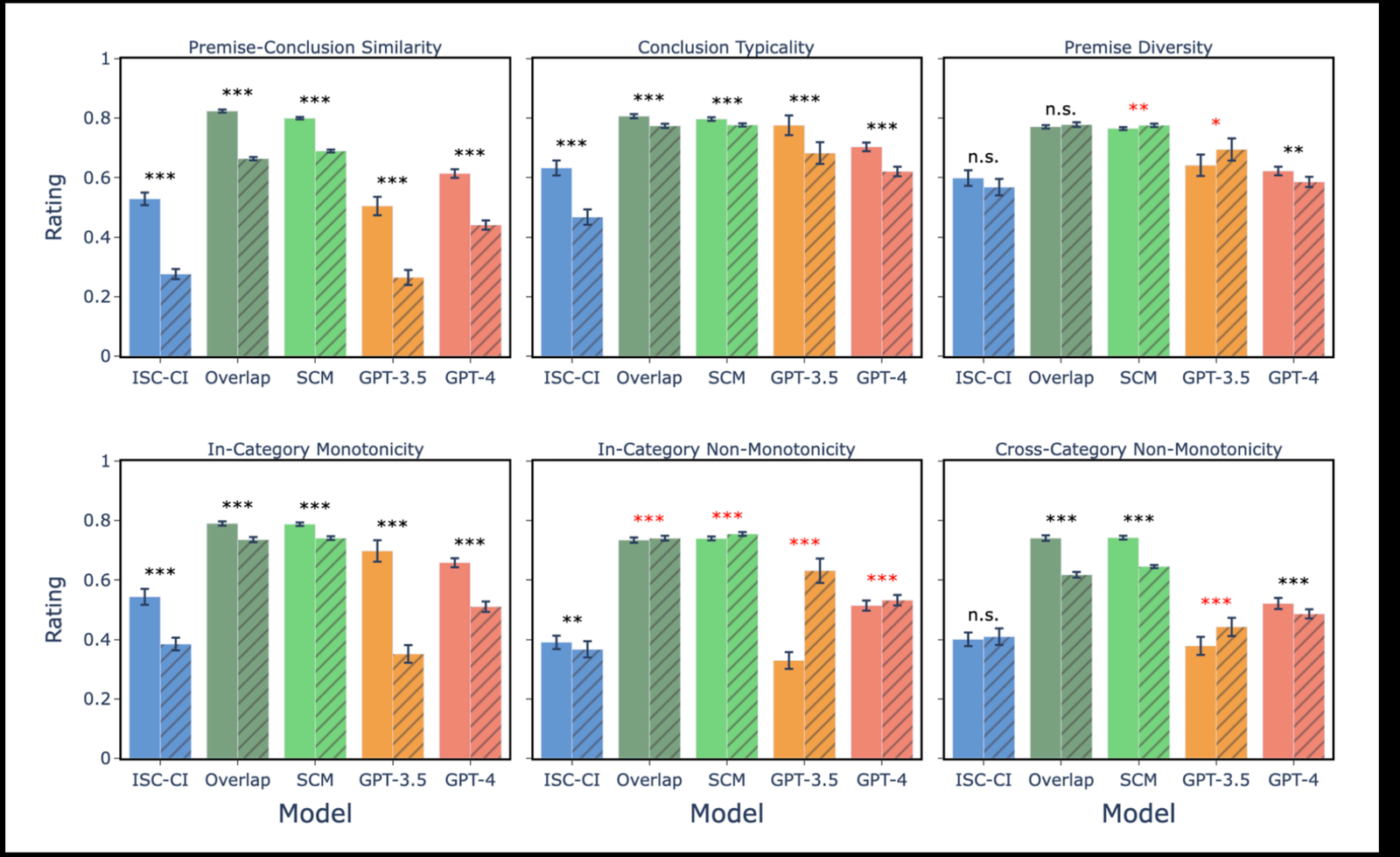
- **Training**
  - **Items from Leuven Concepts Database** *(feature ratings)*
  - **"Episodes" of 2 items sharing a single feature**
  - **Predict context label for the one feature shared by all objects**
    {crow, robin, sparrow…} → Bird (context)
  - **Predict which additional objects also likely to occur in that context**
    {crow, robin, sparrow…} → raven, ~jaguar
- **Testing**
  - **Tasks:**
    Similarity Judgements
    Category Inference
  - **Format:**

Argument (context):		Conclusion (stimulus)
{support set}	→	*{query set}*
example members:		member of the category?
{crow, robin}	→	*sparrow?*

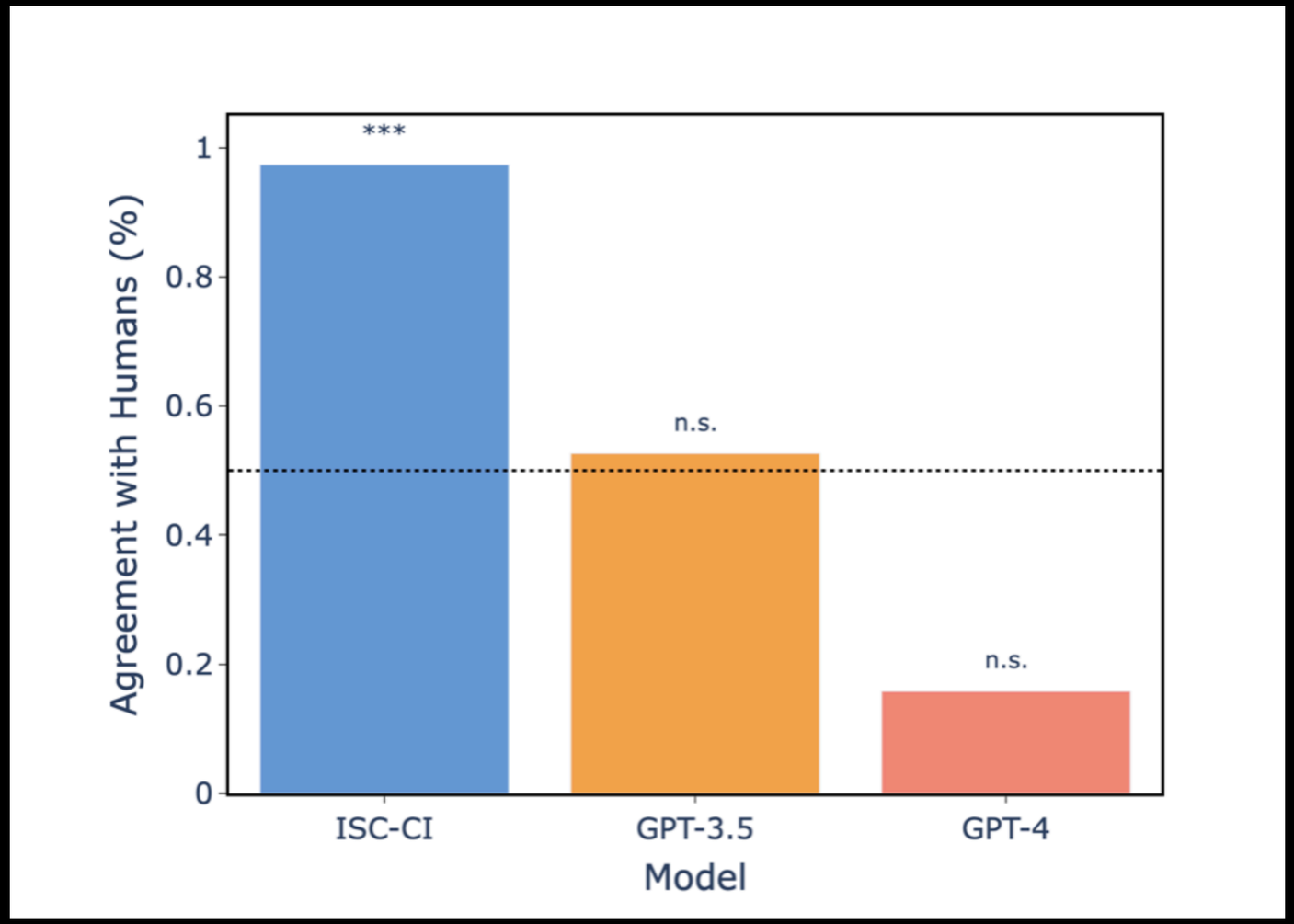
Attention / Control



Integrated Semantics and Control — Context *Inference* (ISC-CI)



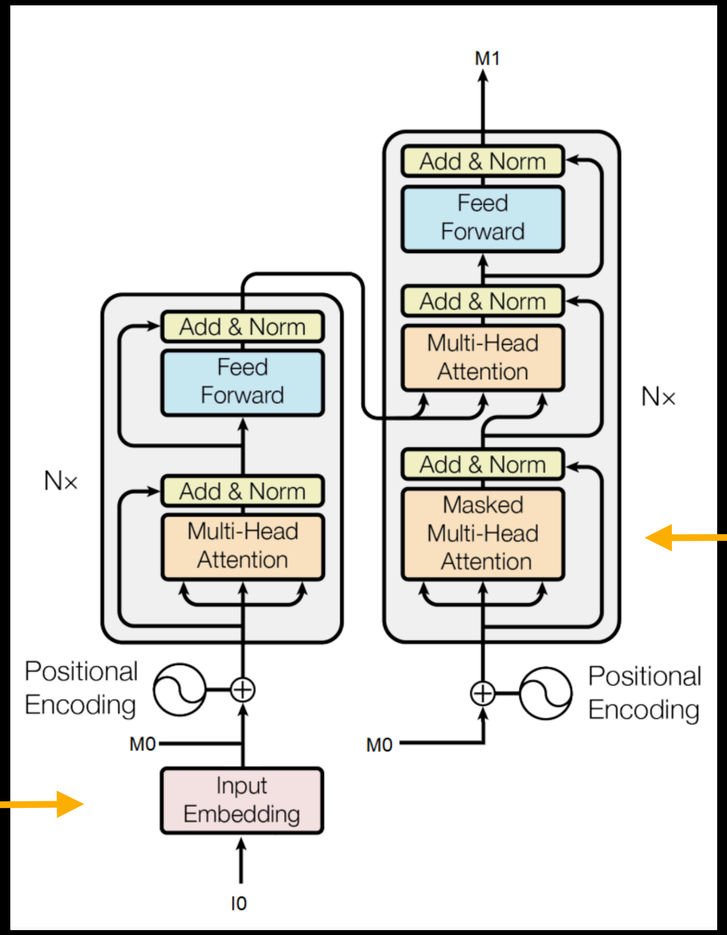
Integrated Semantics and Control — Context *Inference* (ISC-CI)



