

# **Epistemic-probabilistic models of Information Retrieval**

**Corrado Boscarino**

*Information Access (IA)*

# Outline

The logo for CWI (Centrum voor Wiskunde en Informatica) is a red trapezoidal shape with the letters 'CWI' in white, bold, sans-serif font.

Context & motivation:

Probabilistic (classic) IR vs. Cognitive (more general) IA

# Outline

Context & motivation:

Probabilistic (classic) IR vs. Cognitive (more general) IA

Reconciling efforts:

Possible joint retrieval model: Epistemic Relevance Model

# Outline

Context & motivation:

Probabilistic (classic) IR vs. Cognitive (more general) IA

Reconciling efforts:

Possible joint retrieval model: Epistemic Relevance Model

Application example:

ERM instantiation with TREC data

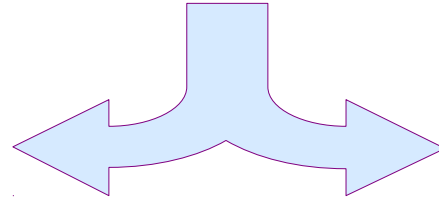
# Context & motivation: IR vs. IA



Use 'Relevance' as a conceptual lens

## Context & motivation: IR vs. IA

Use 'Relevance' as a conceptual lens



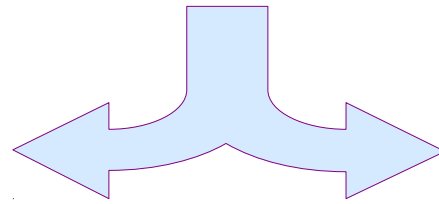
IR: relation between  
Queries and Documents

IA: behavioural change

## Context & motivation: IR vs. IA

Use 'Relevance' as a conceptual lens

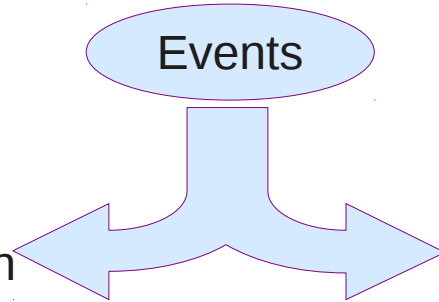
IR: relation between  
Queries and Documents



IA: behavioural change

IR: depend on  
description of information  
units

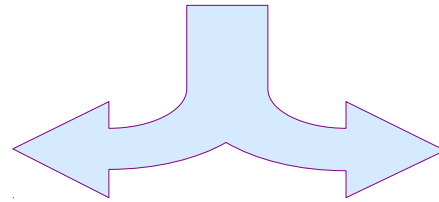
Events



IA: depends on  
description of tasks

# Context & motivation: IR vs. IA

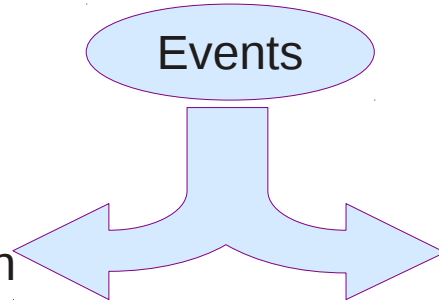
Use 'Relevance' as a conceptual lens



IR: relation between  
Queries and Documents

IA: behavioural change

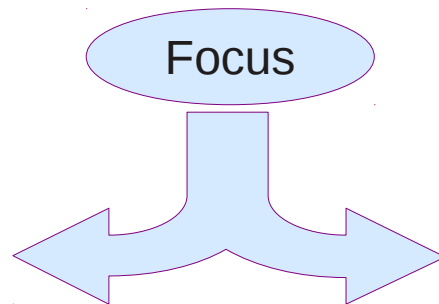
Events



IR: depend on  
description of information  
units

IA: depends on  
description of tasks

Focus



IR: Technology  
(probability th.,  
information spaces)

IA: cognitive science  
(more qualitative, closer  
to real users)



## A Standard relevance model:

Main Assumption: observed queries and documents are random samples from a model  $R$

## A Standard relevance model:

Main Assumption: observed queries and documents are random samples from a model  $R$

Goal: given observed events (queries, documents), deciding whether they're drawn from different distributions (**null** hyp.) or from the same one (**relevant** hyp.)

