- When is EM used?
- Expectation step does what?
- Maximization step does what?
- EM is a kind of gradient descent in what?
When is EM used?
- Unobservable latent variables (GMM, HMM, LDA)
- Missing data

Expectation step does what?
- E(z) – expected value of the missing data

Maximization step does what?
- Finds the MLE or MAP of the model parameters

EM is a kind of gradient descent in what?
- likelihood
The LDA Model

For each document,

- Choose the topic distribution $\theta \sim \text{Dirichlet}(\alpha)$
- For each of the $N$ words $w_n$:
  - Choose a topic $z \sim \text{Multinomial}(\theta)$
  - Then choose a word $w_n \sim \text{Multinomial}(\beta_z)$
    - Where each topic has a different parameter vector $\beta$ for the words
The LDA Model

- Generative or discriminative?
- What is observed?
- What is hidden?
- What are the parameters?

- What does the E step estimate?
- What does the M step estimate?
RL: model-based vs. model free

- **Model-based**
  - MDP: \( p(s_{t+1}|s_t, a_t) \)

- **Model-free**
  - Q-learning
Model-based RL

- **Policy iteration**
  - Policy evaluation: Bellman’s equation

\[
\nu_{k+1}(s) = \sum_a \pi(a|s) \sum_{s',r} p(s',r|s,a) [r + \gamma \nu_k(s')] 
\]

- Policy improvement

\[
\pi'(s) = \arg\max_a \sum_{s',r} p(s',r|s,a) [r + \gamma \nu_\pi(s')] 
\]
Model-free RL

- **Q-learning**

Choose \( A \) from \( S \) using policy derived from \( Q \) (e.g., \( \epsilon \)-greedy)
Take action \( A \), observe \( R, S' \)
\[
Q(S, A) \leftarrow Q(S, A) + \alpha \left[ R + \gamma \max_a Q(S', a) - Q(S, A) \right]
\]

- **What are**
  - \( Q(s, a) \)
  - \( \alpha, \gamma \)
  - \( \epsilon \)-greedy?

- **Is the above on-policy or off-policy?**
Update Current V or Q

- Look only one step ahead
  - Q learning = TD(0)

- Do randomized search
  - Monte Carlo
  - Much faster than trying to do exhaustive search
  - alphaGo approach
Auto-encoders

- What is the most widely used auto-encoder?
- What loss function do auto-encoders minimize?
- What prevents an auto-encoder from learning the identity mapping?
- When do you use a linear vs. a nonlinear auto-encoder?
Auto-encoders

- What is the most widely used auto-encoder?
  - PCA

- What loss function do auto-encoders minimize?
  - Reconstruction error (always L2 in this course)

- What prevents an auto-encoder from learning the identity mapping?
  - Limited number of components, noise, sparsity penalties …

- When do you use a linear vs. a nonlinear auto-encoder?
Belief nets

- **D-separation**
  - X and Y are d-separated if there is no active path between them.

- **Active path**
Ten rules of Bayes Ball

An undirected path is active if a Bayes ball travelling along it never encounters the “stop” symbol: $\rightarrow$.

If there are no active paths from $X$ to $Y$ when $\{Z_1, \ldots, Z_k\}$ are shaded, then