Comparison of model and human choices in multi-alternative similarity judgments Tversky & Gati (1978)

Transformer Architecture

Output



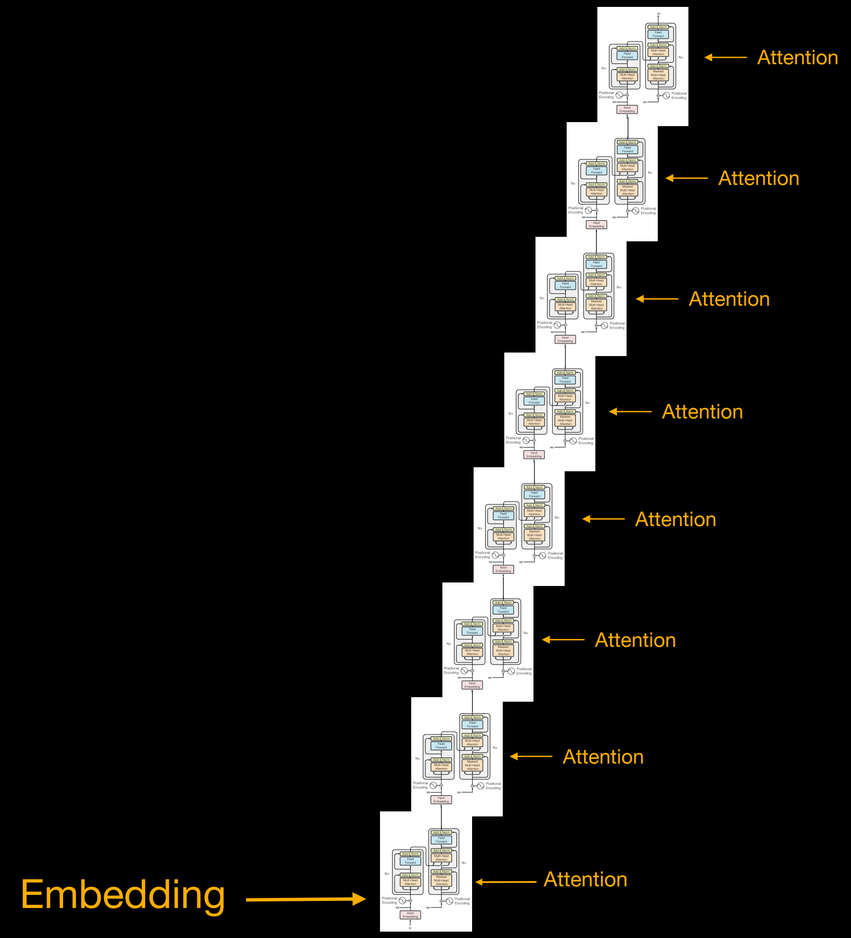
Attention

Embedding

Input

Large Langauge / Vision Models (LLMs)

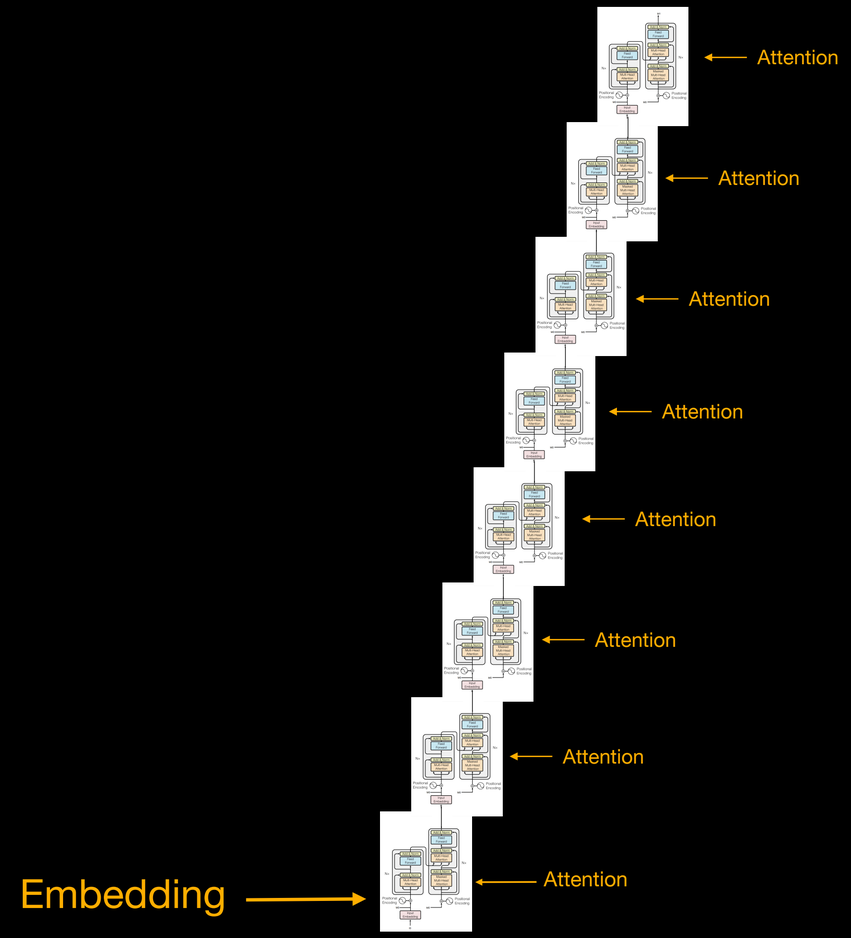
Output



Input

Large Langauge / Vision Models (LLMs)

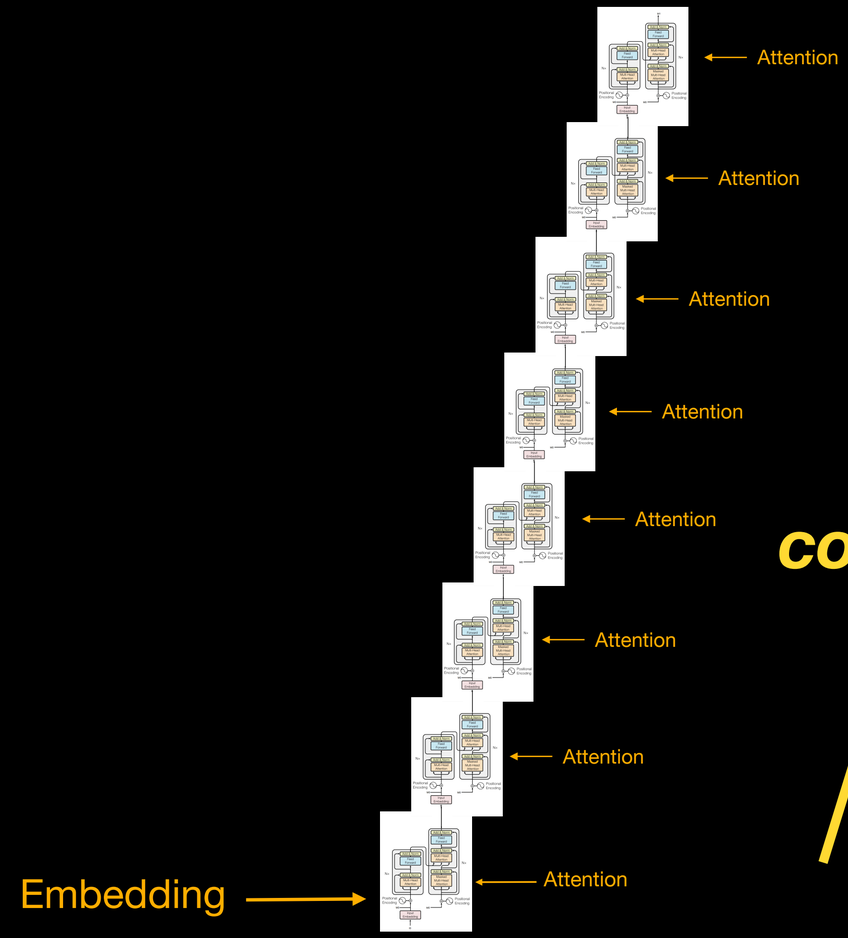
Output



Input ***5,000 years worth of data!***

Large Langauge / Vision Models (LLMs)

