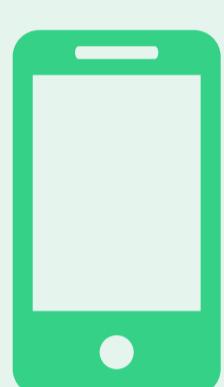


Controlling steering with Energy-Based Models

Mykyta Baliesnyi, Ardi Tampuu, Tambet Matiisen

Autonomous Driving Lab, University of Tartu

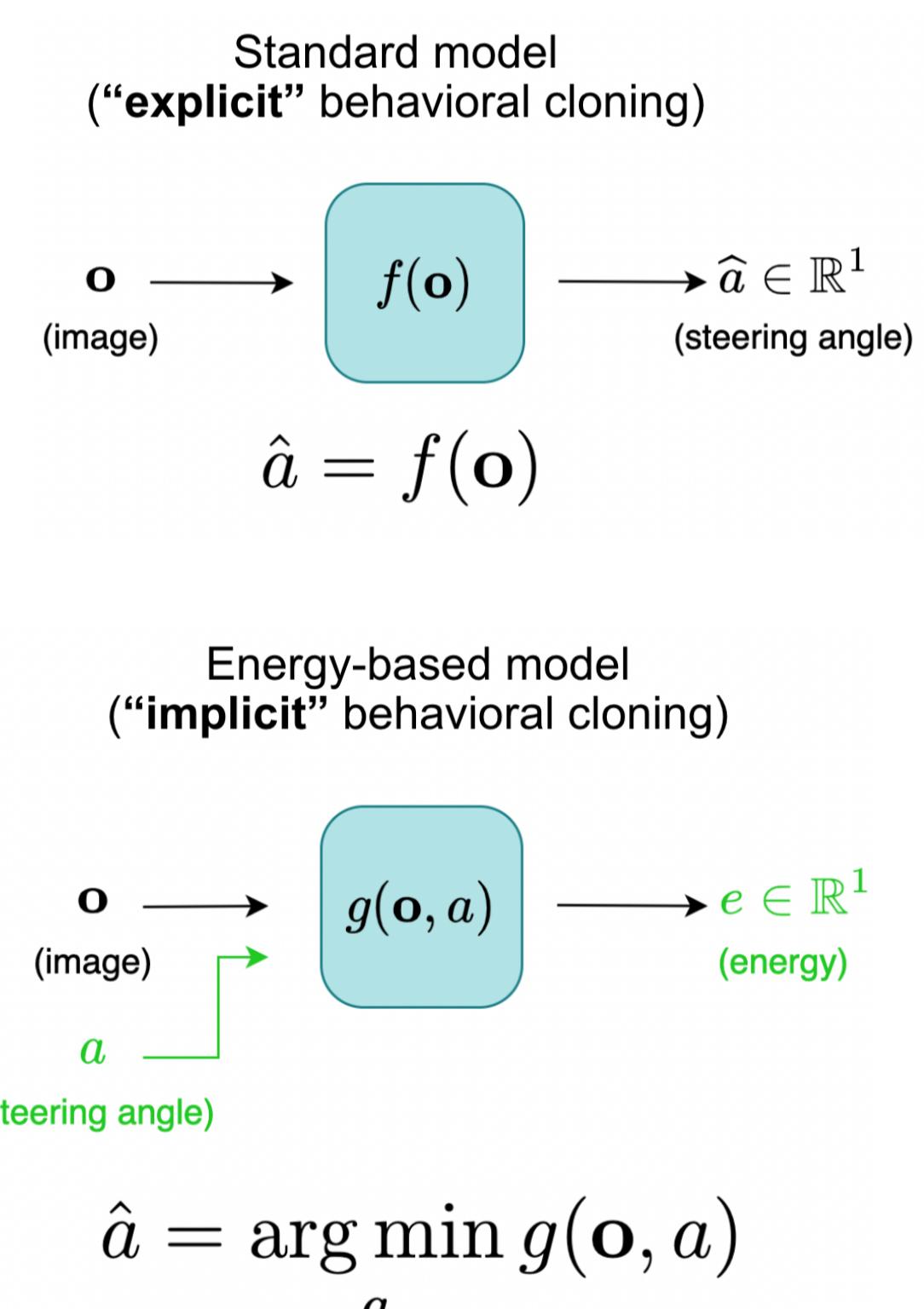
We tested energy-based models at road-following with a real car.



