Why

[1]

Parameterizing distributions

Definition

A *variational autoencoder* is an ordered pair whose first coordinate with *latent distribution* (density) $p_z : Z \to \mathbf{R}$ and *observation distribution* (density) $p_x : X \to \mathbf{R}$ is a ordered pair () discrete (continuous) latent set Z and discrete (continuous) observation set X is a tuple

where (a) ν is an autoencoder (which need not be regular, see Autoencoders), (b) $q_{z|x} : Z \times X \to \mathbf{R}$ is a conditional distribution (density) called the *recognition distribution* (*recognition density*), (c) $p_z : Z \to \mathbf{R}$ is a distribution (density) called the *latent prior model*, and (d) $p_{x|z} : X \times Z \to \mathbf{R}$ is a conditional distribution (density) called the *generating model*.

In other words, for (a) $q_{z|x}(\cdot, \xi) : Z \to \mathbf{R}$ is a distribution (density) for each $\xi \in X$ and for (d) $p_{x|z}(\cdot, \zeta) : X \to \mathbf{R}$ is a distribution (density) on X for each $\zeta \in Z$.

If the model has discrete latent set and discrete observation set (or continuous latent set and continuous observation set),

[1] Future editions will include. Future editions may also change the name of this sheet. It is also likely that there will be added prerequisite sheets on variational inference.

the *joint distribution* (*joint density*) $p_{zx} : Z \times X \to \mathsf{R}$ is defined by $p_{zx} = p_z p_{x|z}$. The *observation distribution*

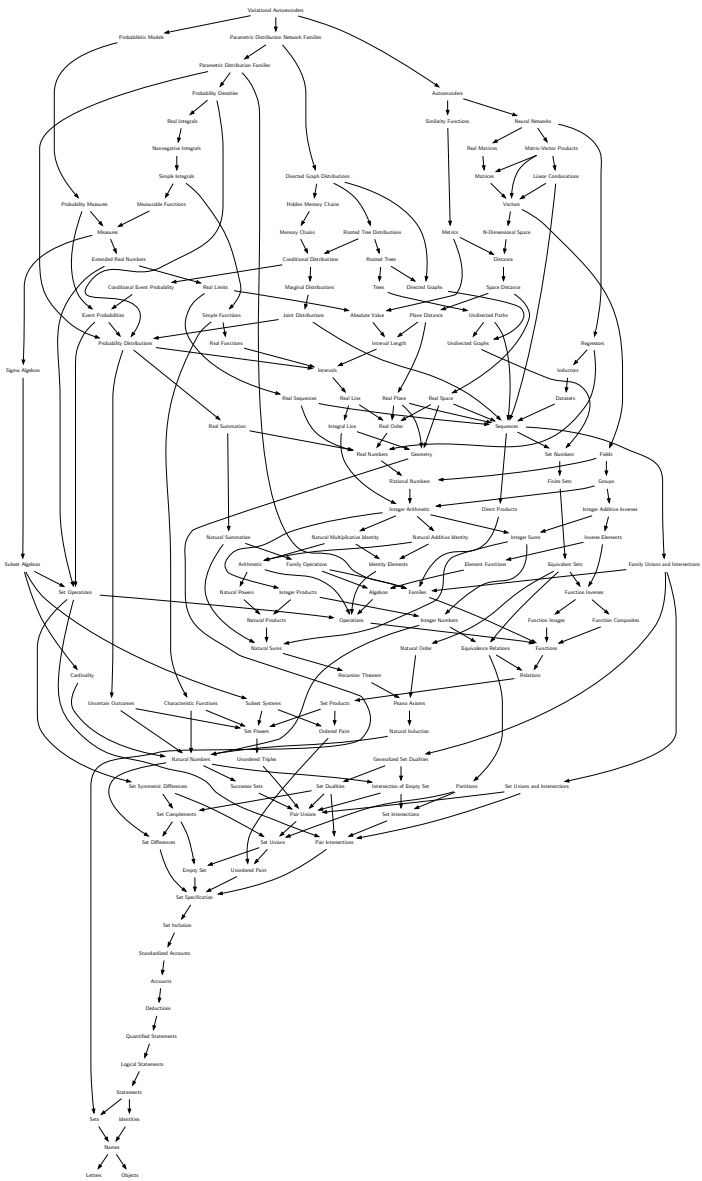
A *continuous-continuous variational autoencoder family* (*discrete-discrete*, *discrete-continuous*, *continuous-discrete*) is a tuple

$$(\nu, \{(q^{(\theta)}, p_z^{(\theta)}, p_{x|z}^{(\theta))})\}_{\theta \in \Theta}),$$

where:

- ν is an autoencoder with encoder $f : \mathsf{R}^d \to \mathsf{R}^k$ and decoder $g : \mathsf{R}^\ell \to \mathsf{R}^m$. The autoencoder need not be regular, see Autoencoders).
- $\Theta \subset \mathsf{R}^p$. The *parameter set* (or *parameter space*).
- $q^{(\theta)} : \mathsf{R}^h \to \mathsf{R}$ is a density (distribution, density, distribution), for each $\theta \in \Theta$. We call $\{q^{(\theta)}\}_{\theta \in \Theta}$ the *recognition model family.*
- $p_z^\theta : \mathsf{R}^h \to \mathsf{R}$ is a density (distribution, distribution, density), for each $\theta \in \Theta$. We call $\{p_z^{(\theta)}\}_\theta$ the *latent prior model family.*
- $p_{x|z}^{(\theta)} : \mathsf{R}^d \times \mathsf{R}^h \to \mathsf{R}$ is a conditional density (distribution, density, distribution). In other words, $p_{x|z}^{(\theta)}(\cdot, \zeta) : \mathsf{R}^d \to \mathsf{R}$ is a density (distribution, density, distribution) for every $\zeta \in \mathsf{R}^d$. We call $\{p_{x|z}^{(\theta)}\}_{\theta \in \Theta}$ the *observation model family.*

A *variational autoencoder* (or *VAE*) may refer to any of the above. The convention we have adopted is "latent type"-"observation type".


Variational Autoencoders
Probabilistic Models
Parametric Distribution Network Families
Parametric Distribution Families
Probability Densities
Autoencoders
Real Integrals
Similarity Functions
Neural Networks
Nonnegative Integrals
Real Matrices
Matrix-Vector Products
Simple Integrals
Directed Graph Distributions
Matrices
Linear Combinations
Probability Measures
Measurable Functions
Hidden Memory Chains
Vectors
Measures
Memory Chains
Rooted Tree Distributions
Metrics
N-Dimensional Space
Extended Real Numbers
Conditional Distribution
Rooted Trees
Distance
Conditional Event Probability
Real Limits
Marginal Distributions
Trees
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Space Distance
Event Probabilities
Simple Functions
Joint Distributions
Absolute Value
Plane Distance
Undirected Paths
Probability Distribution
Real Functions
Interval Length
Undirected Graphs
Regression
Signed Algebras
Intervals
Inductors
Real Sequences
Real Line
Real Plane
Real Space
Datasets
Real Summation
Integral Line
Real Order
Sequences
Real Numbers
Geometry
Set Numbers
Fields
Rational Numbers
Finite Sets
Groups
Integer Arithmetic
Direct Products
Integer Additive Inverses
Natural Summation
Natural Multiplication Identity
Natural Additive Identity
Integer Sums
Inverse Elements
Subset Algebras
Arithmetic
Family Operations
Identity Elements
Element Functions
Equivalent Sets
Family Unions and Intersections
Set Operations
Natural Powers
Integer Products
Algebras
Families
Function Inverses
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Integer Numbers
Function Images
Function Compositions
Natural Sums
Natural Order
Equivalence Relations
Functions
Cardinality
Recursion Theorem
Relations
Uncertain Outcomes
Characteristic Functions
Subset Systems
Set Products
Peano Axioms
Set Powers
Ordered Pairs
Natural Induction
Natural Numbers
Unordered Triples
Generalized Set Dualities
Set Symmetric Differences
Successor Sets
Set Dualities
Intersection of Empty Set
Partitions
Set Unions and Intersections
Set Complements
Pair Unions
Set Intersections
Set Differences
Set Unions
Pair Intersections
Empty Set
Unordered Pairs
Set Specification
Set Inclusion
Standardized Accounts
Accounts
Deductions
Quantified Statements
Logical Statements
Screenwords
Sets
Identities
Names
Letters
Objects