SciSports: Player evaluation in soccer using 2D tracking data

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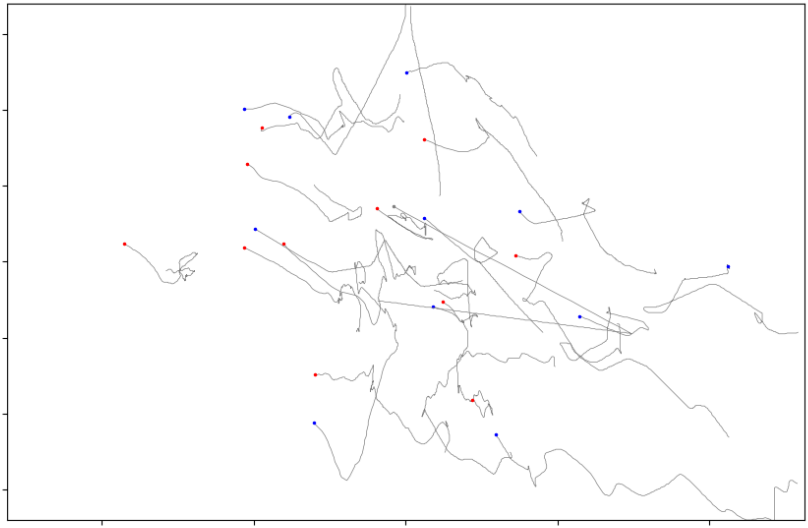
2D Tracking Data



Goals

- Quantifying football.
- Player Evaluation using 2D tracking data.

Game Plan towards Player Evaluation

1. Gain insights on player's space-time geometry and statistics of trajectories of players.
2. Generate trajectories of a single player.
3. Generate trajectories of all players.
4. Generate trajectories conditional on players' positions.
5. Use reinforcement learning to evaluate game setup and eventually individual players.

Dynamic Linear Model and Newtonian Dynamics

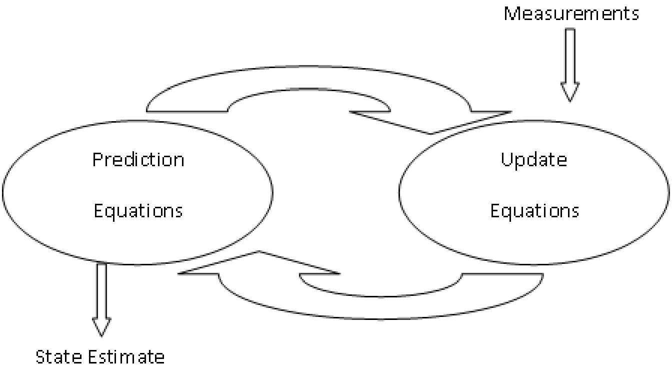
$$\boldsymbol{y}_t = \boldsymbol{F}_t \boldsymbol{\alpha}_t + \boldsymbol{\epsilon}_t \quad \text{(Observation)}$$
$$\boldsymbol{\alpha}_{t+1} = \boldsymbol{G}_t \boldsymbol{\alpha}_t + \boldsymbol{\eta}_t \quad \text{(Latent process)}$$

$\boldsymbol{\epsilon}_t, \boldsymbol{\eta}_t$ are Gaussian error and innovation

$$\boldsymbol{\alpha}_t = \begin{pmatrix} \text{position } x \\ \text{position } y \\ \text{velocity } x \\ \text{velocity } y \end{pmatrix}$$

