CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Markov Chains, and Random Text Generation

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Random Text Generation Project

- Goal
  - Read in text
  - Generate similar semi-random text
- Approach
  1. Build DenseBag to store word frequencies
  2. Use DenseBag to build Markov chain
  3. Use Markov chain to generate semi-random text

DenseBag

- Properties
  - Like a Set
  - But can contain duplicates
- Examples
  - { 1, 3, 1, 1, 3, 5 }
  - { 1, 1, 1, 3, 3, 5 }
  - { three 1’s, two 3’s, one 5 }
  - All represent same DenseBag

DenseBag<E> Operations

- Operations supported
  - Set<E> getUniqueElements( )
  - int getCount(E e)
  - E choose(Random r)

- Examples
  - Given DenseBag<Integer> x = { 1, 1, 1, 3, 3, 5 };
    - x. getUniqueElements( ) → { 1, 3, 5 }
    - x. getCount(1) → 3
    - x. choose(r) → 1 (50%), 3 (33%) or 5 (17%)

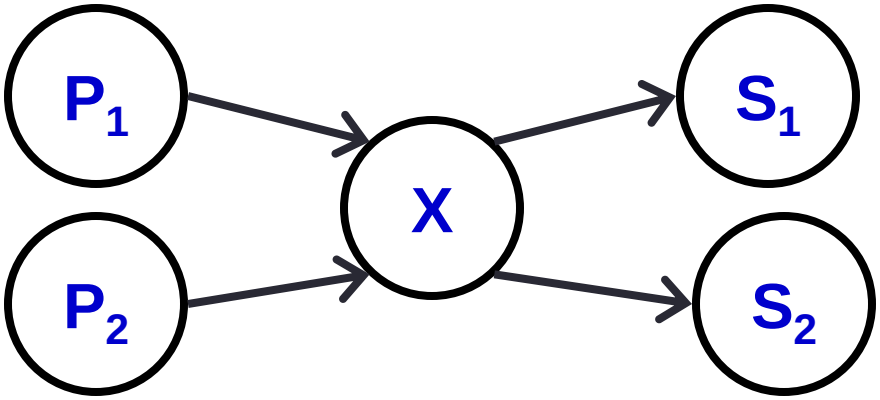
DenseBag<E> Operations

- Efficiency
  - Most operations should take O(1)
    - If using hashing
  - choose(Random r) may take O(|unique items|)

- Iterator
  - Iterates over all elements
  - Order is undefined

Markov Chain

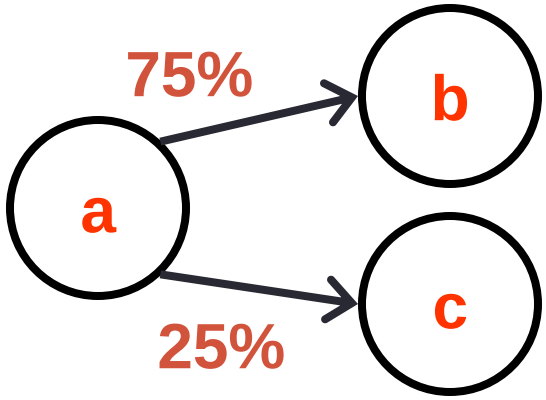
- Definition
  - A series of states with the Markov property
  - Where probability of future states depends only upon the present state and not on any past states
  - Example: Probability of X going to S_1 or S_2 is independent of whether P_1 or P_2 originally moved to X



- Used in
  - Statistical machine learning (artificial intelligence)

