CS 182
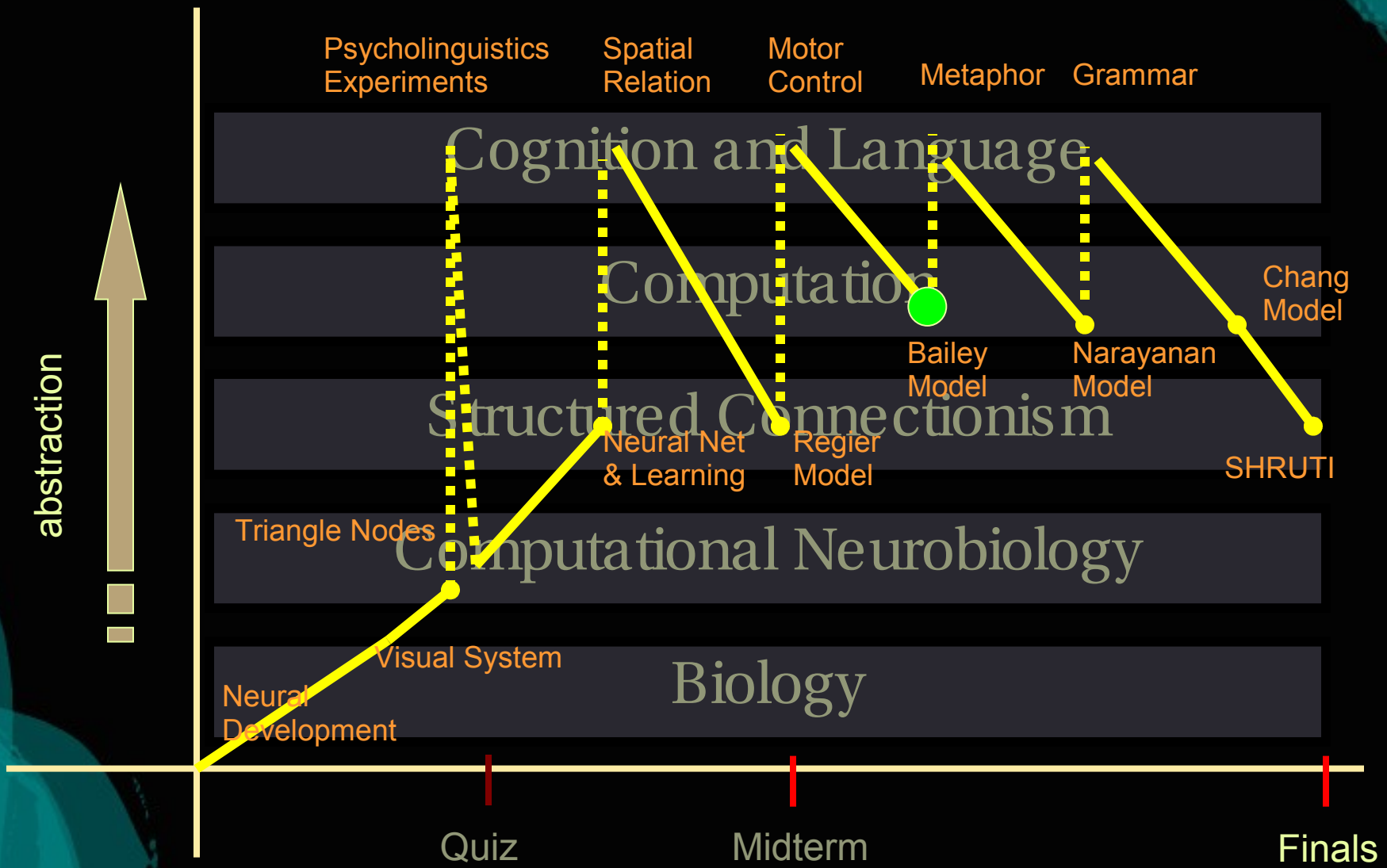# Sections 103 - 104

slides derived from those of

Eva Mok and Joe Makin

March 21, 2007

Questions

- What is Constrained Best Fit?
- How does Bailey use multiple levels of representation to learn different senses of verbs?
- What is Minimum Description Length?
- How do we use Minimum Description Length to merge a grammar?
- What does the prefix affix tree look like for the following sentences:
  - eat them here or there
  - eat them anywhere
- What does the affix tree look like after the best prefix merge?