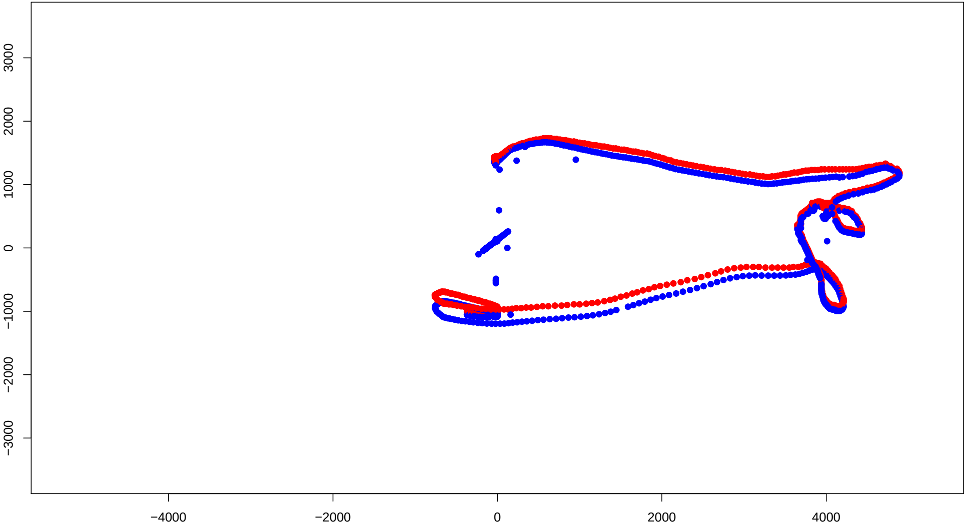
We only observe the (x, y) positions. The entries of $\boldsymbol{G}_t$ are based on $s = vt + \frac{1}{2}at^2$

Kalman Filter

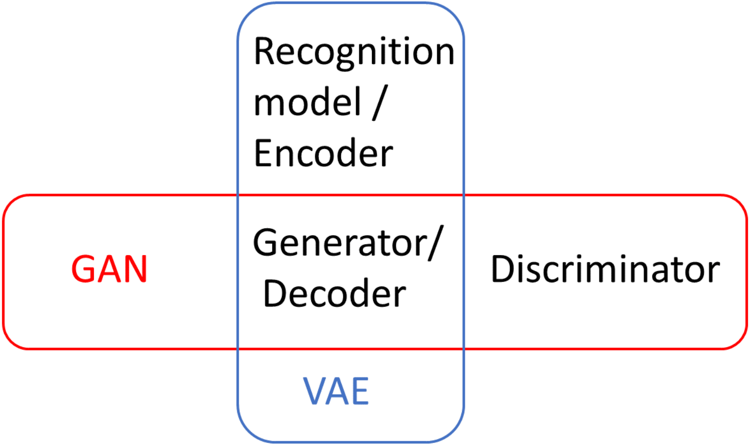


One-step ahead online prediction

Red: Actual footballer's position, Blue: Predicted



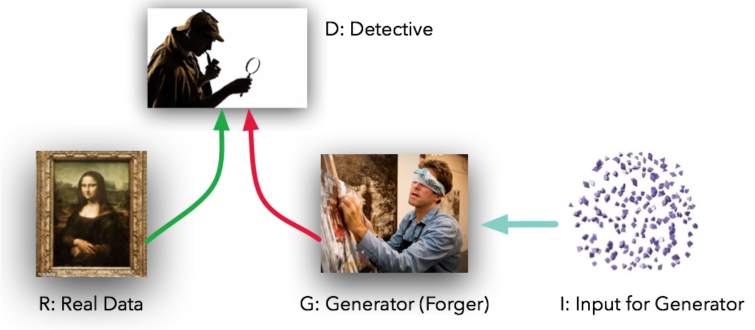
Generative Adversarial Network and Variational Autoencoder



Generative Adversarial Network

Two competing neural networks:

1. One tries to generate the best trajectories possible
2. One tries to distinguish generated and real trajectories



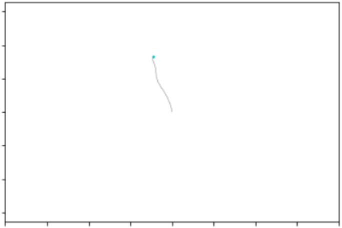
Generative Adversarial Network

GAN works well for generating images

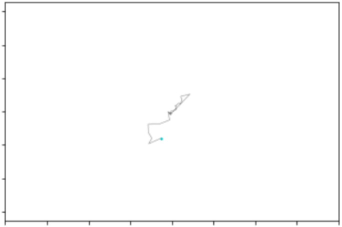
Generative Adversarial Network

Can we generate trajectories instead?

Results



(a) Realised Trajectory



(b) Generated Trajectory

Generative Adversarial Network

- Problem with GAN: Not enough computation power to train two Neural Networks.
- We train the discriminator to distinguish between players.
- We train the discriminator to distinguish between artificial and realised trajectories.