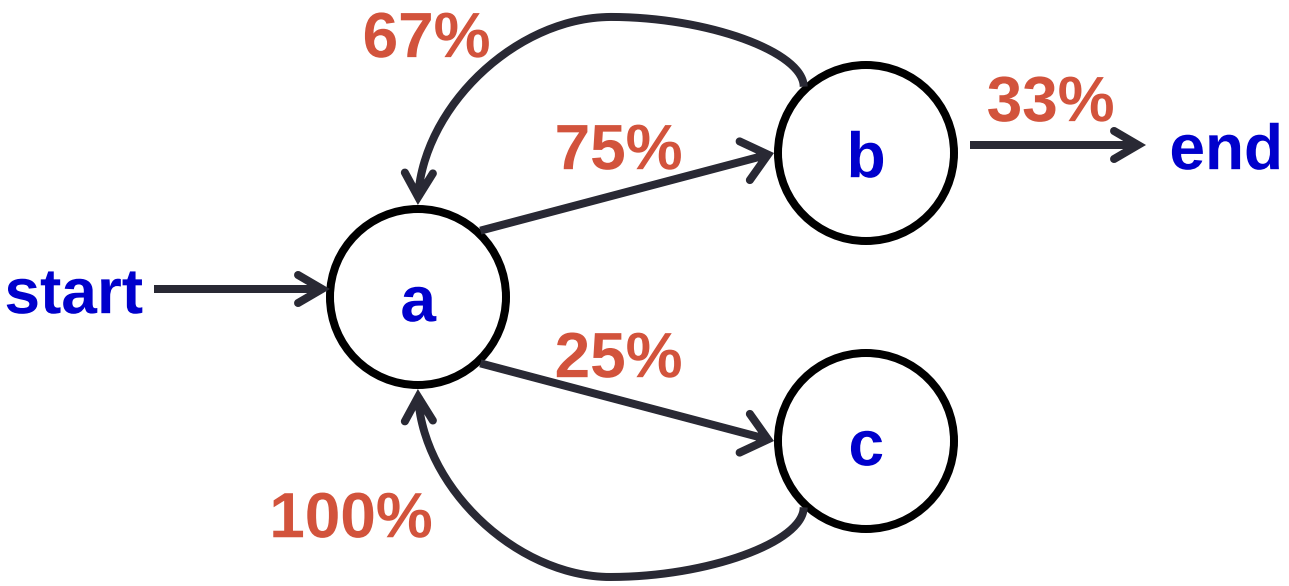
Markov Chain For Text

- Application of Markov chain
  - Represent probability of word following each word
  - Based on actual frequencies found in text
- Example
  - In the text "a b a c a b a b"
    - Word a is followed by b (75%) or c (25%)
    - Markov chain for words following a



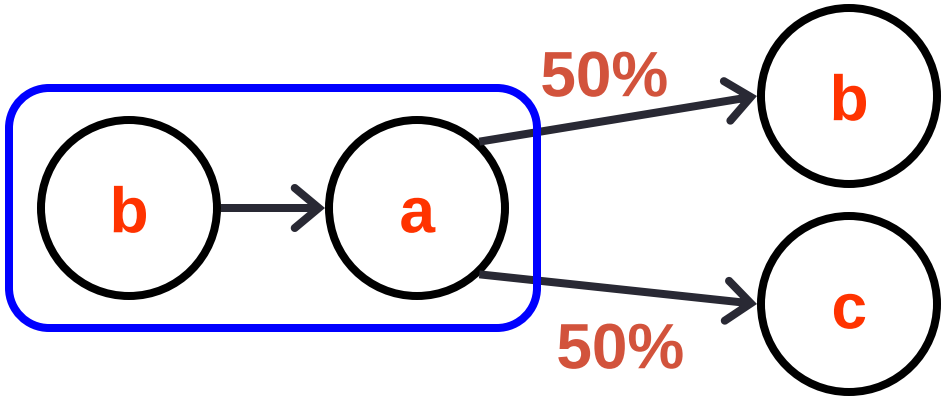
Markov Chain For Text

- Example
  - For the text “a b a c a b a b”
    - Markov chain for entire text



Higher-Order Markov Chain

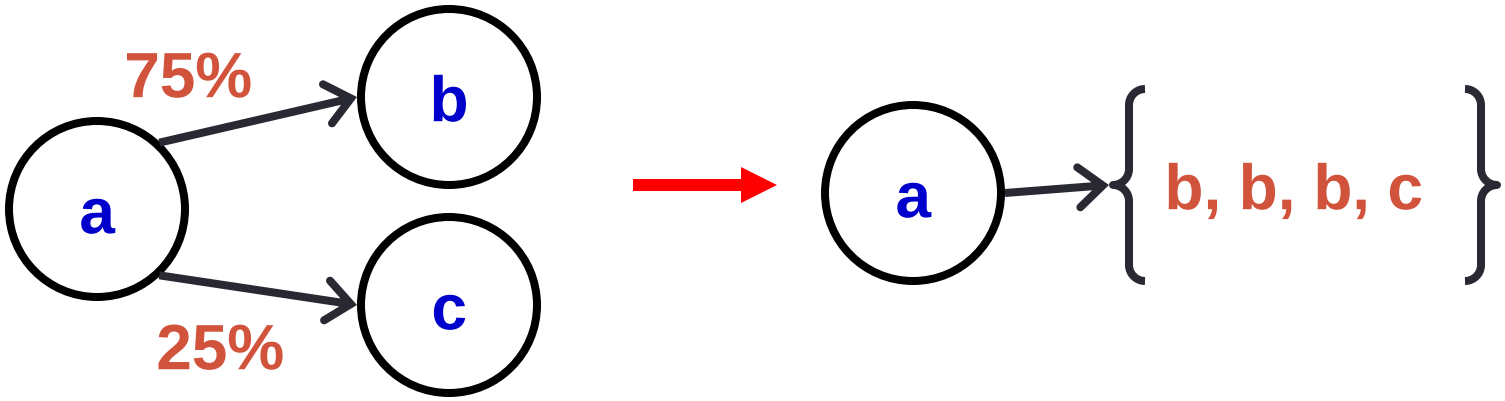
- Application
  - Can represent probability of word following each group of words (order-k for k consecutive words)
- Example
  - In the text "a b a c a b a b"
    - Words b a are followed by b (50%) or c (50%)
  - Represent with following Markov chain



DenseBag → Markov Chain

- DenseBag can represent state in Markov chain
  - Contains output in proportion to probability

- Example
  - Markov state transitions



DenseBag

Markov Text Generation

- Approach (for order-n Markov text)
  1. Generate higher-order Markov chains
     - Analyze “training” text(s)
  2. Represent Markov chains as DenseBags
  3. Connect DenseBags
     - To build probabilistic transition table
  4. Use transition table to generate text

Handling Start & End of Text

1. Use empty string(s)
   - Start text generation with “”
   - End text if “” generated
   - “” → “a”
   - “”,“” → “”,“a”
   - “a” → “”
2. Augment input with <Start> & <End> markers
   - “a b a c” → “<Start> a b a c <End>”
   - Start text generation with <Start>
   - End text if <End> generated