Questions

- **What is Constrained Best Fit?**

- How does Bailey use multiple levels of representation to learn different senses of verbs?

- What is Minimum Description Length?

- How do we use Minimum Description Length to merge a grammar?

- What does the prefix affix tree look like for the following sentences:

  - eat them here or there

  - eat them anywhere

- What does the affix tree look like after the best prefix merge?
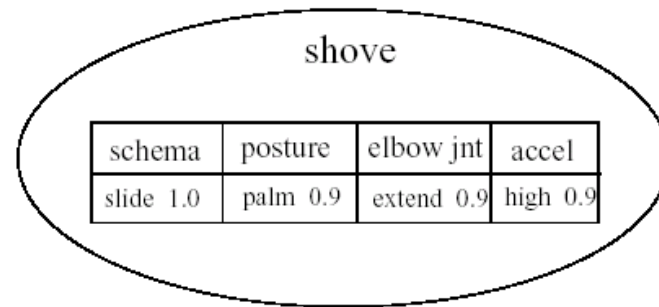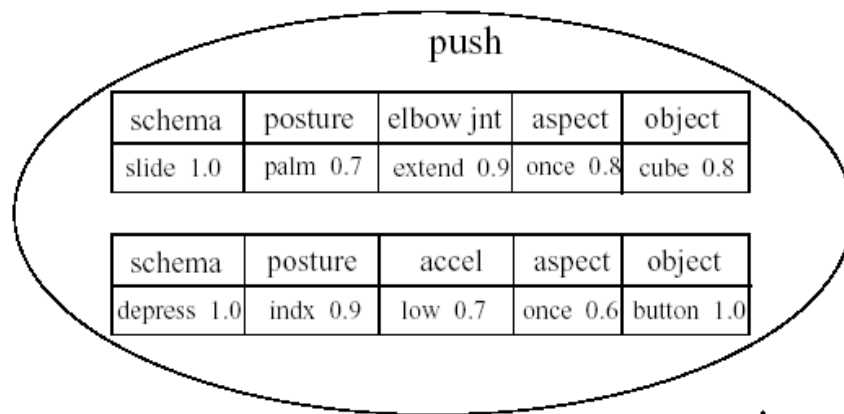
Constrained Best Fit

- Physical example?

- Chemical example?

- Biological example?

Questions

- What is Constrained Best Fit?
- How does Bailey use multiple levels of representation to learn different senses of verbs?
- What is Minimum Description Length?
- How do we use Minimum Description Length to merge a grammar?
- What does the prefix affix tree look like for the following sentences:
  - eat them here or there
  - eat them anywhere
- What does the affix tree look like after the best prefix merge?

Bailey's VerbLearn Model

- 3 Levels of representation
    1. cognitive: words, concepts
    2. computational: f-structs, x-schemas
    3. connectionist: structured models, learning rules
- Input: labeled hand motions (f-structs)
- learning:
    1. the correct number of senses for each verb
    2. the relevant features in each sense, and
    3. the probability distributions on each included feature
- execution: perform a hand motion based on a label

