

# Information Geometry

G H Lathrom

April 29, 2021

## 1 Background

Information Geometry is a area which combines Differential Geometry, Probability Theory and Information Theory into one discipline. Because of this, it is somewhat difficult to get a grasp on all of the concepts which go into Information Theory. By molding these three disciplines together we also see connections between Physics and Machine Learning also with implications for Artificial Intelligence. Let's just see where all of these things take us, while supplementing necessary background along the way. One of the books of interest will be [AD08] along with a collection of papers available here. We begin with the connection between Information Geometry and Mechanics using [LZ17] as the guide.

$$\Gamma^{ij}_{\phantom{ij}k} = \dots$$

## 2 Mechanics

Suppose we have a manifold  $Q$  with local coordinates  $(q^1, q^2, \dots, q^n)$ . That is,  $Q$  is a collection of charts,  $\{U_\alpha\}$ , which is an open cover of  $Q$ . For each chart  $U_\alpha$  we have a diffeomorphism

$$\varphi_\alpha : U_\alpha \rightarrow \varphi_\alpha(U_\alpha) \subseteq \mathbb{R}^n,$$

where, together with the natural projection functions from the product space  $\mathbb{R}^n$  onto the individual coordinates,  $\pi^i : \mathbb{R}^n \rightarrow \mathbb{R}$ , we obtain the coordinate functions  $q^i = \pi^i \circ \varphi_\alpha$ . This gives rise to what we have referred to as the local coordinates above for the chart  $U_\alpha$ .

A **Lagrangian** is simply a function from the tangent bundle into the real numbers,  $L : TQ \rightarrow \mathbb{R}$ .

## References

- [AD08] K. Arwini and C. Dodson. *Information Geometry*. Lecture Notes in Mathematics 1953. Springer, 2008.

- [LZ17] M. Leok and J. Zhang. Connecting information geometry and geometric mechanics. *Entropy*, 2017.