Formalization of opacity in OT
(this contains new stuff interspersed with old bits from last 2 handouts)

1. Summary of last 2 lectures:
   (a) the learner benefits from unraveling an opaque system: might discover structure in noise
   (b) the system benefits from being opaque, in certain ways:
   (i) more expressive contrasts available in certain opaque cases, compared to transparent
   (ii) less distance in perceptual space between UR and SR, in counterfeeding cases
   (c) but not all opaque interactions provide these benefits, compared to transparent ones

	Epenthesis counterbleeding VA		Epenthesis bleeding VA (= Voice Assimilation)[1]
(i)	dt -> tt	-> tet	dt -> det -> det
(ii)	tt	-> tet	tt -> tet

   (d) opaque interactions useful to the system are common, the others perhaps less so, suggesting that learners are not unaware of the benefits of the useful opaque systems.

2. Today: exploring recipes for formalizing opacity in OT
   (a) ordering does not distinguish good from bad opacity or opaque from transparent systems
   (b) standard OT (rankings of simple markedness and faithfulness constraints) does not characterize opacity
   (c) extensions: local conjunction, sympathy, comparative markedness.

3. Target-counterfeeding interaction (in so-called chain-shift situations):

Rules	Constraint Rankings
A -> B /X_Y	*XAY >> Corresp A/B (I-O)
D -> A/ X_Y	*XDY >> Corresp D/A (I-O)
(i) e -> i/ __V	*[-high]/ __V >> Ident [high]
(ii) a -> e/ __V	*[+low]/ __V >> Ident [low]
this order yields	these rankings yield
/eV/ -> [iV]	/eV/ -> [iV]
/aV/ ->[eV]	**but** /aV/ ->*[iV]

Source: Basque problem in Kenstowicz and Kisseberth 1978

• counterfeeding rule interaction models a lesser departure from input than one might expect from maximal application of existing rules.

• standard OT lacks the means to mimic the effect of counterfeeding order.

4. Analyzing system-friendly counterfeeding opacity: local conjunction of correspondence

• Kirchner (LI 1996): combining 2 Corresp. constraints Corresp A and Corresp B into one constraint Corresp A∧B[2] (violated only if **both** A and B are violated in *a local domain*). Local domain below is the segment. Ident ([high]∧ [low]) >> *[+low]/ __V, *[-high]/ __V >> Ident [high], Ident [low]

/aV/	Ident [high]∧ [low]	*[+low]/ __V	*[-high]/ __V	Ident [high]	Ident [low]
aV		*!	*		
☞eV			*		*
iV	*!			*	*

Effects of local domain restriction: allows scattered violations of both constraints conjoined in the same expression, provided they don't all occur in the same domain. Compare (a), (b) with (c).

[1] Carlo Geraci (p.c. 04/11/05) notes the parallel effect with V-V assimilation and C-epenthesis.
[2] The name can also be (and sometimes is) "Corresp A∨B" or "Corresp A&B".

	/auteu/	Ident [high]∧ [low]	*[+low]/ __V	*[-high]/ __V	Ident [high]	Ident [low]
a	iutiu	*!			**	*
b	iuteu	*!		*	*	*
c	☞ eutiu			*	*	*

• Gnanadesikan's solution (UMass diss.1997) consists of identifying in some relevant cases a ternary feature F, & two strictly ranked types of Corresp. constraints (Ident 2F >>...Ident 1F). Ident 2F penalizes 2-interval deviations from UR value. E.g. [low] and [high] combined into one ternary feature [open]. Ident open penalizes any deviation from the UR value for [open]. By contrast, Ident 2[open] penalizes 2-interval departures from the UR [open] value: thus a-> i, but not e-> i or a -> e.

open-2	open-1	open
a	e	i

Ident 2[open] >> *[-high]/ __V, *[+low]/ __V >> Ident [open]

	/aV/	Ident 2[open]	*[-high]/ __V	*[+low]/ __V	Ident [open]
a	aV		*	*!	
b	☞eV		*		*
c	iV	*!	*		**

Local conjunction or the mention of local domain are unnecessary in this case:

	/auteu/	Ident 2[open]	*[-high]/ __V	*[+low]/ __V	Ident [open]
a	iutiu	*!			
b	iuteu	*!	*		
c	☞ eutiu		*		**

5. Recall that an unusually large number of the randomly selected cases of counterfeeding opacity surveyed by Moreton are amenable to an analysis involving a single dimension of contrast and 3 or more categories defined on it. This is *exactly* what Gnanadesikan's solution can describe, if we appropriately extend her features & grant that some are not ternary but plus-quam-ternary.
6. Kirchner's solution *can* describe these, but it can describe much more and cannot distinguish the plausible and frequent cases below from implausible or non-existent ones, discussed a bit further down.