Output

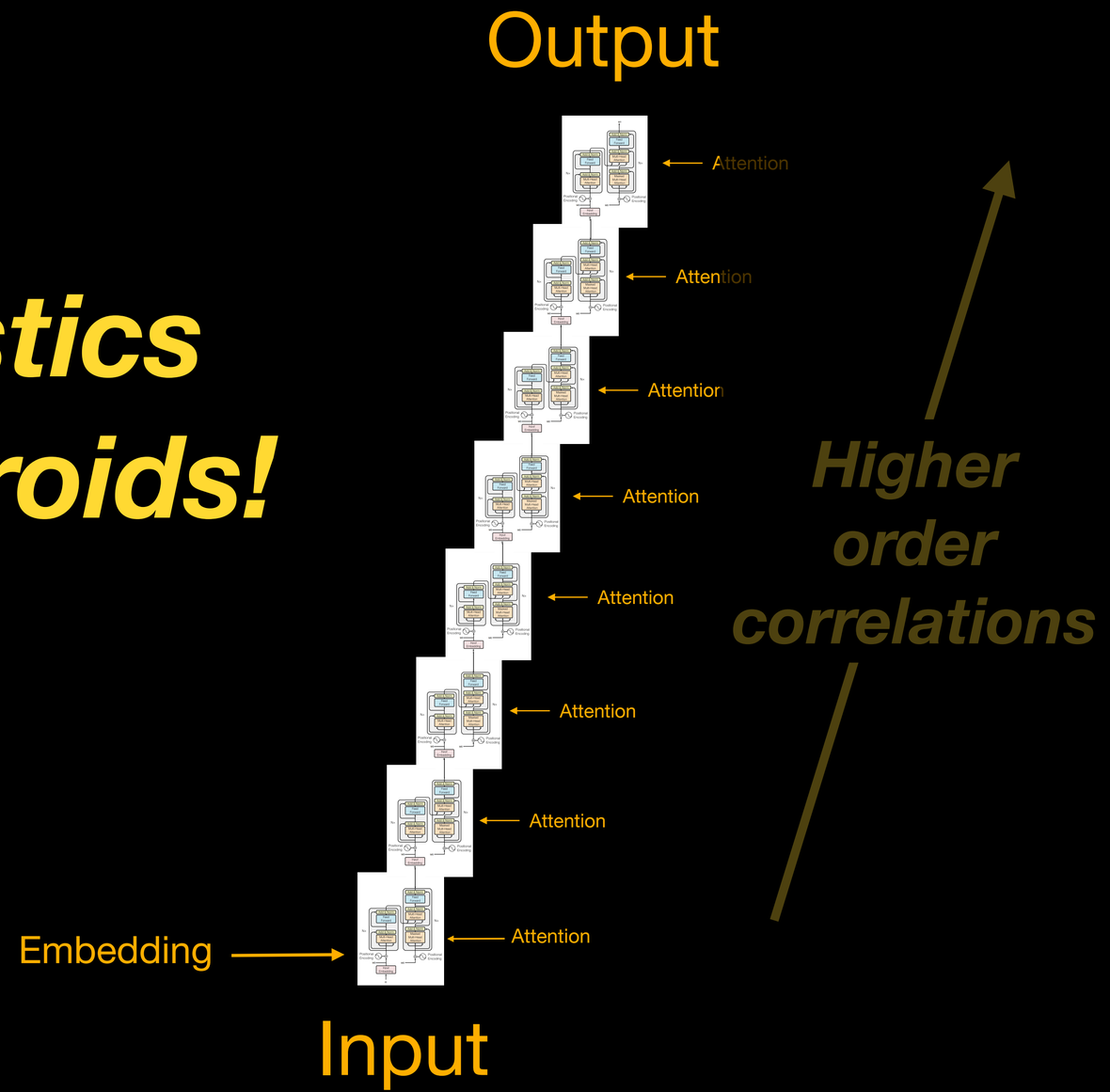


Higher order correlations

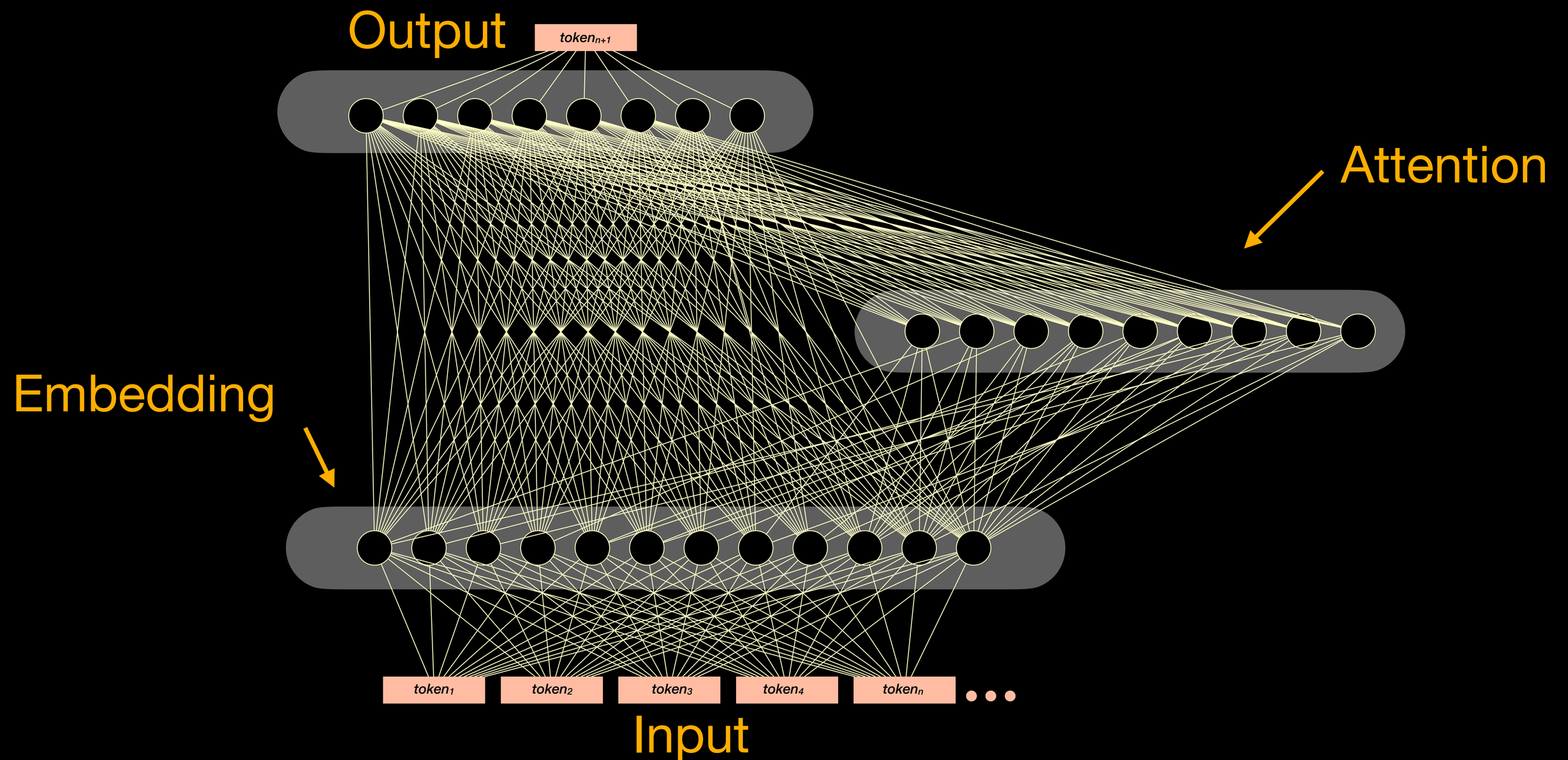
Input ***5,000 years worth of data!***

Large Langauge / Vision Models (LLMs)

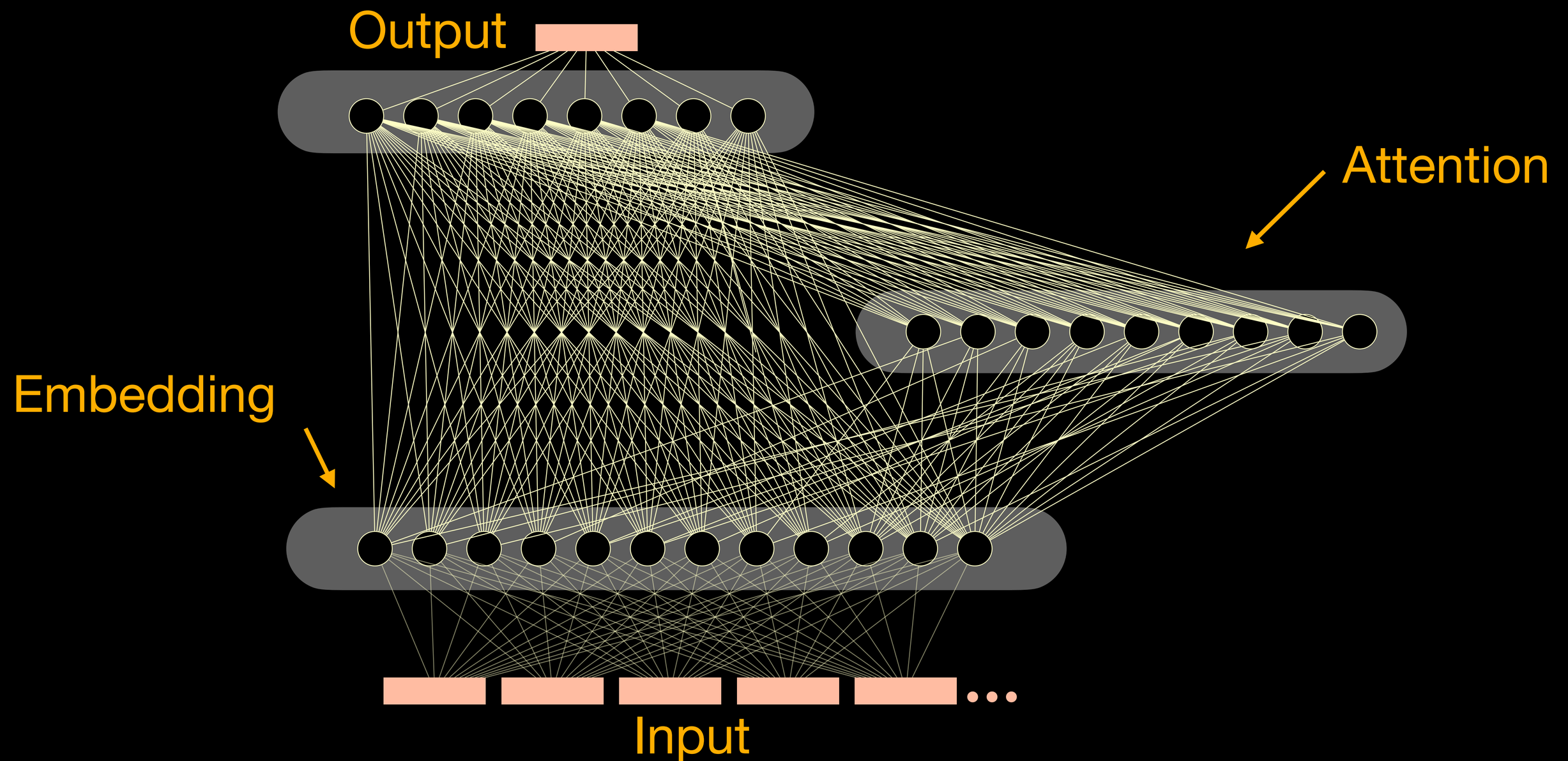
Statistics on Steroids!