## A standard relevance model:

Main Assumption: observed queries and documents are random samples from a model  $R$

Goal: given observed events (queries, documents), deciding whether they're drawn from different distributions (**null** hyp.) or from the same one (**relevant** hyp.)

Method: resolving uncertainty about a distribution parameter set  $\vartheta$

Step 1: conditioning over a 'known' sample  $\mathbf{r}$  from model  $R$ .

$$P(\vartheta|\mathbf{r}) = P(r_1 \dots r_m | \vartheta) P(\vartheta) / P(r_1 \dots r_m)$$

Step 2: Integration over possible parameters

$$\text{RelMod}(\bullet) = \int_{\Theta} P_{\vartheta}(\bullet) P(\vartheta|\mathbf{r}) d\vartheta$$

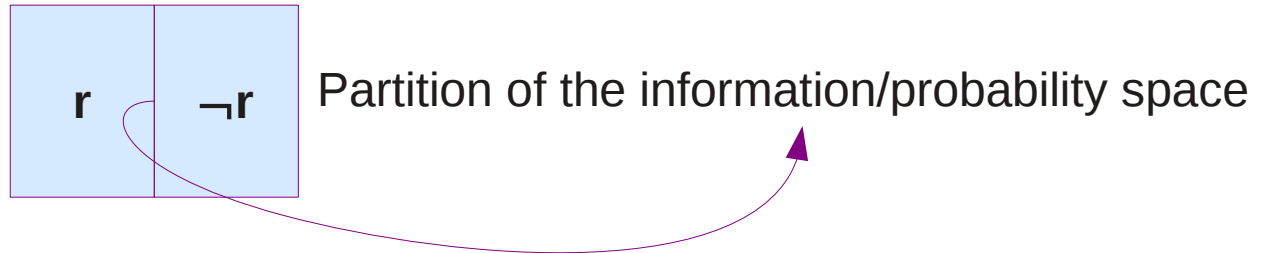
Update of a posterior  $P(\vartheta|\mathbf{r})$  because of the observation that  $\mathbf{r}$

# Alternative interpretation

'Logic-Epistemic' interpretation of a relevance model: 'knowing' means 'knowing-is-relevant'

Step 1:

From a system p.o.v.  $\text{RelMod}(\bullet)$  is correct, the system observes interaction  $r$  and wants to update  $\text{RelMod}(\bullet)$  accordingly:

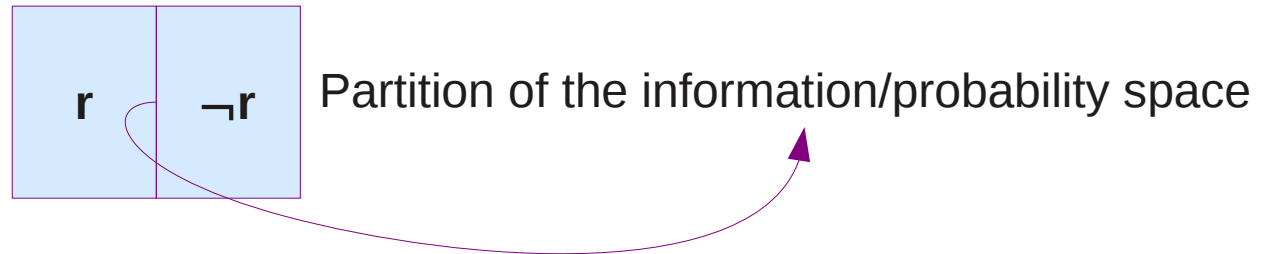


# Alternative interpretation

'Logic-Epistemic' interpretation of a relevance model: 'knowing' means 'knowing-is-relevant'