push

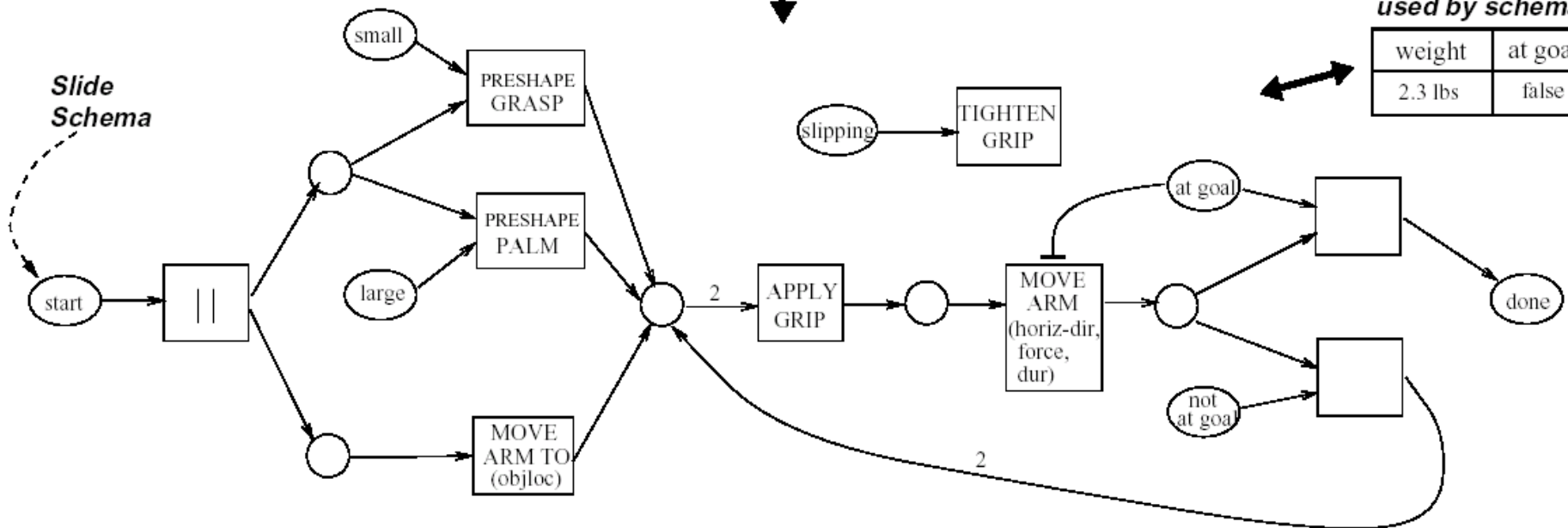| schema	posture	elbow jnt	aspect	object
slide 1.0	palm 0.7	extend 0.9	once 0.8	cube 0.8

schema	posture	accel	aspect	object
depress 1.0	indx 0.9	low 0.7	once 0.6	button 1.0

shove

schema	posture	elbow jnt	accel
slide 1.0	palm 0.9	extend 0.9	high 0.9

relevant linking features

motor parameter features — world state features

schema	posture	elbow jnt	direction	aspect	accel	object
slide | depress	grasp|palm|indx	flex | extend	up | dn | lf | rt	once | iterated	low | med | hi	cube | button

world state features used by schema

weight	at goal
2.3 lbs	false

Slide Schema

small → PRESHAPE GRASP

large → PRESHAPE PALM

start → || → (PRESHAPE GRASP / PRESHAPE PALM / MOVE ARM TO (objloc)) → 2 → APPLY GRIP → MOVE ARM (horiz-dir, force, dur)

slipping → TIGHTEN GRIP

at goal → done

not at goal

2

schema	elbow jnt	posture	accel
slide 0.9	extend 0.9	palm 0.9	[6]- 8]
		grasp 0.3	

schema	elbow jnt	posture	accel
depress 0.9	fixed 0.9	index 0.9	[2]

data #1

schema	elbow jnt	posture	accel
slide	extend	palm	6

data #2

schema	elbow jnt	posture	accel
slide	extend	palm	8

data #3

schema	elbow jnt	posture	accel
depress	fixed	index	2

data #4

schema	elbow jnt	posture	accel
slide	extend	grasp	2

TRAINING EXAMPLES (linking f-struct)

WORD SENSES FOR "PUSH"

ex1

schema	elbow jnt	posture	accel
slide	extend	palm	6

initial sense

schema	elbow jnt	posture	accel
slide 0.9	extend 0.9	palm 0.9	[6]

ex2

schema	elbow jnt	posture	accel
slide	extend	palm	8

merge

schema	elbow jnt	posture	accel
slide 0.9	extend 0.9	palm 0.9	[6 - 8]

ex3

schema	elbow jnt	posture	accel
depress	fixed	index	2

new sense

schema	elbow jnt	posture	accel
depress 0.9	fixed 0.9	indxfgr 0.9	[2]

