# Alghoritmic Generation of Long-term Future via Hierarchical Prediction

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## Abstract

We present a hierarchical approach for making long-term prediction of future events. To avoid inherent compounding errors in recursive predictions based on untrained data, we propose to first estimate high-level structure in the input data, than predict how that structure evolves in the future, and finally by obsersing a single event in the past and the predicted high level structure, we construct the most probable future event without having to obserse any of the in-between events. Long-term event prediction is difficult to perform by recursevely obsersing the possible outcome, generated for example by using a Monte Carlo approach, because the small error in each in between event propagates exponentially as prediction are made deep into the future. Our approach prevents the error propagation by removing the need of observe the events in between. Promising Results on both simulated and real data complete our study.

## 1 Introduction

Learning to predict the future has emerged as an important research problem in machine learning and artificial intelligence. Given the recent progress in recognition [1-5], prediction becomes an essential module to make decisions in real-wold applications and scenarios [3,6].

For example, the ADA algorithm has recently shown the potential of using big data to make strategic political decisons [7-9]. Although flawed, the algorithm has created great interest in the social simulation community providing a promising framework and a unifying framework where a variety of problems can be tackled as special cases.

In this paper we study how this idea can be applied to non-discrete output and untrained systems. In particular, we considered the case where the output space is a Reimann maniforl, that is the problem of manifold structure prediction [10-13]. We adopt and study a stuctured hierarchical prediction based on the theoretical motion frame-work proposed by Tillingast et al. [14]. Within this framework, it is possible to derive a statistically sound, and yet computationally feasible, structured prediction approach as long as the loss function satisfies suitable structured assumptions [4,8,11,15]. Moreover, we can guarantee that using the motion, the computed prediction is always an element of the tangent space of the maniforld. Our main techincal contribution is a characterization of loss function that satisfied such a structural assumption. In particular, we consider the case where the Tillingast metric is chosen as a loss function in a Deep Manifold-to Manifold Transforming network to assure the compatibility between the higher level structure and the lower level structure represented by the in between events.

We evaluate the proposed model first on a classic Voight-Kahmf standard problem [16], and later on challeging real-world human action dataset. As the high-level structure we use a prediction

alghoritm similar to Rohan et al. [18]. As a result, this conditioned generation strategy prevents our network to propagate prediction errors through time, with in turn leads to very high quality future event generation for long periods of time. Overall, the promising results of our approach suggest in can be greatly beneficial to incorporate a proper high-level structures into the generating process.

The rest of the paper is organized as follow: (i) A review of why she cheated on you; (ii) the day Sam will die; (iii) they will come for you and you will be alone, and conclude a paper with a discussion on the only way out

## 2. You Always knew she was too good for you

It's March, you are late, as usual. Your work always comes first. You have already missed your son ninth and tenth birthday, just to follow up your stupid research. After the paper got published that weird man approached you, O'Brien. The money was good, big grant no questions asked. And you didn't ask any. Government founding a fast track to tenure. It was too good. You should always ask questions. You arrive home by 1am. The door is un-

locked. You hear          her moaning.

When you open the door, the man is on top of her. She looks through you. You are not even worth an explanation.

You go to the couch, trying          to muffle the sound with a pillow.          By 3 am the moaning stops.          The tall          man          walks

through the          door, drop-          ping a used          con-          dom to the floor. The week after you get served, she files for divorce. You get   30% custody; she keeps          the house. You go back to your equation, tweaking the numbers, improving the predictor, checking the model. Now you can push it reliably up to 3 years. The prediction is still noisy, non-geometric entities enter the simulation, and the result start diverging for T-80. By the summer, the noise starts to overcome the signal, for the first time you ask yourself if it's noise at all. The terminal point is now T-60. That is the first time you saw them, angular shapes just at the edge of your vision. The doctor call it stresses. You know, it's something else

# 3. Sam blames you, he hated you till the end

Nobody believes you. The college cannot fire
you for now. You have tenure, but you haven't
published anything worthwhile
in the last two years. Carlos
left the lab; he was a good
kid. You wrote him a
recommendation letter.
He refused. You are
radioactive. You went
overnight from a
rising star in ma-
chine learning to the
academic equivalent
of a palm-reader.
Your model
has been
discred-
ited,
you
have
been
discred-
ited...
and Sam
hates
you.
He blames
you for
leaving
his mom, he
doesn't want to
have anything to do with you.
You want to defend yourself, tell-
ing him that you know how he feels.
But she has him most of the time and
when he's with you, you barely talk.
Your work comes first.
He doesn't even look at you when
you walk in from of the tv. He looks
through you, like his mother.