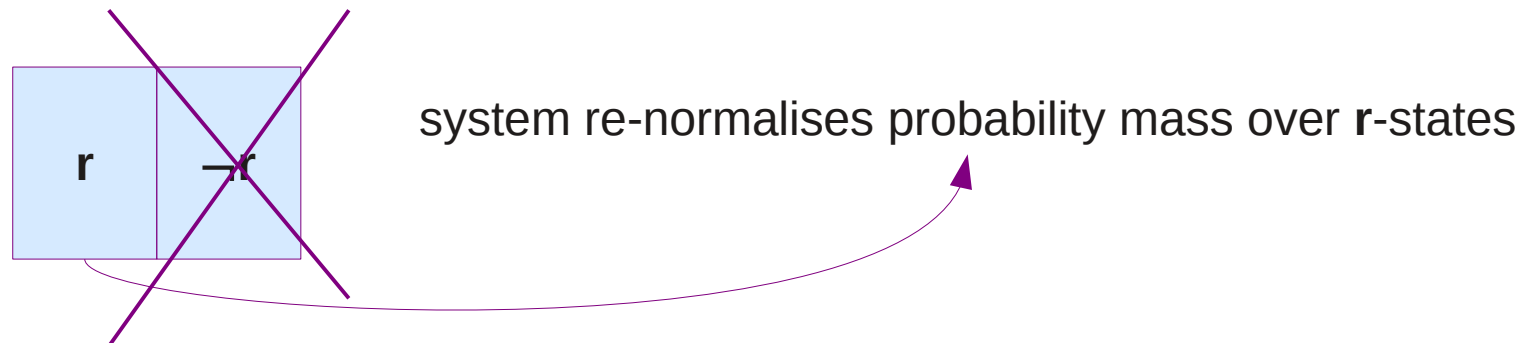
Step 1:

From a system p.o.v.  $\text{RelMod}(\bullet)$  is correct, the system observes interaction  $r$  and wants to update  $\text{RelMod}(\bullet)$  accordingly:



Step 2:

The total probability over the parameter space is defined as one:

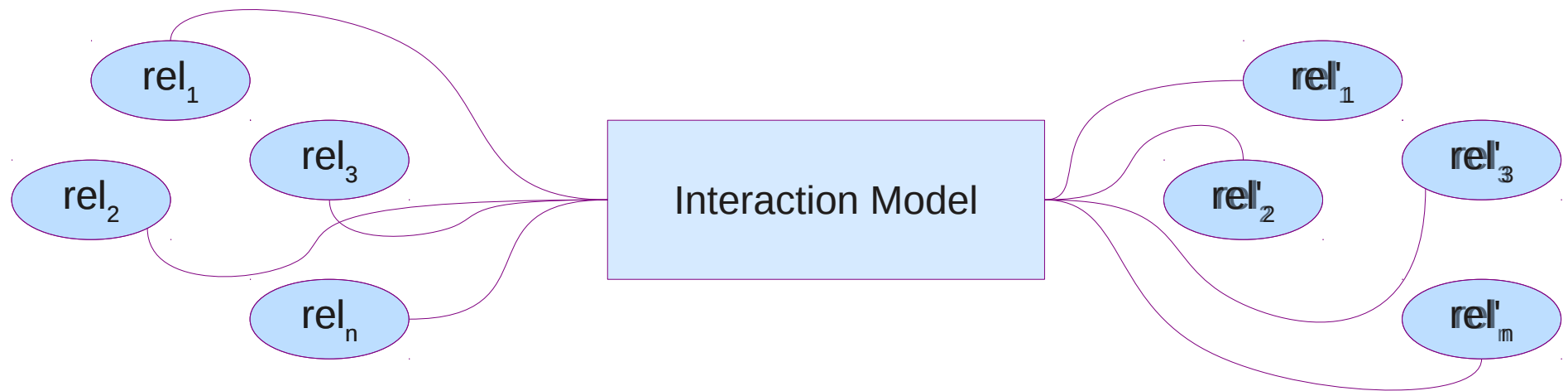


# Epistemic Relevance Model:

Step 1:

From a system p.o.v. RelMod( $\bullet$ ) is correct, the system observes interaction  $r$  and wants to update RelMod( $\bullet$ ) accordingly:

New: system has *interaction model* (beyond the  $r / \neg r$  we can include **any** rule, derived from user studies, past interactions with the system, sentiment analysis, profiling.....)

