Chapter 31

Phonological theory and computational modelling

by Jane Chandlee and Adam Jardine

Phonology Reading Group HT24 Week 4

Xiaoye Wu

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Timeline

- ➢ Evolvement of computational modelling: practical implementation -> active part of phonological theory
- ➢ General Questions:
- How does computational modelling develop along with the development of phonological theory?
- In turn, how does computational modelling contribute to modern phonological theory?

Generative Grammar (SPE, 1968) | Autosegmental Phonology (1970s) | Optimality Theory (1990s) | Stochastic Phonology (2000s) …

Finite-state models

Linear -------------------> Non-linear

Rule-based ------------------------> Constraint-based

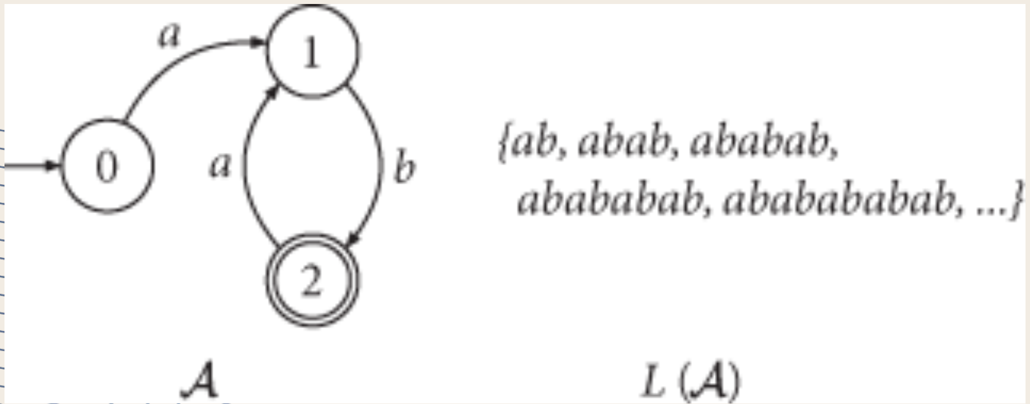
A probabilistic notion

Automata theory

- Two finite-state models:
  Finite-State Acceptor (FSA) & Finite-State Transducer (FST)

- Motivation: to define a model that can provide a finite description of the infinite set of well-formed strings in a language

Chomsky (1956): Use FSA to describe sets of strings -> finite-state/regular languages

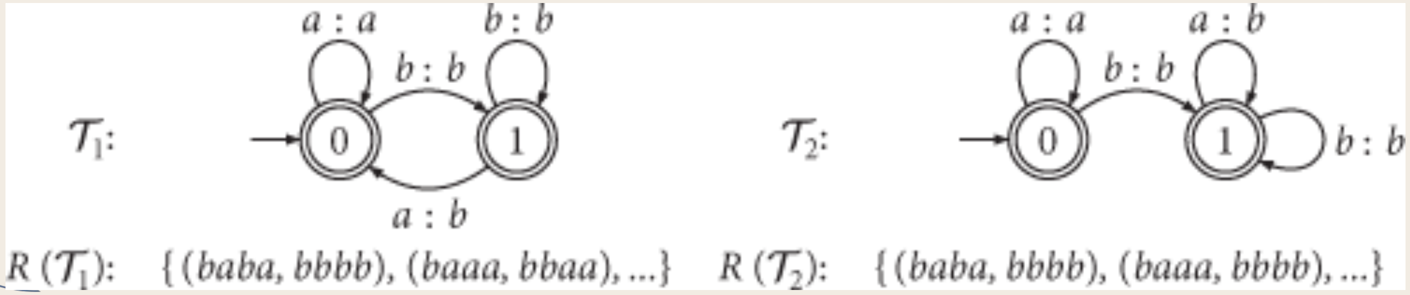


Finite-state models

Johnson (1972): use FST to describe relations between strings -> finite-state/regular relations

Equivalent to SPE rewrite rule formalism

e.g. a -> b / b _ (simultaneous & iterative)



