

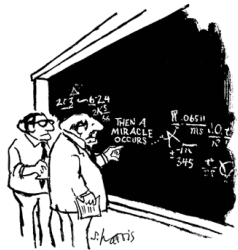
INFI-CG 2016
Lecture 29

Cognitive modelling: Some
examples, some advantages,
some limitations

Richard Shillcock

1/21

Today's goals



To look at some of the
choices that are made
in cognitive modelling
and the implications
that flow from them.

"I think you should be more explicit here in
step two."

2/26

Today's reading

McClelland, J. L. (2009). The place of modeling in
cognitive science. *Topics in Cognitive Science*, 1(1),
11-38.

3/26

“Classical” models
Ellis & Young (1988)

4 / 21



“Classical” models

A “classical” box-and-arrow model lets us put our ideas down on paper.

It is a shorthand version of our theorizing.

It helps us to see the options for the ordered relations between the entities (and ‘suggests’ modifications to us).

It helps us communicate the model to other researchers. 5/21

“Classical” models

It helps us make predictions ...

... which we can test in the laboratory.

That’s about it.

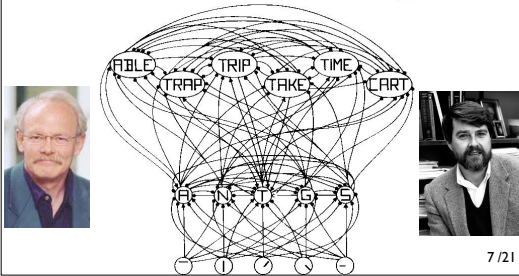
It can’t *surprise* us.

It can’t really persuade us we’re wrong.

It can only really be as complicated as we can work through it ourselves. 6/21

Interactive-Activation Model
model of reading

McClelland & Rumelhart (1981)



Computational models

A model can be implemented on a computer; the computer runs the model automatically.

It has all the advantages of the box-and-arrow model.

But it can be hugely complex.

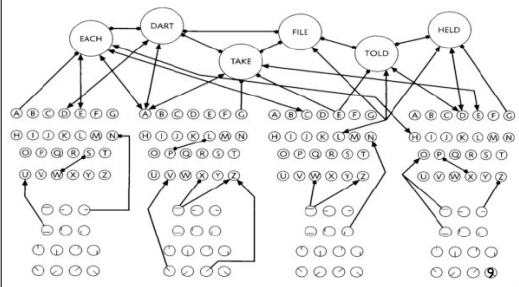
It can really surprise us with *emergent behaviours*.

It can test our informal theory rigorously and show us where we were wrong.

8/21

Interactive-Activation Model
model of reading

McClelland & Rumelhart (1981)



Interactive-Activation Model

The authors took existing entities (from linguists and psychologists).

They *hand-wired* the model. They told the computer exactly what to do for every individual choice it would ever have to take.

They built in a few *parameters* they could later manipulate.

They gave it an input and let it run.

They recorded its behaviour and compared it with human behaviour.

1021

Interactive-Activation Model

The model generated expected and unexpected behaviours.

Similar words became partly activated at the same time.

The model could 'restore' missing data: WORK

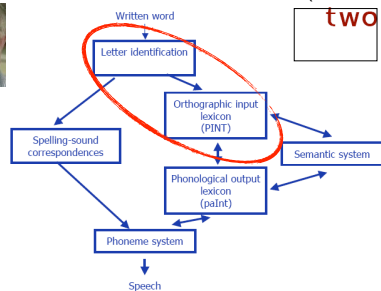
Complex conspiracies of partly activated words produced a range of behaviours.

A new *conceptual vocabulary* (e.g. 'decay' in the model's representations; 'letter slot') is produced to describe how the problem is solved.

1121

Dual-Route Cascaded Model (DRC)

Coltheart et al. (1993, 2002)



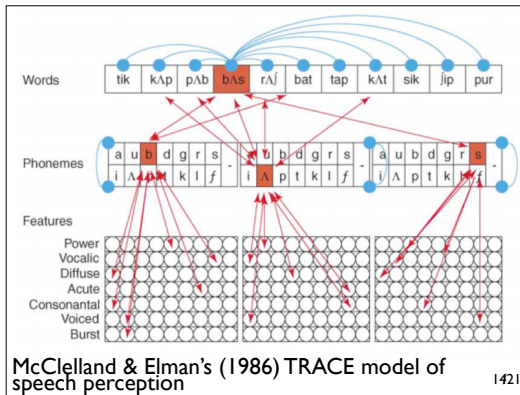
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Computational models

Computational models can, in principle, be added together ('nested') in a modular way (Perry, Ziegler, & Zorzi, 2007).

They can be 'lesioned' to inspect their impaired behaviour. Does it resemble dyslexic behaviours? (This applies more interestingly to connectionist models, which can learn their own internal 'representations' by example.)

1321



1421

TRACE

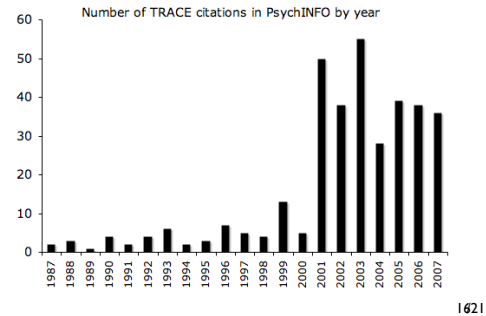
McClelland and Elman created TRACE as a version of the Interactive-Activation Model, but stretched out in time, to resemble speech perception.

There is a temporal dimension, composed of 'timeslots'.

It was designed to instantiate Marslen-Wilson's Cohort Model (a 'classical' model of spoken word perception) based on the phoneme-by-phoneme arrival of information about a perceived word.

1521

TRACE is hugely successful ...



... but ...

TRACE has remained in its original form, with only minor parametric explorations.

Our field contains a large number of cognitive models.

We want them to be *vehicles* of scientific exploration ...

1721



... but ...

TRACE has remained in its original form.
TRACE is (trivially) defeated by new data.
TRACE has participated in a long-running debate:

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Merging information in speech
recognition: Feedback
is never necessary

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19/21

Challenges

Should our models be static or developing?

Should we be able to say something
philosophical about the nature of our models?

Should we be able to say something about
*simplicity, completeness, complexity, theory of
knowledge, explanation, ...?*

20/21

References

- McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, 18(1), 1–86.
- Norris, D., McQueen, J. M., & Cutler, A. (2000). Merging information in speech recognition: Feedback is never necessary. *Behavioral and Brain Sciences*, 23(3), 299–324.
- Perry, C., Ziegler, J. C., & Zorzi, M. (2007). Nested incremental modeling in the development of computational theories: the CDP+ model of reading aloud. *Psychological review*, 114(2), 273.

21/21