Take a picture to:

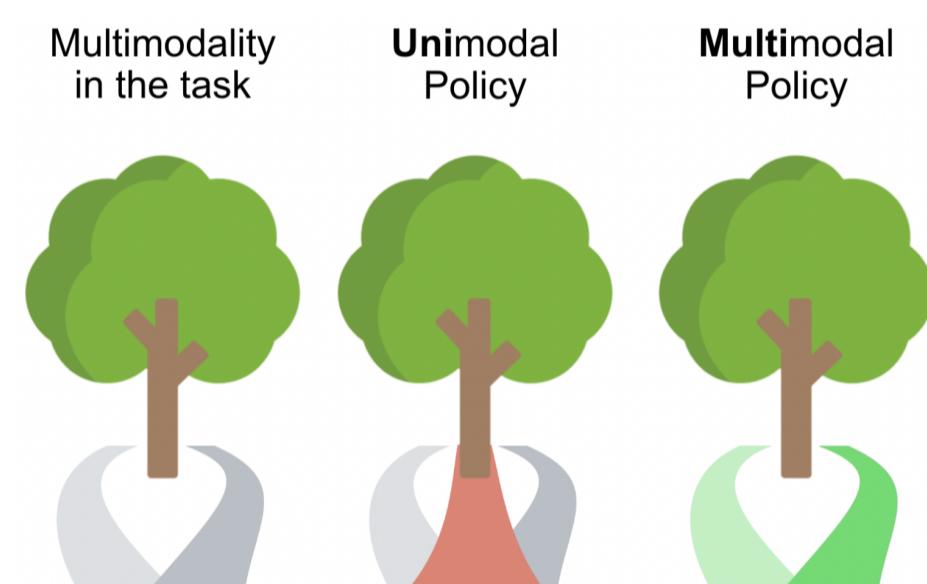
- get the full paper
- get this poster

What is Energy-based



What we thought

- 1 Standard PilotNet would **do this**
- 2 Energy-based PilotNet would **do this**
- 3 Energy-based → fewer interventions



What happened

- 1 Standard PilotNet **did a lot of this (89%)** - expected!
- 2 Energy-based **did mostly this (61%)** - great!
- 3 Energy-based → ~same # interventions - oh :(
- 4 Energy-based → less smooth - can we fix?



What we tried (see results in the paper)

- 1 Soft targets in the cross-entropy loss
- 2 Temporal smoothing loss term (see formula →)

$$L_{temp} = \alpha \left\| \mathbf{e}_t - \mathbf{e}_{t+1} \right\|,$$

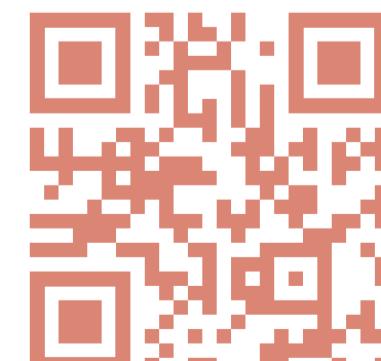
\mathbf{e}_t : energies of all possible angles at time t
 α : smoothing strength (e.g. 1.0)

Replicate our results!