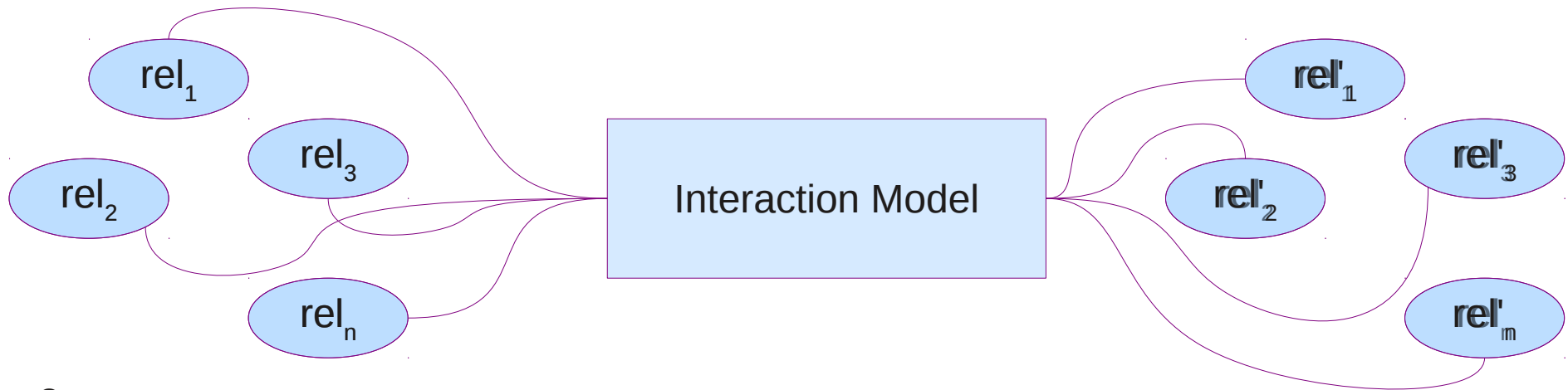


# Epistemic Relevance Model:

Step 1:

From a system p.o.v.  $\text{RelMod}(\bullet)$  is correct, the system observes interaction  $r$  and wants to update  $\text{RelMod}(\bullet)$  accordingly:

New: system has *interaction model* (beyond the  $r / \neg r$  we can include **any** rule, derived from user studies, past interactions with the system, sentiment analysis, profiling.....)



Step 2:

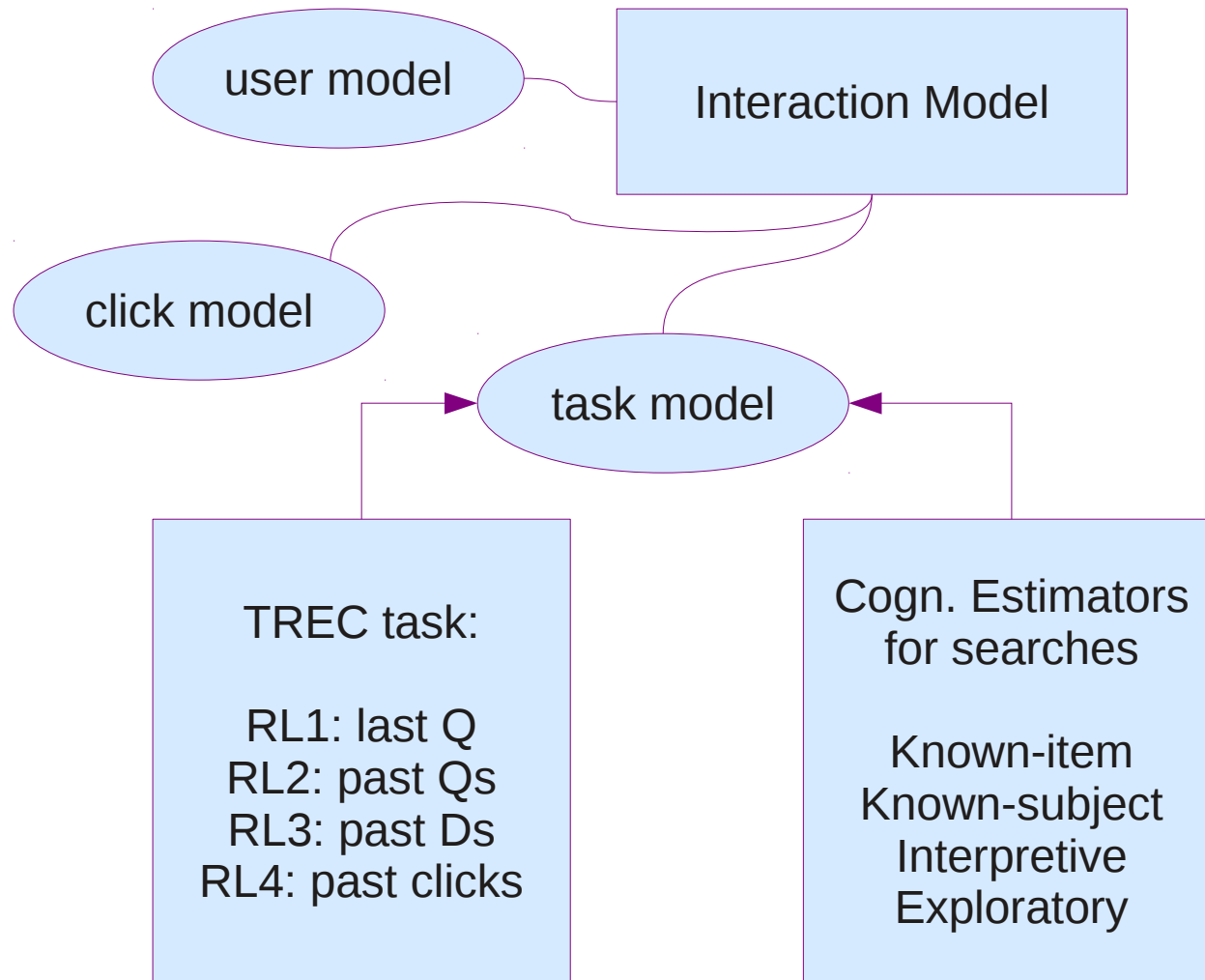
The total probability over the parameter space is defined as one:

system re-normalises probability mass over **rel'**-states

New: ERM *generalises* relevance models beyond one single strategy for dealing with relevance observations