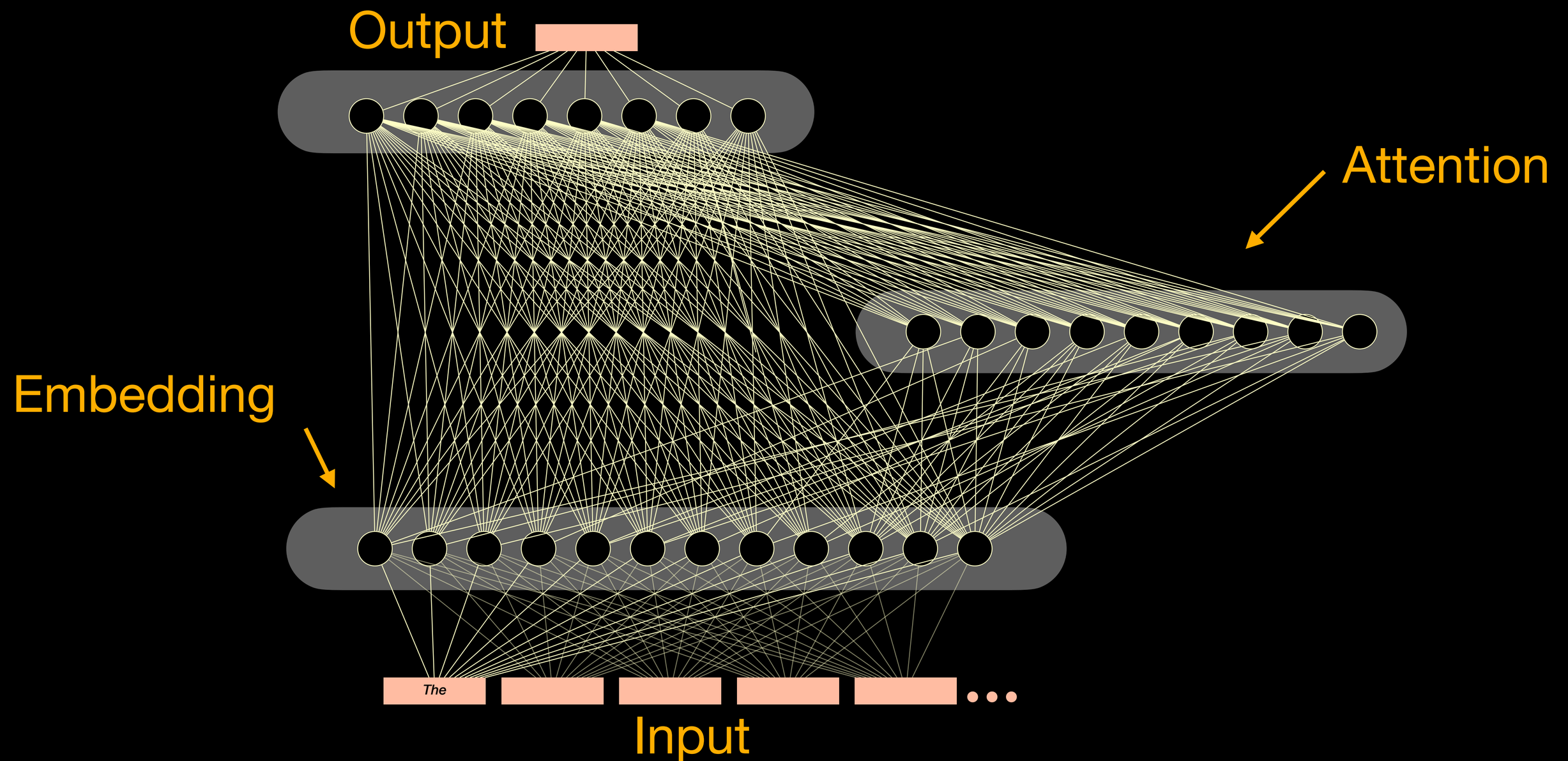
Transformer Architecture



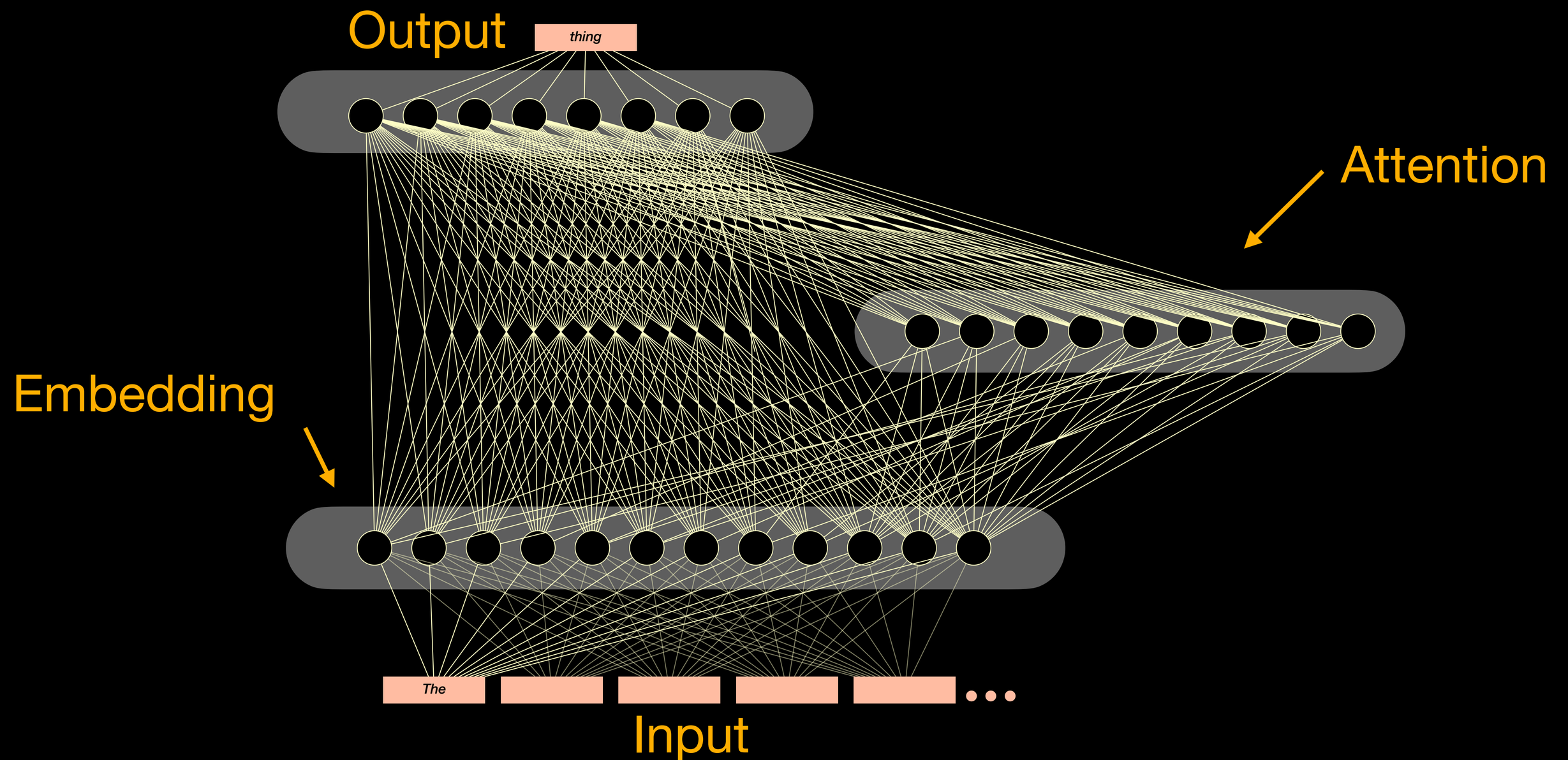
Transformer Architecture



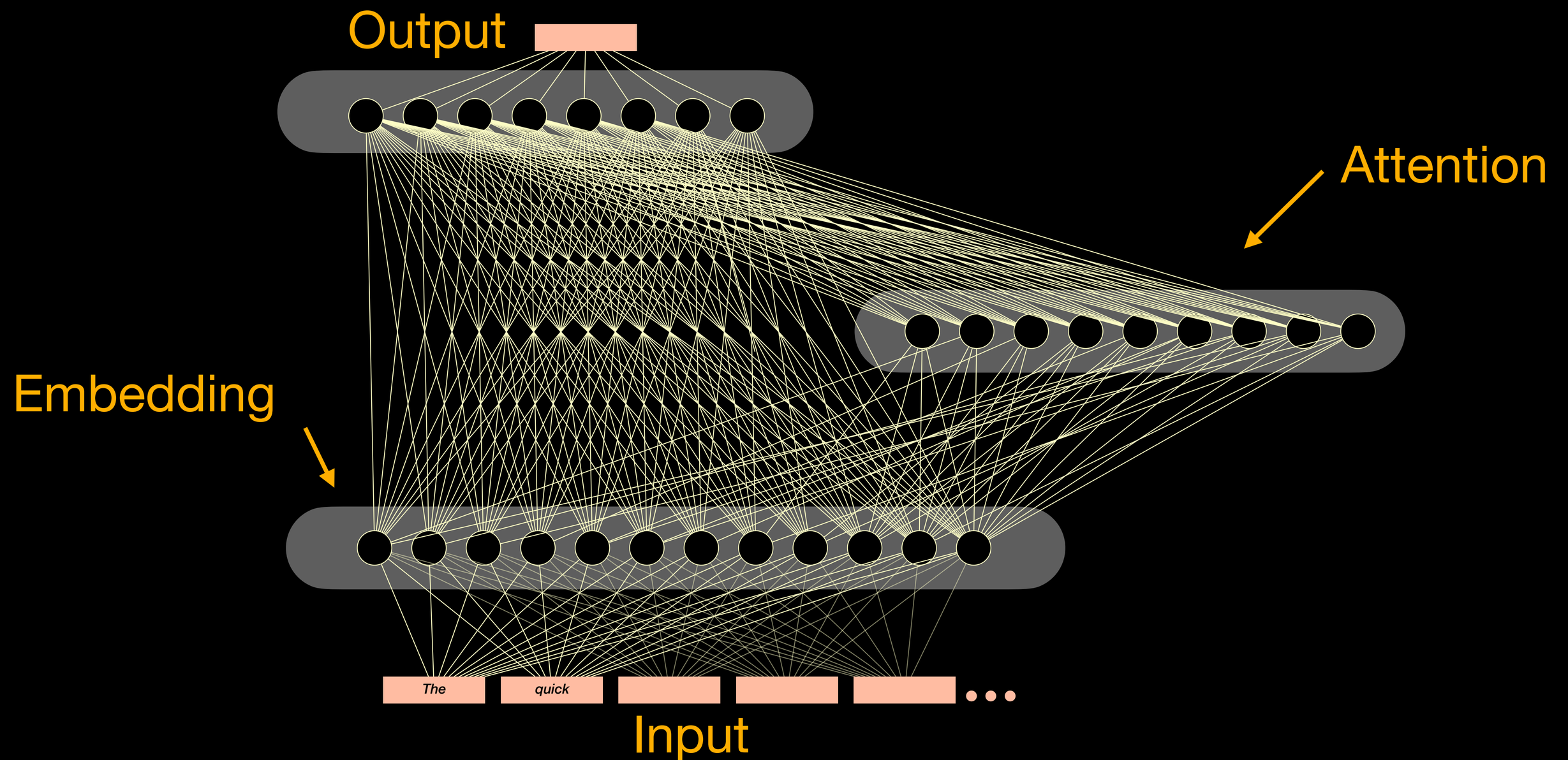
Transformer Architecture



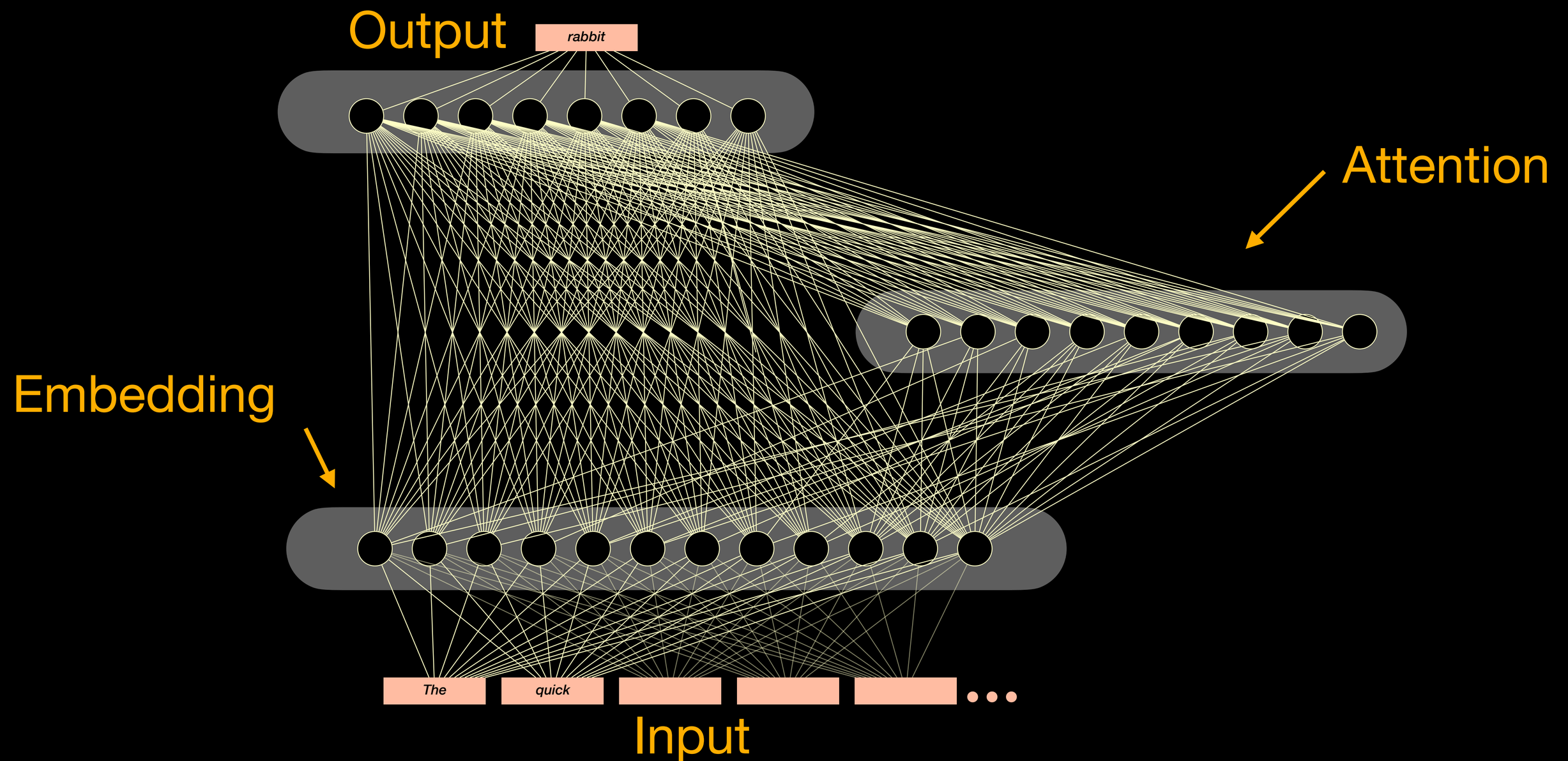
Transformer Architecture



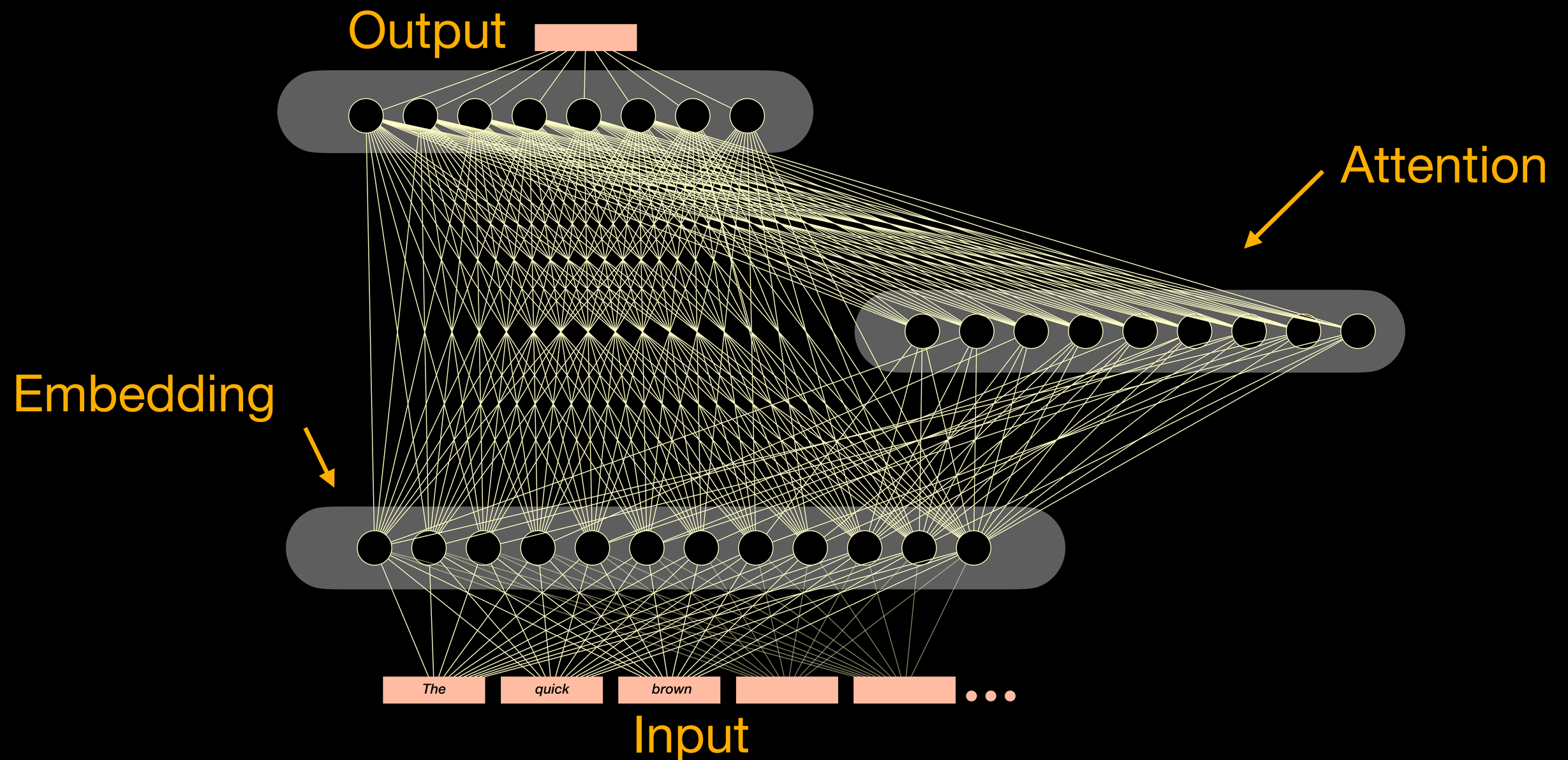
Transformer Architecture



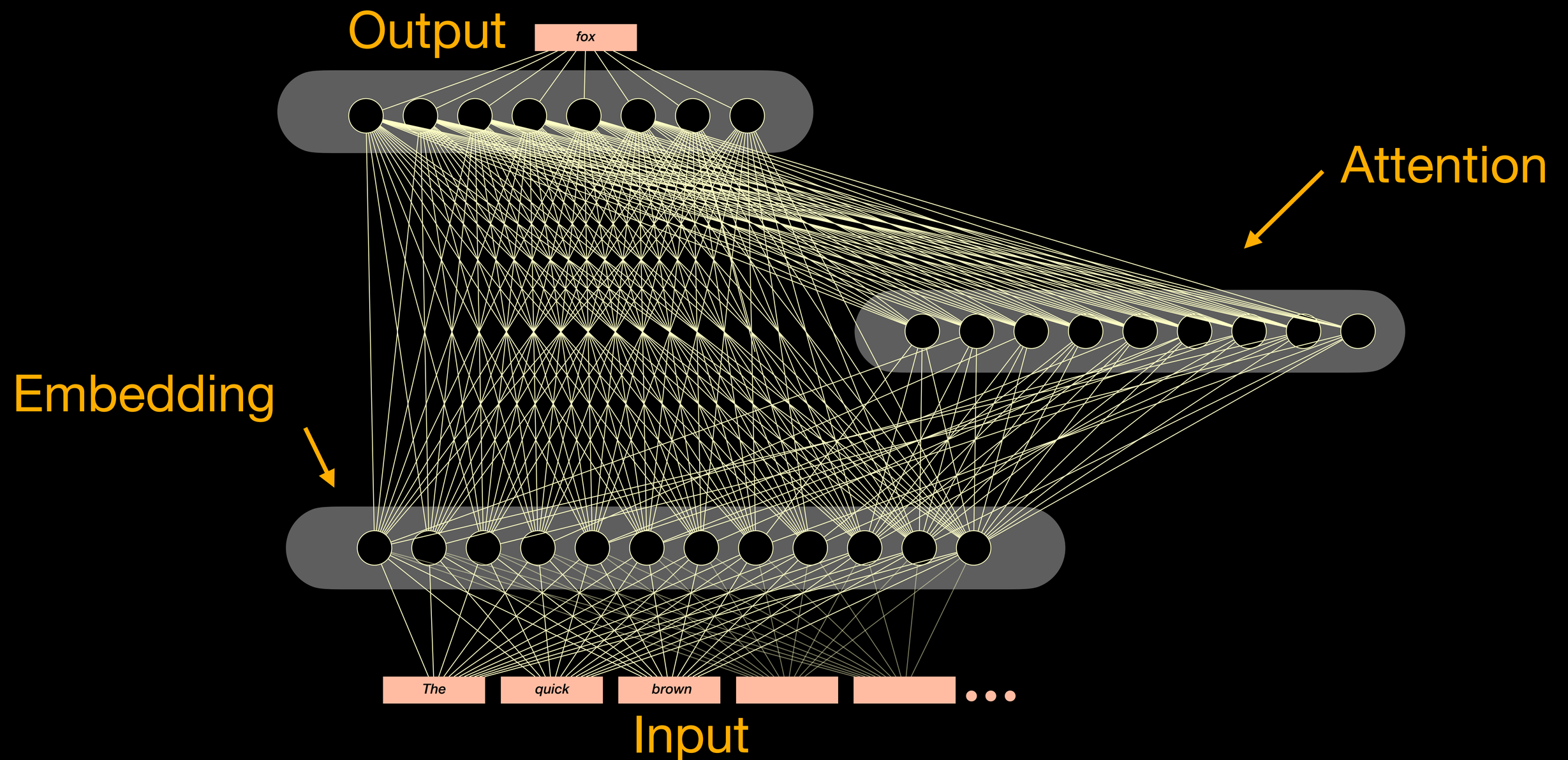
Transformer Architecture



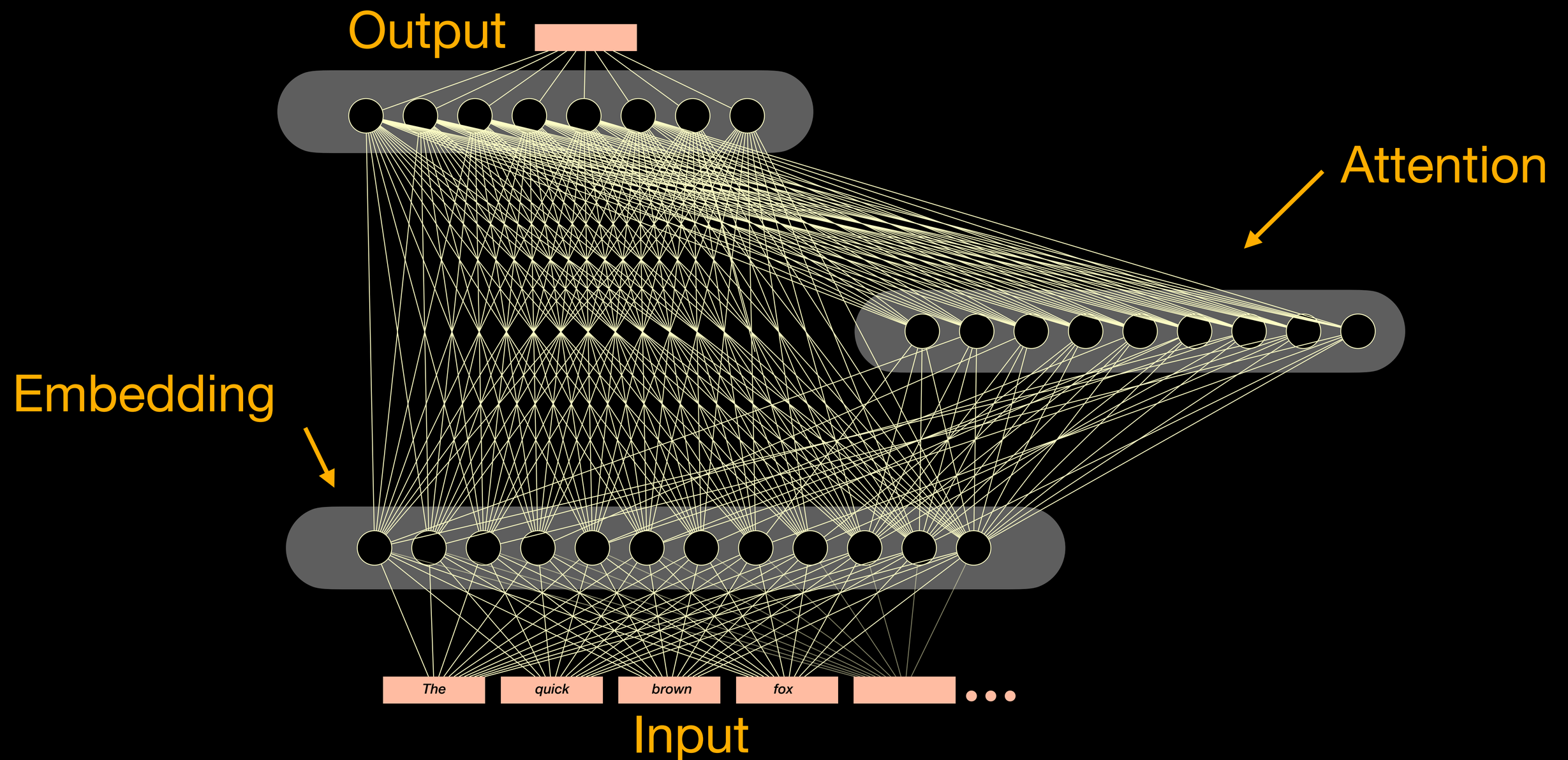
Transformer Architecture



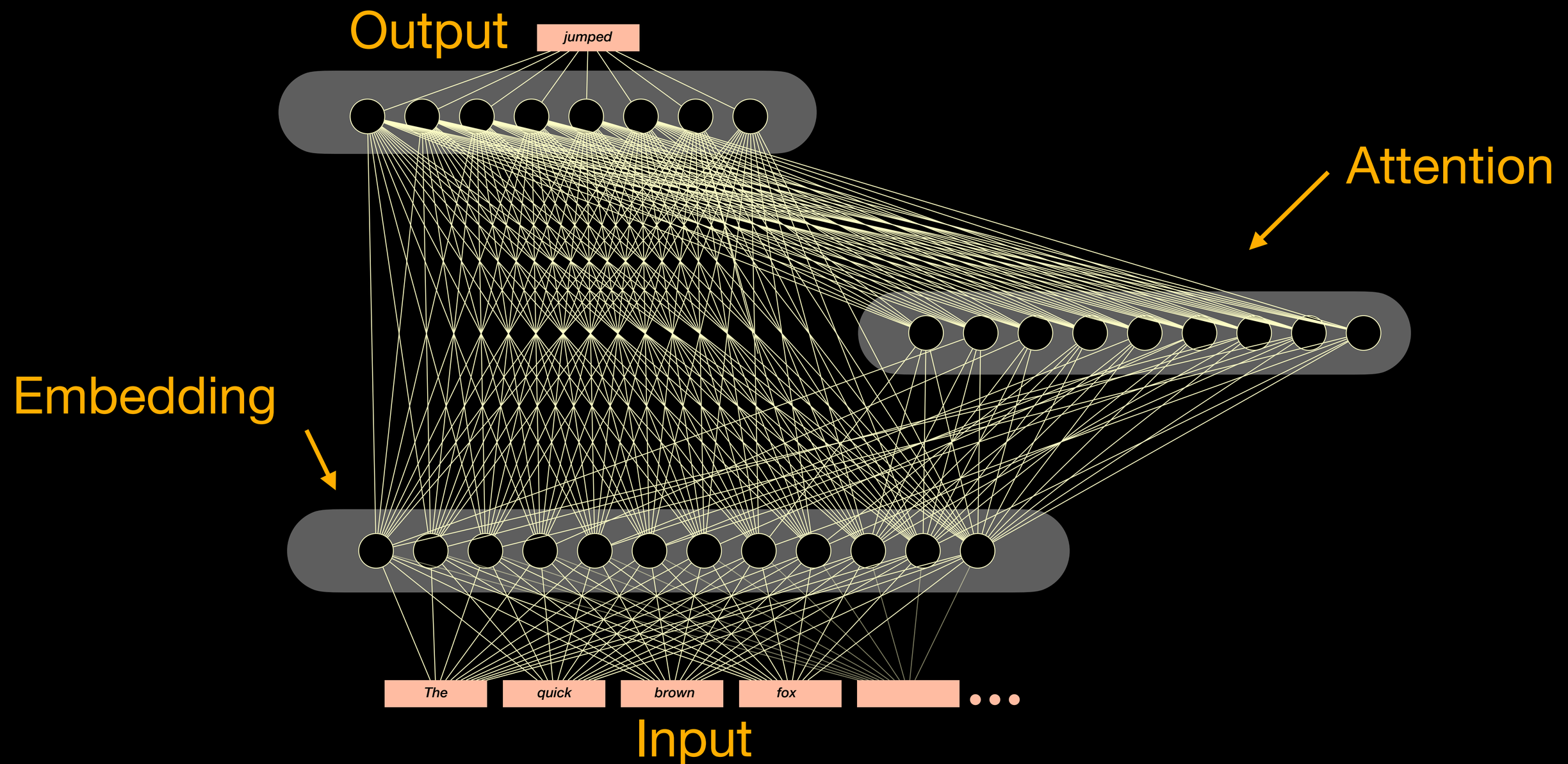
Transformer Architecture



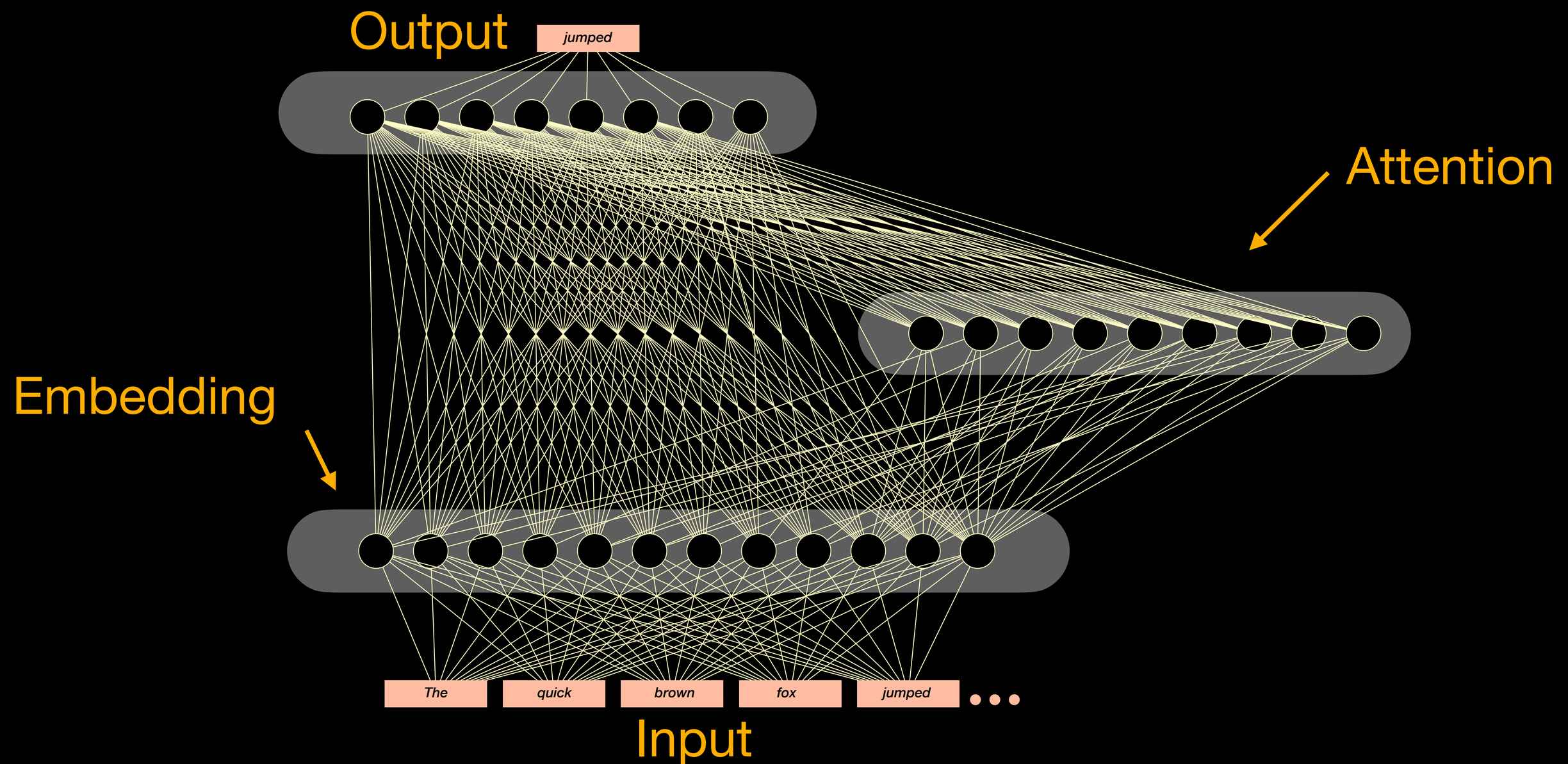
Transformer Architecture



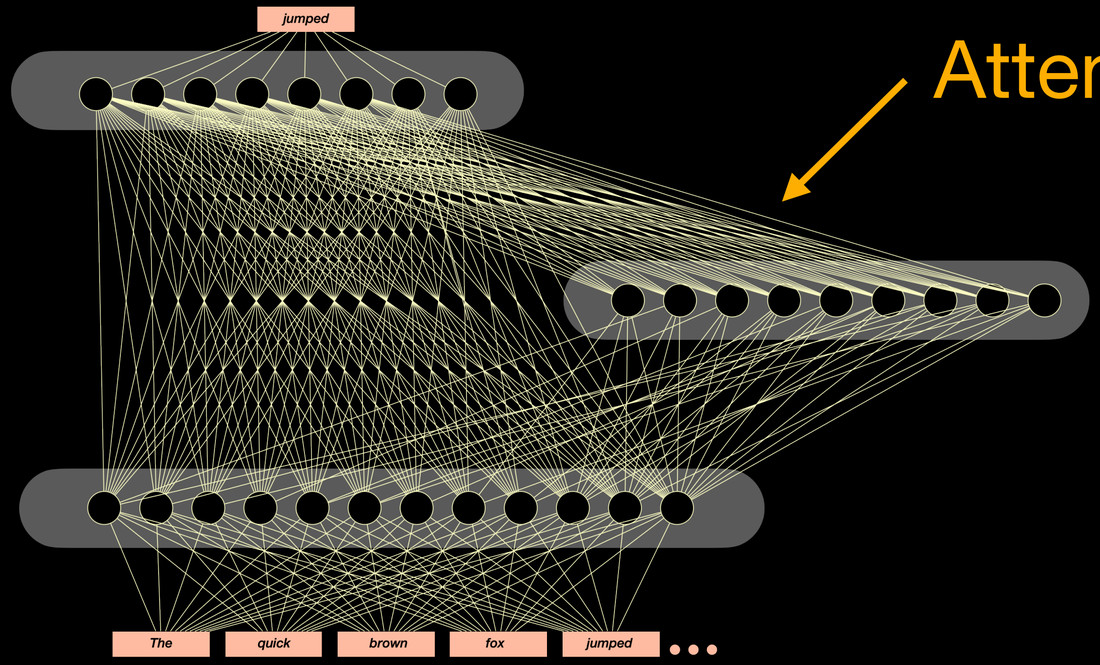
Transformer Architecture



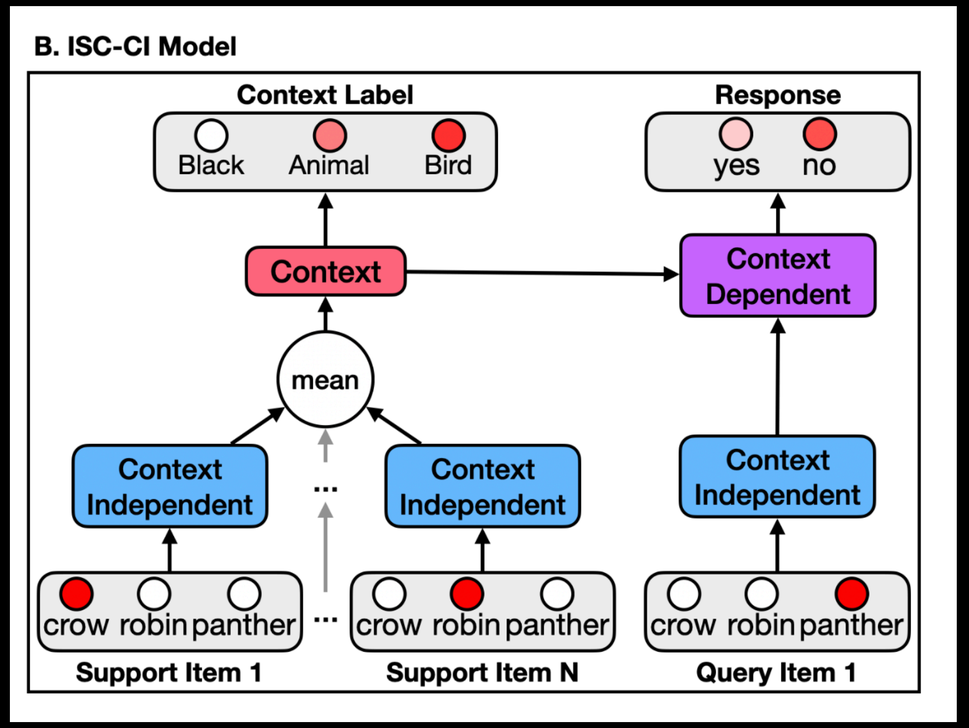
Transformer Architecture



Transformer Architecture

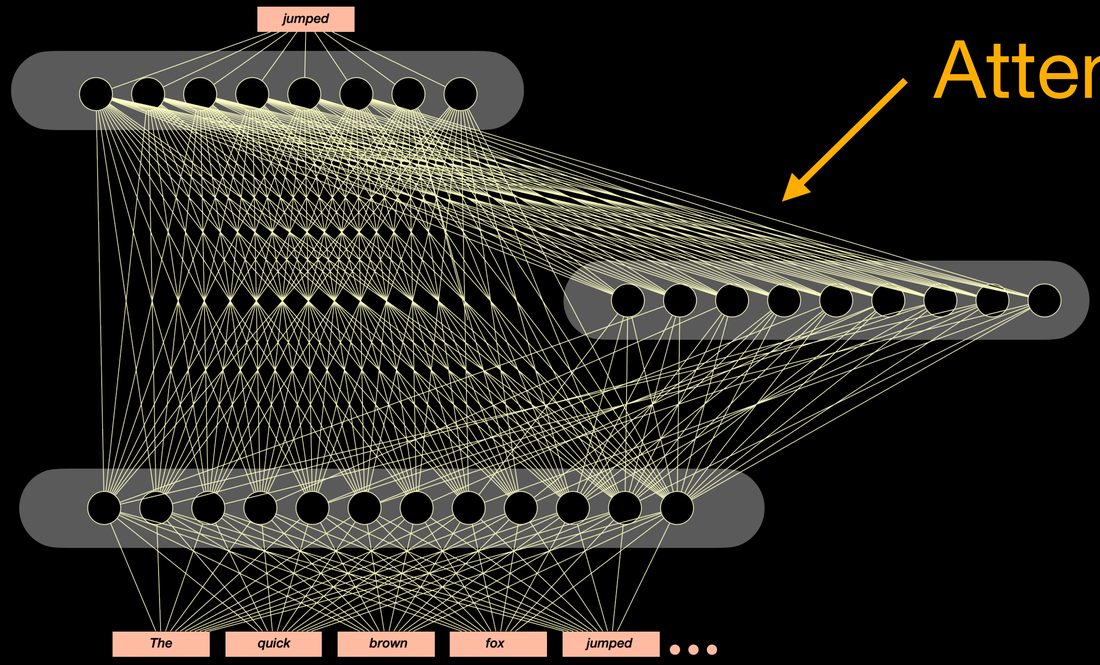


Attention

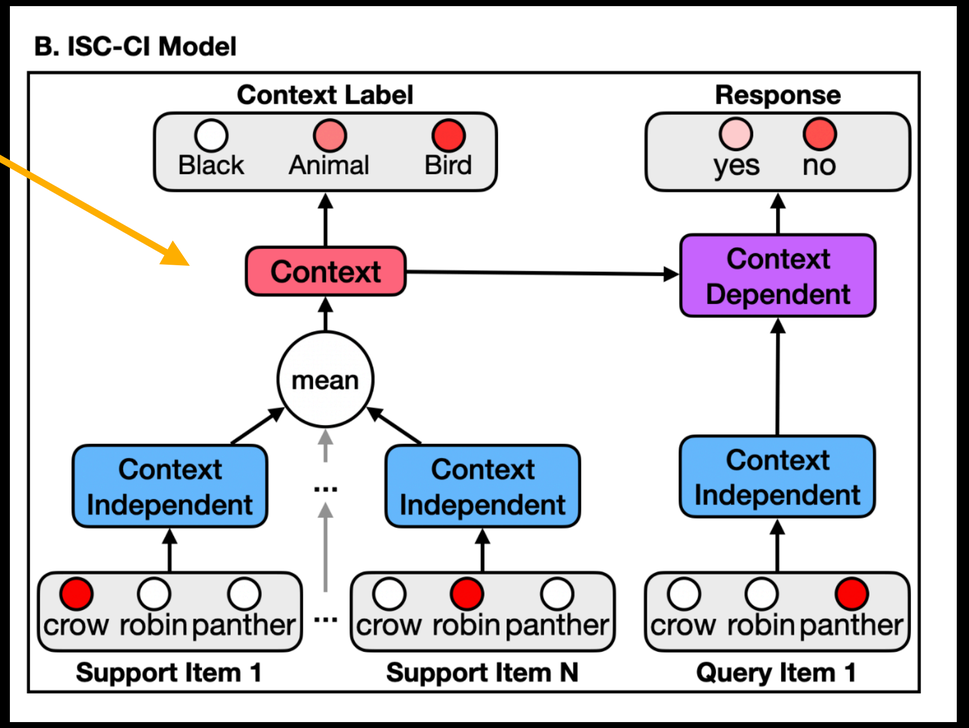


Embedding

Transformer Architecture



Attention



Embedding

Semantics and Context

