Spatially Structured Recurrent Modules

- Paper review -

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Contents

Introduction (contd)

Want to forecast future state of a dynamical system; which scale do we operate at?

- Global scale captures all information, but interactions dont scale well with larger environments.
- Local scale captures dynamics in a small neighborhood, and sparsely interacting only with neighboring local subsystems. This can scale well to larger environments but makes the fundamental assumption that local short-term dynamics are only impacted by immediate neighbors, and could miss out on important long-range interactions across the environment.

A sub

With something to say

Introduction (contd)

The spectrum of resolution here encodes a scale space of problem representation, a continuum of tradeoffs.

We want to *learn* a notion of locality instead of hinging on an existing one. Scale ranges subjectively

Problem

Environment dynamics model stated as

$$\phi : \mathbb{Z} \times \mathcal{O}_{\mathcal{X}} \mapsto \mathcal{O}_{\mathcal{X}}$$

Recurrent dynamics

Typical RNN-based dynamics model

$$H_{t+1} = F(O_t, h_t) O_t = D(h_t)$$

We lean on our hidden state h_t

Model

High-level framework goal: model sub-systems as independent RNNs, capable of interacting sparsely via an attention bottleneck

1. Embed sub-systems in a topology and use a metric on this topology to encode the strength of interaction between embedded submodules.
2. In some ways mirrors [[Neural scene representation and rendering]] spatiotemporal setup

Model specifics

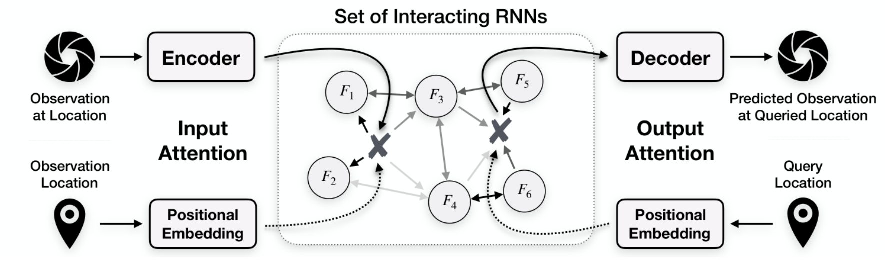

Figure 1: Local subsystem interaction

ideas

- dynamic kernel bounds submodule by submodule? Break imposed symmetry, could reflect even more flexibility through scales
- Or superimposing levels of thresholds on modules, have an intermediate layer, then finer layer that necessarily must be related to small sets of other modules or data points due to tighter threshold, then for larger threshold. Could tie inter-threshold embedding a together, learn jointly. Is this useful, or can single level do this on its own?

Follow up ideas (contd)

- Simply re-project S onto new topology, learn set of interactions over initial space? Might embody a hierarchical notion, could keep projecting to new subspaces and learn more specialized submodules, finer locality
- Continuous notion of locality: the continuous extension from embedding where all su modules interact and have wide thresholds in interaction geometry, all the way down to super tight, only self inducing scope. You can sort of imagine a cloudy transition space in 3D between these two points, where the embedded modules move around and make small adjustments between finite differences between scales. Picture a flat 2D layout of nodes in a graph sort of deal, with kernel thresholds visualized. Then you pull that thin slice into 3D and can see tubes through the 3D geometry connecting nodes between different heights, merging and breaking arbitrarily. Interesting visual, not sure it leads to anything