ex4

schema	elbow jnt	posture	accel
slide	extend	grasp	2

merge

schema	elbow jnt	posture
slide 1.0	extend 1.0	palm 0.7 / grasp 0.3
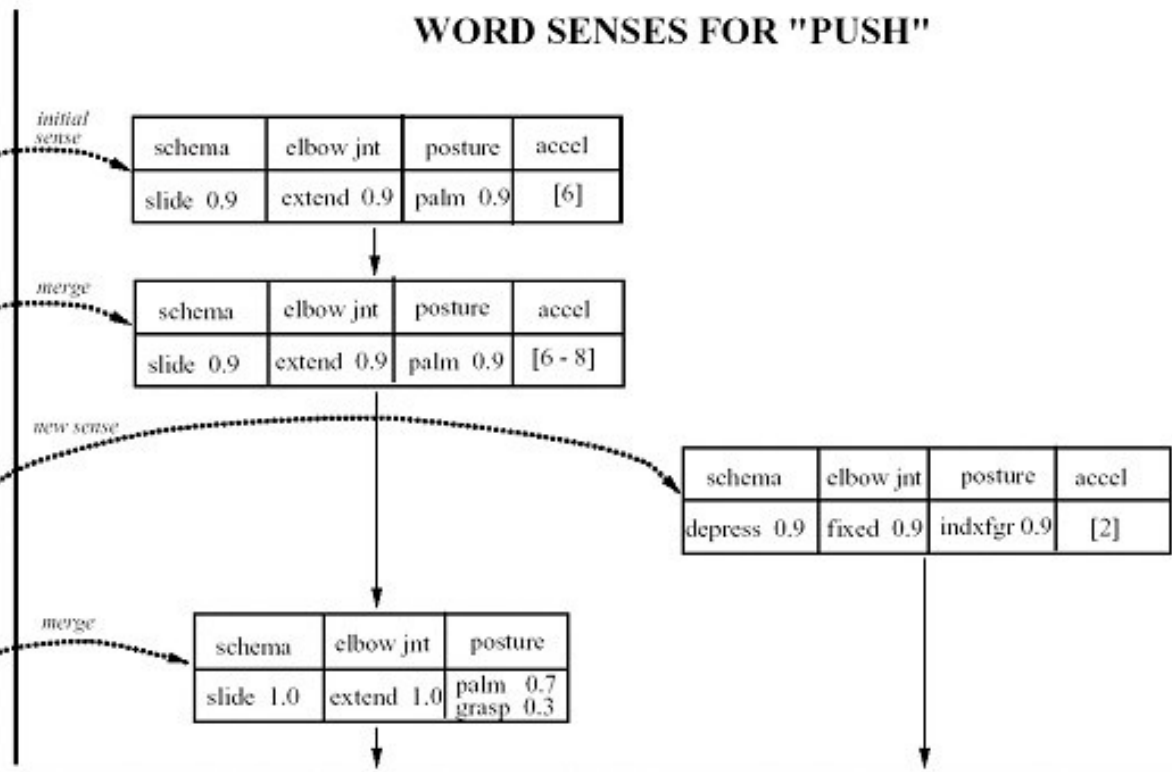
Limitations of Bailey's model

- ✓ an instance of recruitment learning (1-shot)
- ✓ embodied (motor control schemas)
- ✓ learns words and carries out action
- ✗ the label contains just the verb
- ✗ assumes that the labels are mostly correct
- ✗ no grammar

Questions

- What is Constrained Best Fit?
- How does Bailey use multiple levels of representation to learn different senses of verbs?
- What is Minimum Description Length?
- How do we use Minimum Description Length to merge a grammar?
- What does the prefix affix tree look like for the following sentences:
  - eat them here or there
  - eat them anywhere
- What does the affix tree look like after the best prefix merge?

Minimum Description Length

- Occam's Razor
- Constrain set of hypotheses
    - Like "prior distribution" over hypotheses
    - from Tom Griffiths's lecture
    - prior distribution is more flexible

Questions

- What is Constrained Best Fit?
- How does Bailey use multiple levels of representation to learn different senses of verbs?
- What is Minimum Description Length?
- How do we use Minimum Description Length to merge a grammar?
- What does the prefix affix tree look like for the following sentences:
  - eat them here or there
  - eat them anywhere
- What does the affix tree look like after the best prefix merge?