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***
- Control reflects its use to ***select information*** relevant in particular ***contexts*** and for particular ***purposes***

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***
- Control reflects its use to ***select information*** relevant
  in particular ***contexts*** and for particular ***purposes***
- Representations used for particular contexts and purposes
  may require ***specialized processing apparatus***
  such as for rapid association formation, active maintenance, sequencing and search
  (e.g., novel settings, and temporally extended goal directed action)

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***
- Control reflects its use to ***select information*** relevant in particular ***contexts*** and for particular ***purposes***
- Representations used for particular contexts and purposes may require ***specialized processing apparatus*** such as for rapid association formation, active maintenance, sequencing and search *(e.g., novel settings, and temporally extended goal directed action)*
- ***(Attentional) control: a parametric warping of semantic space by context***

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***
- Control reflects its use to ***select information*** relevant in particular ***contexts*** and for particular ***purposes***
- Representations used for particular contexts and purposes may require ***specialized processing apparatus*** such as for rapid association formation, active maintenance, sequencing and search *(e.g., novel settings, and temporally extended goal directed action)*
- ***(Attentional) control: a parametric warping of semantic space by context***
- ***Semantics and control are inextricably intertwined***

Semantics and Context

- Same mechanisms of learning and representation of ***statistical structure***
- That structure ranges from **simple** *(e.g., color vs. words)*
  to **complex** *(faces, scenes)*