Input:		*b*		*a*		*a*		*a*	
State:	0	→	1	→	0	→	0	→	0
Output:		*b*		*b*		*a*		*a*	

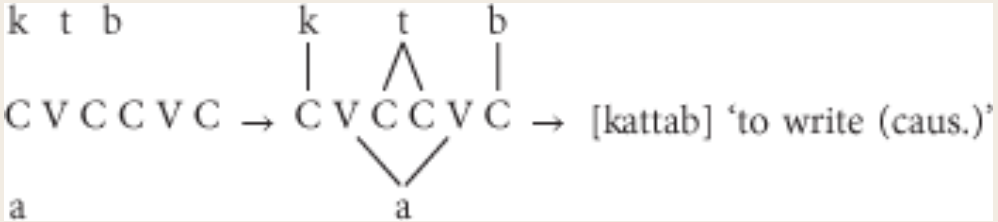
Input:		*b*		*a*		*a*		*a*	
State:	0	→	1	→	1	→	1	→	1
Output:		*b*		*b*		*b*		*b*	

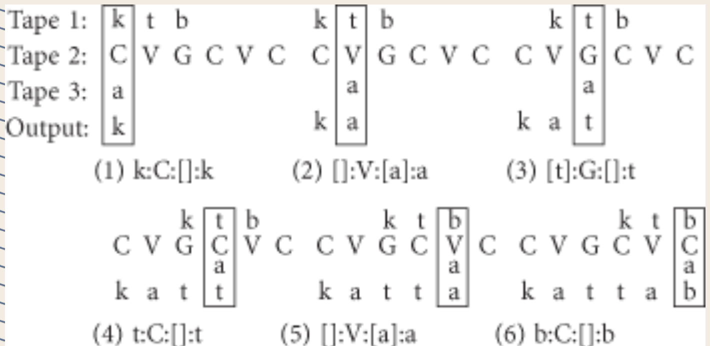
Non-linear phonology

Question: How could non-linear representations be modelled in a finite-state (linear) framework?

Approach: Linearisation -> find a way to translate non-linear representations into a linear coding

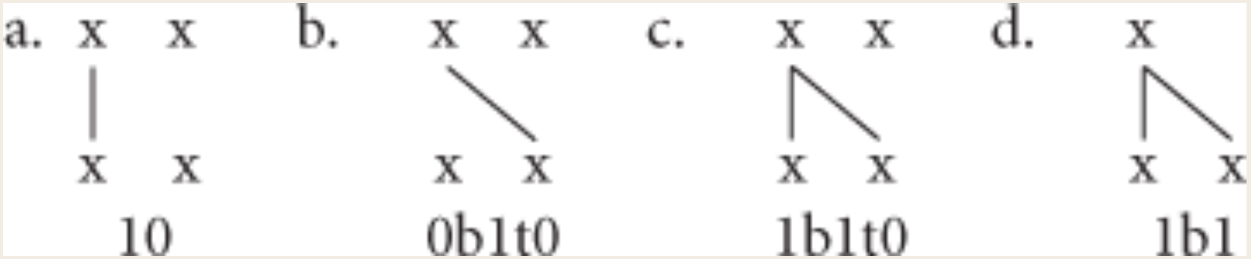
- Kay 1987 (Arabic morphology)





Non-linear phonology

- Kornai 1995 scanning code



Optimality Theory

Question: How could constraint-based grammar be modelled in a finite-state framework?

Why is OT > FST a problem?