Distinguishing between two players

Given a trajectory, can we guess which player it belongs to?

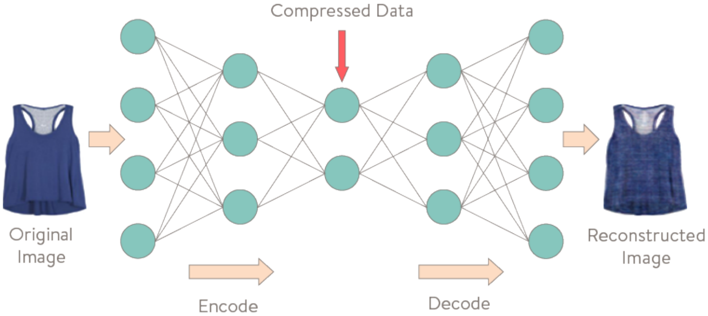
Discriminator

Using neural network:

When trajectories represent (x, y) coordinates, accuracy $\approx 90\%$
When using centered trajectories, accuracy $\approx 60\%$

(Longer training period may improve results)

Variational Autoencoder



Results

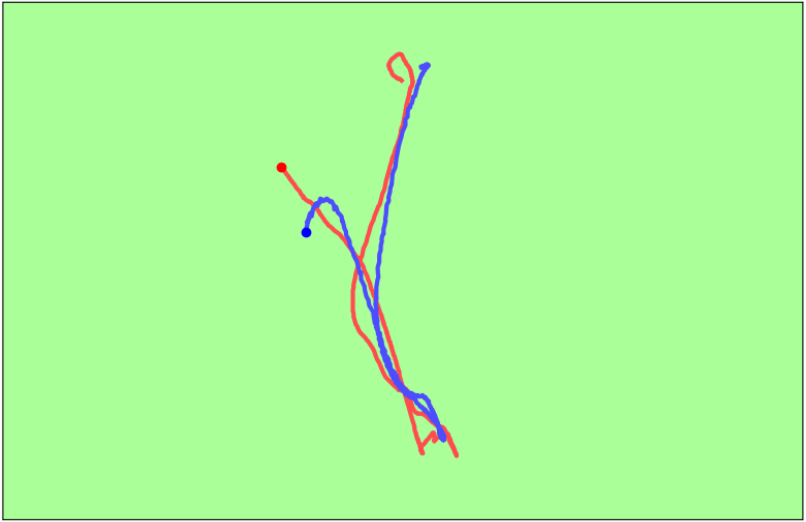
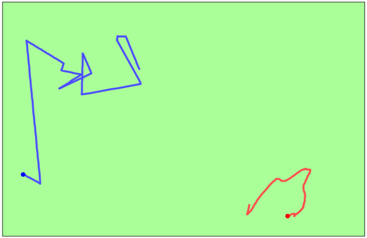


Figure: Generated (red) and Realised (blue) Trajectory.

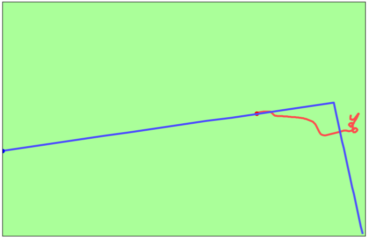
Results



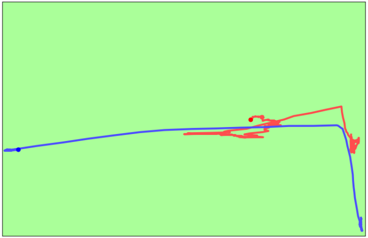
(a) Realised Trajectory: Player and Ball

(b) Generated Trajectory: Player and Ball

Results



(a) Realised Trajectory: Player and Ball



(b) Generated Trajectory: Player and Ball

Summary, Recommendations and Future Work

- Kalman Filter, GAN, VAE
- Preliminary results seem promising: individual player's trajectory can be predicted and generated

Recommendations:

- Kalman Filter suitable for short-term fast/online prediction
- Longer horizons might need more sophisticated (deeper) methods, e.g. GAN + VAE or deep Kalman
- However need lots of data and GPUs to speed up computations

Future Research:

- All trajectories of 22 players and ball, complex interactions, extract underlying strategy