  and from ***specific*** *(red, green… big, small…)*
  to ***abstract*** *(colors, size, living, self…)*
- It just as sensitive to statistical relationships involving ***action*** as ***perception***
- Control reflects its use to ***select information*** relevant
  in particular ***contexts*** and for particular ***purposes***
- Representations used for particular contexts and purposes
  may require ***specialized processing apparatus***
  such as for rapid association formation, active maintenance, sequencing and search
  (e.g., novel settings, and temporally extended goal directed action)
- ***(Attentional) control: a parametric warping of semantic space by context***
- ***Semantics and control are inextricably intertwined***

Semantics and Context

Semantics and Context

Connectionist networks are an appropriate “tool box” for studying such effects:

Semantics and Context

Connectionist networks are an appropriate “tool box” for studying such effects:

- ***statistical learning mechanisms*** that
  - capture relevant semantic structure through *experience*
  - that reflects relationships present in the *environment*
  - under pressure of their usefulness for *prediction* and/or *action*

Semantics and Context

Connectionist networks are an appropriate "tool box" for studying such effects:

- ***statistical learning mechanisms*** that
  - capture relevant semantic structure through *experience*
  - that reflects relationships present in the *environment*
  - under pressure of their usefulness for *prediction* and/or *action*
- ***mechanisms for context processing and control*** that
  - help *exploit* and *shape* representational structure
    (e.g., via biasing effects and non-linearities)
  - accommodate *special processing requirements* for different purposes
    (e.g., episodic memory mechanisms for rapid association formation
    and gated attractors [LSTMs] for active maintenance, sequencing and search