7. Examples (selections from the survey in Monday's handout):

Language	scenario	Unified dimension, assuming some extension of F theory	Local conjuction of Corresp., assuming standard F's
Nzebi	a -> ɛ -> e -> i ɔ -> o -> u	F1	(Ident [±high]& Ident [±low] & Ident [±ATR])$_{segment}$
B.Inupiaq	ɨgl -> igl -> igʎ	Duration of [-back]	(Ident [±back]&Ident [±anter])?[3]
Sea Dayak	ŋga -> ŋa -> ŋã	Duration of [+nas]	(MAX C & Ident [±nas])$_{SR\sigma}$
Mwera	mp -> mb -> m	Duration of cluster	(MAX C & Ident [±voice])[3]
Finnish	pp,tt,kk-> p,t,k-> v,d,Ø		(Ident [±long]& Ident[±voice]) [3]

An analysis of Mwera, in the spirit of Gnanadesikan:

/mp/	Ident 2-long	Use shortest[4]	Ident long
mp (longest)		**!	
mb (shorter)		*	*
m (shortest)	*!		**

[3] LD is unclear here: can't be σ or segment. Local conjunction does not stipulate a minimal LD so this would not be viewed as problematic.

[4] Use shortest assigns one * for every degree of length in a surface C above shortest.

An analysis of Barrow Inupiaq, in the spirit of modified Gnanadesikan:

/ɨgl/	Ident 2-long/palatal	*ɨ	Palatalize =*[iC$_{0[+back]}$	Ident long/palatal
ɨgl (0)		*!		
igl (short)			*	*
iɟʎ (longer)	*!			**

What remains to be worked out: unlike G's cases, the number of categories defined on each dimension cannot be pre-set at n (e.g. 3 for G). But to measure distance between UR and SR and penalize too large departures from UR, we need to know in advance how to divide the relevant dimension into steps.

8. Context-counterfeeding interaction.

Rules	Constraint Rankings
A -> B /X_Y	*XAY >> Corresp A (I-O)
D -> A/ X_Y	*XDY >> Corresp D (I-O)
(i) n-> m/ _[+labial]	*n[+labial] >> Ident [coronal]
(ii) ə -> Ø/VC_CV	*ə >> MAX V
This order yields:	These rankings yield:
/anba/ -> [amba]	/anba/ -> [amba]
/anəli/ -> [anli]	/anəli/ -> [anli]
/kanəbis/ ->[kanbis]	**but** /kanəbis/ ->*[kambis]

Source: Hindi problem in Kenstowicz and Kisseberth 1978

9. Similarly

(i) n -> ŋ/k	*Heterorganic >> Ident place/nas
(ii) t-> Ø/ C_C	*CCC >> MAX C
This order yields:	These rankings yield:
/ktn/ -> [kn] not *[kŋ]	/ktn/ -> [kŋ]
[kn] -> [kŋ]	

Source: Dutch data in Moreton

10. Score: • Gnanadesikan's ternary features don't help.
• Kirchner's local conjunction of faithfulness conditions could help here (LD= σ[1]):
• Extended Gnanadesikan also does well.

Kirchner: [Ident [coronal] ∧ Max V]$_\sigma$, *ə >> *n[+labial]>> Ident [coronal], MAX V.

kanəbis	[Ident [coronal] ∧ Max V]$_\sigma$	*ə	*n[+labial]	Ident [coronal], MAX V
☞kanbis			*	*
kambis	*!			**
kanəbis		*!		

Kirchner: [Ident [coronal] ∧ Max C]$_\sigma$, *CCC >> *Hetero>> Ident [coronal], MAX C.

ktn	[Ident [coronal] ∧ Max V]$_\sigma$	*CCC	*Hetero	Ident [coronal], MAX C
☞kn			*	*
ktn		*!		
kŋ	*!			**

• Extended Gnanadesikan: the relevant property is a type of relation - *overlap*- with 4 steps:

velar vs. nasal	Non-adjacent -	Adjacent -	Overlap -	Simultaneous
ktn	√			
kn		√		
kŋ			√	
ŋ				√

[1] It's the *UR* syllable that's the local domain in this analysis. If syllables are absent in UR a non-obvious modification is needed and the example becomes hard to analyze using local conjunction: no obvious local domain smaller than the word.

Correspondence 2-overlap: penalizes candidates containing F1 and F2 whose underlying correspondents stand in an overlap relation that's 2+ steps removed from their surface overlap relation.

ktn	Corresp. 2-overlap	*CCC	*Hetero	Corresp. overlap
☞kn			*	*
ktn		*!		
kŋ	*!			**

kanəbis	Corresp. 2-overlap	*ə	*n[+labial]	Corresp. overlap
☞kanbis			*	*
kambis	*!			**
kanəbis		*!		

This type of case is actually so frequent that the transparent cases are harder to document:
• French and Russian voicing assimilation after V-deletion: e.g. *sapaga* -> *sapga, *sabga*
• English C-intrusion after V deletion: *Emily* -> *Emly, *Embly*

Extended Gnanadesikan treats these cases in a fully natural and unified way, whereas K's Local Conjunction solution has some trouble defining a plausible local domain.