Grammar merging

- How can we measure description length?
    - complicated rules are bad
    - lots of rules are bad
        - measure "derivation length"
    - alpha * size(rules) + derivationCost(rules, sentences)
- How can we merge rules?
    - extract common prefix
    - extract common suffix

Questions

- What is Constrained Best Fit?
- How does Bailey use multiple levels of representation to learn different senses of verbs?
- What is Minimum Description Length?
- How do we use Minimum Description Length to merge a grammar?
- What does the prefix affix tree look like for the following sentences:
  - eat them here or there
  - eat them anywhere
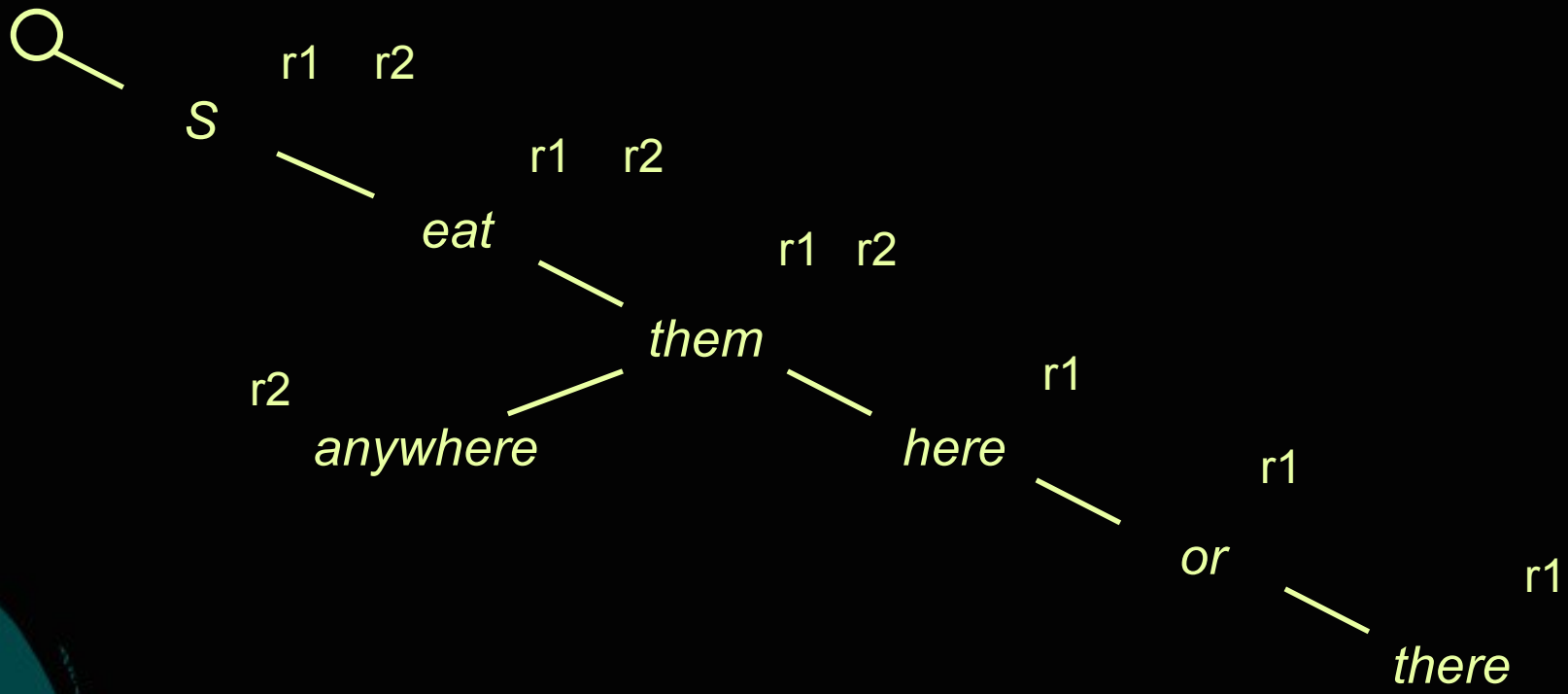- What does the affix tree look like after the best prefix merge?