OR use this as a benchmark

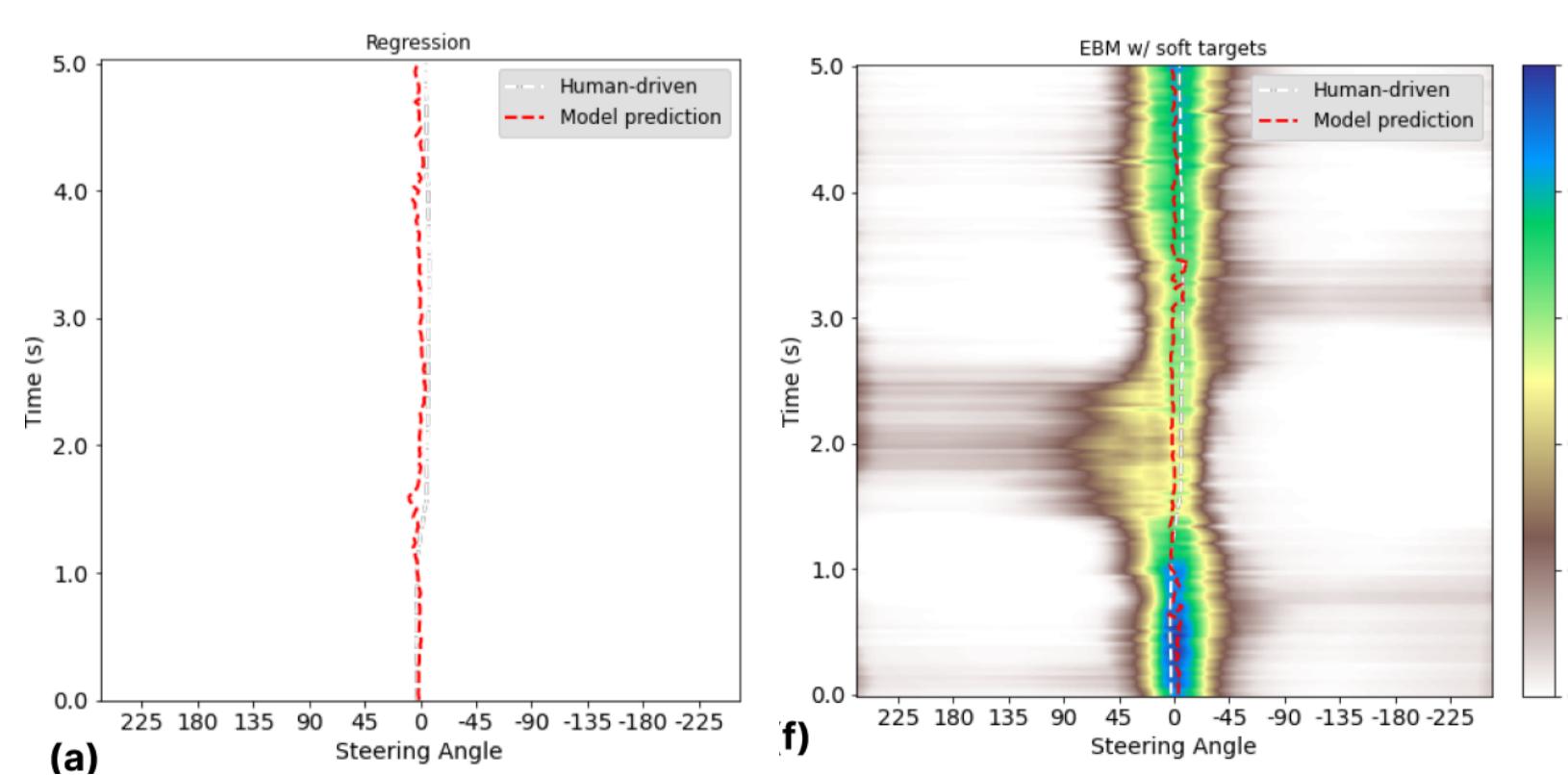
OR to select models you deploy

THE  SIMULATOR



Code to evaluate models on our real-world track in the VISTA Driving Simulator

Extra figures



Model predictions over a 5-sec intersection from above. Energy-Based PilotNet can model multimodalities (left turn @2s and right @3.5s). Standard (MAE regression) PilotNet cannot, because it is unimodal.

Driving ability over three real-world and three VISTA drives per model

Model	Real world		VISTA		
	Interventions	Whiteness	Crashes	Whiteness	
EBM	4	176.93% s	2	114.33% s	
	1	96.94% s	1	121.57% s	
	2	223.59% s	2	121.67% s	
EBM Temp. Smoothing	mean:	2.33	165.82% s	1.67	119.19% s
	5	119.39% s	3	58.70% s	
	2	137.22% s	2	60.37% s	
EBM Soft Targets	mean:	3.33	77.28% s	2	48.86% s
	5	111.30% s	2.33	55.98% s	
	4	56.33% s	3	85.72% s	
Regression (MAE)	mean:	4.66	57.15% s	3	74.97% s
	5	56.86% s	3	81.87% s	
	2	37.84% s	0	24.39% s	
Classification	mean:	1.66	75.34% s	0	24.75% s
	7	33.10% s	0	24.25% s	
	1	182.39% s	1	24.47% s	
MDN	mean:	3.00	162.27% s	1	105.13% s
	5	210.60% s	1	104.31% s	
	1	33.62% s	3	123.69% s	
	mean:	3.66	35.49% s	3	37.22% s
	5	35.46% s	3	35.74% s	
	1	37.39% s	3	35.84% s	