11. For other cases, the local conjunction solution overgenerates severely. One example:

Blocking joint application of unrelated rules targetting same local domain.
Voicing assimilation: t -> d/ [+nas]_ *n[-voice] >> Ident [voice]
Vowel harmony: a -> o/ _C_0o *aC_0o >> Ident [round]
an-to -> [ondo] an-to -> [ondo]

So far so good. But a locally conjunctive combination of two unrelated constraints (Ident [voice]∧Ident [round] (syllable)) can block either of the two processes when both are expected:

Ident [voice]∧Ident [round] (σ) >> *n[-voice] >> *aC_0o >> Ident [voice], Ident [round] (yields /onta/ -> [onda]. Reverse ranking *n[-voice] << *oC_0a and we get /onta/ -> [onto].

/anto/	Ident [voice]∧ [round]	*n[-voice]	*aC_0o	Ident [voice]	Ident [round]
anto		*!	*		
☞ando			*		*
ondo	*!			*	*

The predicted pattern is then as follows:

UR	ato, arto, ando, alto	anta, ampa, onta, onko	anto, ampo, anko
SR	oto, orto, ondo, olto	anda, amba, onda, ongo	anda, ambo, ango
comment	RH applies	Postnasal voicing applies	RH blocked, Postnas. Voic. applies

These types of UR -> SR mappings are unprecedented. If the syllable as a local domain is excluded from consideration then the Hindi and Dutch problems cannot be analyzed with local conjunction even though they are intuitively of the same kind as other distantial faithfulness problems.

For these cases, neither Gnanadesikan's solution nor the Extended version of her solution make nefarious predictions.

12. For other counterfeeding cases, both Gnanadesikan and local conjunction undergenerate, either because no obvious local domain can be identified or because no feature or dimension can be found.

(i) Raising: a -> i/ _]σ	(i) *low/_]σ >> Ident [±high, ±low]
(ii) Glide voc: w' -> u (w' unsyllabifiable)	(ii) SSP >> ident [±syllabic]
this order yields /badw/ -> [badu], *[bidu]	this ranking yields /badw/ -> *[badu], [bidu]

Source: Beduin data in McCarthy 1998

Kirchner: [Ident [high, low] ∧ Ident [±syll]$_{LD}$, SSP >> *a/_.>> Ident [±high], [±low], Ident [±syll].
But what is LD?

13. For counterbleeding cases, neither Gnanadesikan nor local conjunction yield results: see below

Sympathy summary

1. Sympathy (McCarthy 1999 *Phonology*) is an analytical method that covers a large subset of known opacity cases, though not all. In terms of descriptive coverage it compares favorably to all mechanisms on the market. Over and undergeneration issues it has to face will be discussed next week.

2. One case discussed: Hebrew
   a. epenthesis in CC#
      melk -> melex
   b. ʔ deletion unless ʔ = onset
      qaraʔ -> qara
   c. Interaction: counterbleeding in the context
      deʃʔ -> deʃeʔ -> deʃe

3. The other: Beduin Arabic
   a. Raise [a] in open syll
      katab -> kitab
   b. Glide -> V, when non-adjacent to V
      badw -> badu
   c. Interaction: counterfeeding in the context

4. The intermediate representation in a serial opaque derivation:
   deʃʔ -> **deʃeʔ** -> deʃe
   badw -> **bad.w** -> bad.u -> ba.du

   The intermediate representation is one step closer to UR, hence more faithful.

5. The basic idea in Sympathy: the winning candidate is selected, in part, for looking more like a faithful candidate, compared to the transparent candidate, which looks less like the faithful. Even when this more faithful candidate ≠ UR, it is one that better satisfies some correspondence constraint.

   deʃʔ -> **deʃeʔ** -> deʃe. Compare transparent *deʃ*, which resembles the more faithful *deʃeʔ* less.
   badw -> **bad.w** -> bad.u -> ba.du. Compare *bidu*: it resembles less the more faithful *bad.w*.

6. The sympathetic (❀) vs. winning vs. transparent candidates in Sympathy Theory

deʃʔ		❀MAX V	*CC#	DEP V	ʔ/_V	❋MAX C
a	❀**deʃeʔ**			*	*!	
b	☞deʃe			*		*
c	deʃ	*!				*
d	deʃʔ		*!		*	*

The constraint selecting the sympathetic ❀-candidate: ❋MAX C

The ❀-candidate is the most harmonic of the class of candidates satisfying the selector.

The constraint selecting the opaque winner: ❀MAX V

The transparent candidate *deʃ* loses because it preserve fewer of the V's of the ❀-candidate.

badw		❀Ident high	SSP	*Coda	*[-high]/_.	❋Ident syll
a	❀**bad.w**		*	*		
b	☞ba.du				*	*
c	bi.du	*!				*
d	bad.u			*!		*

The constraint selecting the sympathetic ❀-candidate: ❋Ident syll

The constraint selecting the opaque winner: ❀Ident high

The transparent candidate *bi.du* loses because it resembles less (wrt height) the ❀-candidate.