1. OT can generate non-regular relations -> beyond the power of finite-state
2. OT evaluates strings globally

Approach: constrict non-regular relations; limit OT grammars to local evaluation

Optimality Theory

Ellison (1994) relied on three assumptions:

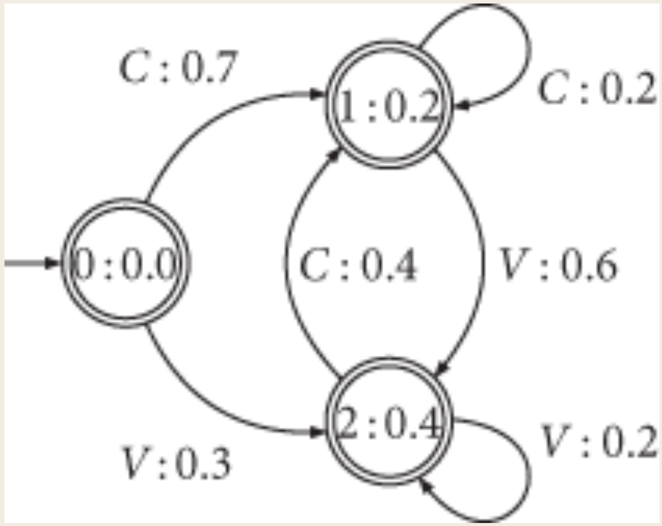
1) All constraints are binary (convert non-binary constraints into local binary ones);
2) The candidate set produced by GEN is a regular language;
3) The constraints can be modelled with regular relations.

Probabilistic models

Model gradient phonological generalisations

Approach: add numerical values or weights to the structures

- Weighed FSA (Mohri et al., 1996)

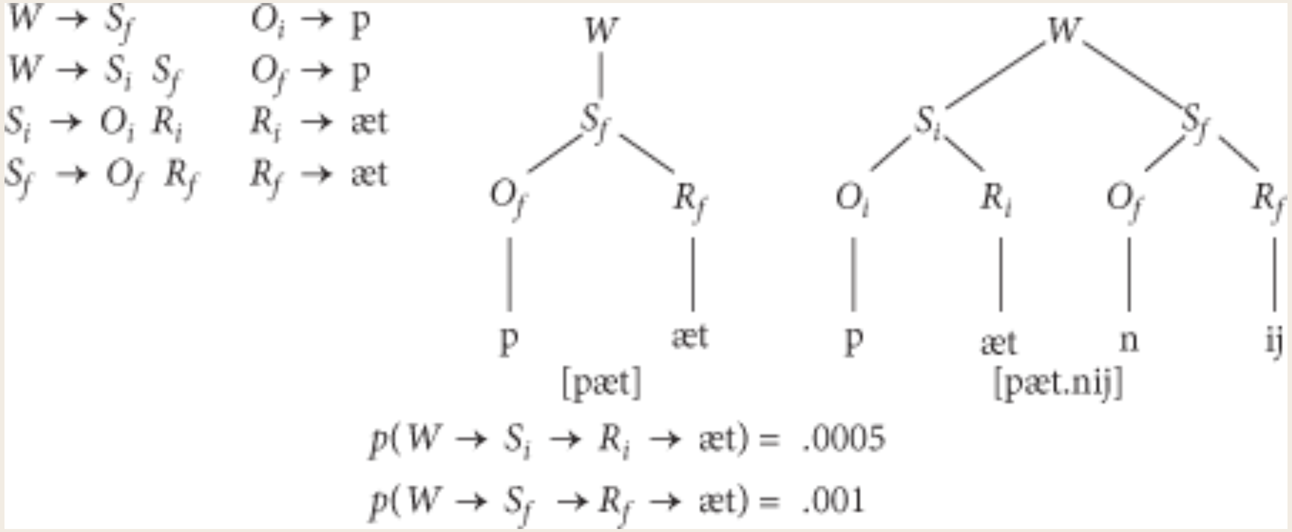


CVCV: 0.7*0.6*0.4*0.6*0.4=0.040

CVCC: 0.7*0.6*0.4*0.2*0.2=0.006

Probabilistic models

- Weighed context-free grammars (WCFGs) (Coleman & Pierrehumbert, 1997): describe hierarchical syllable structures



Probabilistic models in OT

- Stochastic ranking model for Boersma's Gradual Learning Algorithm: adjust the values of constraints

- ->model optionality in native speaker's grammar

Computational nature of phonological patterns

- Lead to better understanding of phonological theory
- Autosegmentel representations

- OT