Affix Trees

- Data structures that help you figure out what merges are possible

- Each node in the tree represents a symbol, either terminal or non-terminal (we call that the "affix" in the code)

- Prefix Tree

- Suffix Tree

Prefix Tree
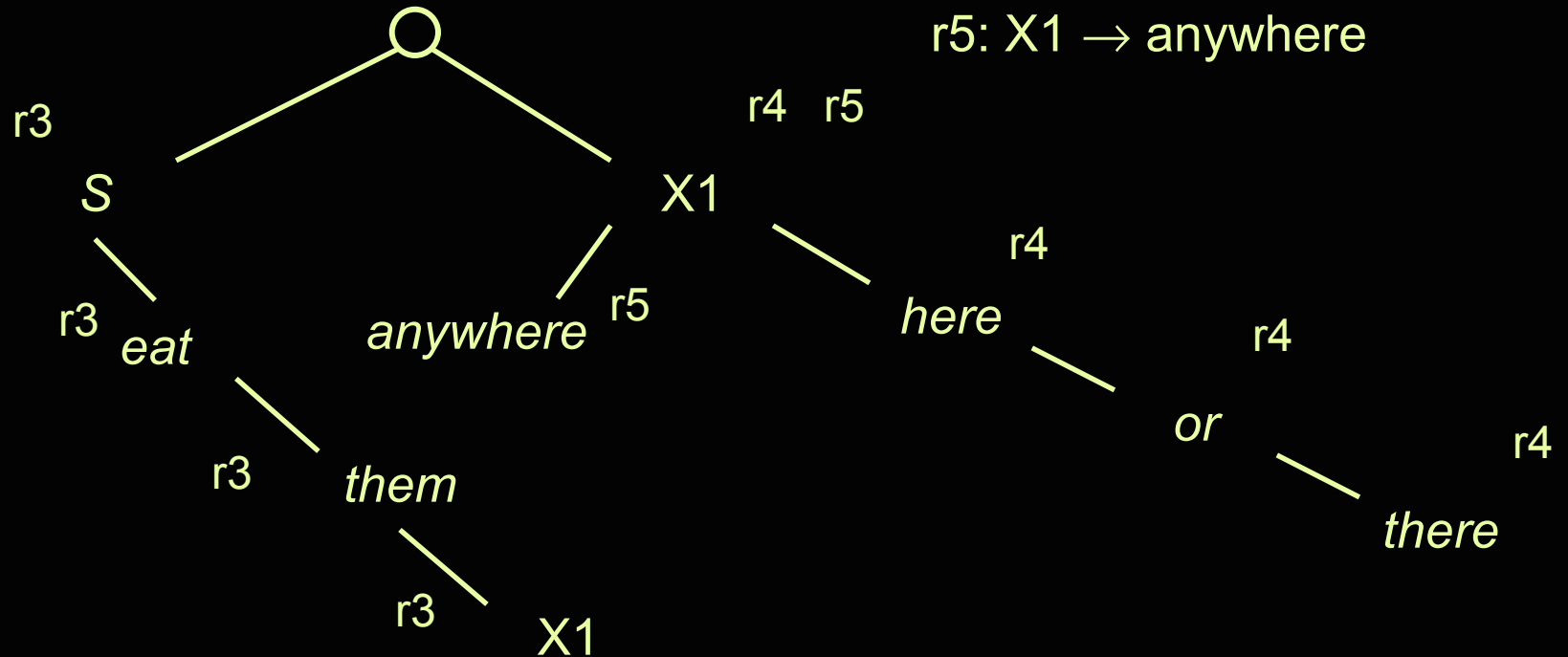
r1: S $\rightarrow$ eat them here or there
r2: S $\rightarrow$ eat them anywhere

                    r1   r2
        S
                    r1   r2
            eat
                        r1   r2
                them
        r2   r1
            anywhere   here
                                    r1
                                or
                                        r1
                                    there

Prefix Merge

r3: S → eat them X1
r4: X1 → here or there
r5: X1 → anywhere

Have a good Spring Break!!!