# Application example

Tested on 3-years TREC (Text REtrieval Conference) session track data

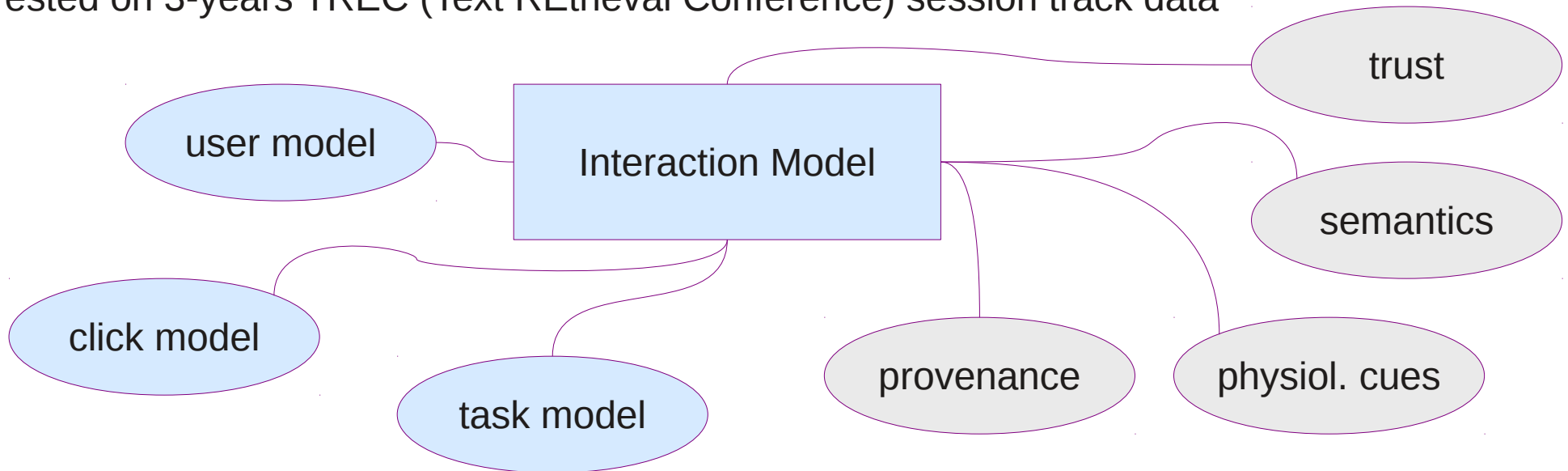




# Application example

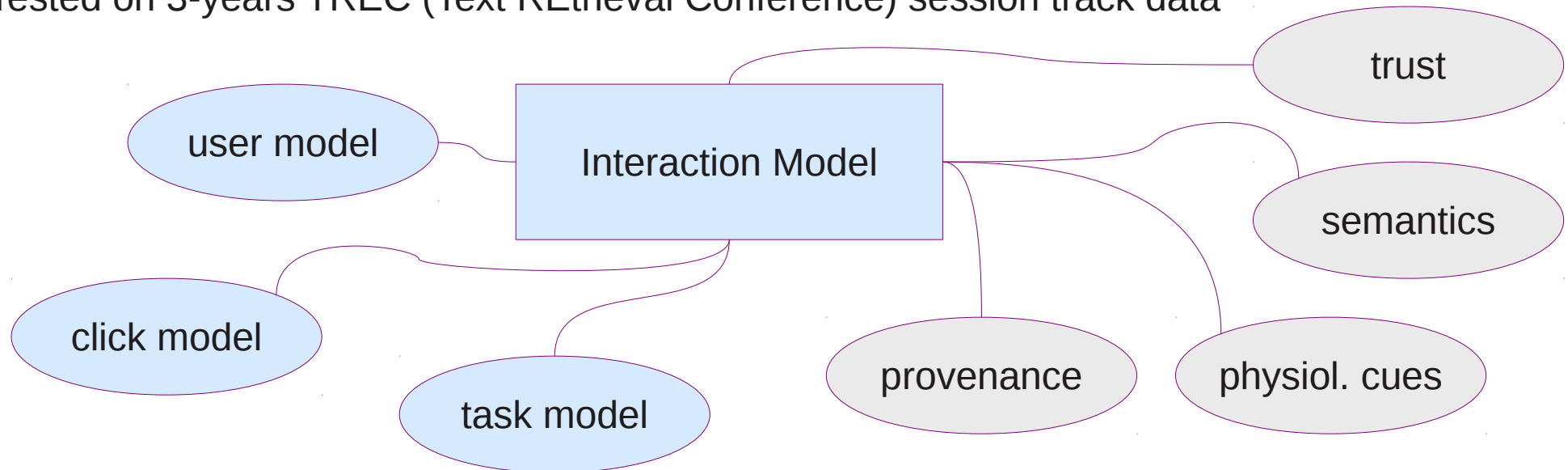


Tested on 3-years TREC (Text REtrieval Conference) session track data



# Application example

Tested on 3-years TREC (Text REtrieval Conference) session track data



We learned that:

- 1) New model significantly improves ranking in TREC
- 2) Performance strongly depends on cognitive model quality

# Conclusion

Take-home message:

In the alternative interpretation:

- 1) Standard Relevance Model = State elimination + re-normalisation
- 2) Epistemic Relevance Model = Interactions between user and system change the model

# Conclusion

## Take-home message:

In the alternative interpretation:

- 1) Standard Relevance Model = State elimination + re-normalisation
- 2) Epistemic Relevance Model = Interactions between user and system change the model

## Useful?

Yes, because findings in cognitive IR can directly be used in the retrieval model and performance improves

# Conclusion

## Take-home message:

In the alternative interpretation:

- 1) Standard Relevance Model = State elimination + re-normalisation
- 2) Epistemic Relevance Model = Interactions between user and system change the model

## Useful?

Yes, because findings in cognitive IR can directly be used in the retrieval model and performance improves

## Nice?

Yes:

- I) user interactions elegantly fit the model,
- II) many possible collaborations: IR, IA, cognitive and social sciences, logic and epistemology.....