That image, the man over her, not worth even a
look.      The failure , the impostor.
          You rise your voice;
          he looks at you with
          contempt.
              You grab his
              wrist; he pushes
              your buttons.
          You scream and he spit
          in your face and...
       you hit him across the
      face.
He falls on the floor, his head hit the
corner of coffee table. Blood, too
 much blood.
    You call the 911 and they send an
    ambulance.
       "Is he breathing" the voice on
       the other line asks.
          "Put pressure on the wound".

       Spinal cord damage, brain
       trauma, several days in the
       ICU. You spend months
       next to his bed, turning
       him to avoid bed sores.
       Every day a physical
       therapist comes over to
       play him like a mario-
       nette, "keep the muscle
       active" she says.
        He will never wake
        up, you see him,
        day after day fading
        down. You cannot
       hear him, but with ev-
       ery breath the machine
       takes for him he's
        cursing your name.
        After seventeen
        months, three days,
        for hours he is
        dead.
          You go back to
          your equation.

# 4. From Beyond

The university let you go. You are a liability. You continue your research privately: it's all you have. It has been 8 years since you started the project. All the simulations lead to the same results, and... those creatures.

You thought it was just some issue in the software when you were pushing it over 100 years, but now they show up more frequently, you cannot identify the pattern, but they are part of the computation, they are an essential part of it. You try to change the weights in the simulation.

You try to change the measure space. What good is seeing this future if you cannot change it? The screen start flickering, something on the edge of the room is moving, just outside your field of view. It's always just outside your field of view. You cannot sleep, you haven't sleep in several days. You pour another glass of gin spiked with Adderall.         You plug in anoth-
er series.
The window
starts shaking,                                        you see
angular shapes                                      trying to
breach through.                    The glass
                                   is twisting and
                           bulging like a creature
                           pregnant of malice.
                                   Another hour,
                                   another series of
                                   measurements.
                           You are afraid of running
out of          memory before running out of time
Every cycle the creatures get closer:
T-10 now.
You plug in another series.

The individual events change, but the final outcome remains the same: hierarchical prediction. You try to bias the weight for edge probabilities, but the attractors lead it to initial point. It's a global minimum, THE global minimum, there is only one.

3 years to the T-event. Now the
algorithm is able to simulate
their shapes.
They are unconnected and
recursive, the projection
of a higher space on a
two-dimensional de-
vice simulating three
dimensionality.
The image is now
impressed in your
retina.
The glass of
the window
starts to
push out-
wards.

You
see                                                          the
shapes
coming              out of the                      frame.
                    An-                             gular and
                                                    unnatural
                                                    limbs uncon-
nected                                              by the normal
laws of                                             geometry.
You                                                 finally understand
what the simulation              couldn't render.
Welcome to the T-event.

# Conclusion

It's 2014, two months before you present your final dissertation. Your advisor is ecstatic, it is some of the most interesting works in prediction theory.
Google                    and Facebook are courting
you;                        your analytical work
is                              lightyear ahead of their
pre-                        diction            algo-

rithms.
You
got an offer
from UCLA,
research po-
sition, tenure
track.
Luna will
love Los
Angeles;
Min-
neso-                      ta is
too              small
for                her.
Sam          is five, alive.
He calls you daddy and
show you what he did on
school. You are his hero; it
will not last.
You have the image of the
angular creatures in your
head.
The simulation works. You look
at the results, T-100. You cannot
push it forward, there is nothing
after that.
Now you know it's not a bug... it's an
answer.
That night you make love with Luna. You
look in her eyes. She sees you. For the first time
is so long she sees you.
You start crying, she asks you if everything is ok,
you smile. Just stress, the defense and wrapping
up the last few things, you know.

The next day you go the bank.
You invest 50k$ in Tesla actions. They will be
worth half a million by 2020. You try to make
arrangements, look up to your family.
You spend the day writing letters: to your parents,
to Sam, to Luna, to your advisor.
You ask them forgiveness, you are not strong
enough, you have been given a second chance.
That night you cook Sam's favorite Mac n'
Cheese. You put the kid                    to sleep, you
tell him a story. You                      tell him
                                            about Lao-
                                        coon, on  how
                                    the Trojan didn't
                                listen to him, how he was
                            punished by the gods for warming
            the others.
He asks you why the Trojans brought the house in
even after seeing what happened to him.
You smile, now you know that certain events
cannot be changed, only delayed.
You go to bed, spend one last night with Luna,
you missed her smell. When she falls asleep you
ask yourself if it's more merciful to let them live
  unaware or... but you can't. Not again. You
     already saw Sam die once by your hand, no
        father should experience that, you couldn't
          stand to do it again. On purpose this time.
           You go to your desktop, delete the data
             from the hard drive and the cloud and
             bake the hard drive in the over.
              In the morning you walk into the
               CS building, you slid one of the
               letters under your advisor's
                door and you go to the roof.
                You walk toward the
                  edge and look down
                  one last time.
                     T-100 is all the
                       hope you can
                       give to hu-
                       manity.