



Croucher Summer Course - Sports Biomechanics



When Clinicians Ask “Why?”

Translating Practice Needs into Biomechanics Research

Professor Roy T.H. Cheung

Professor in Physiotherapy, PhD in Biomechanics

School of Health Sciences, Western Sydney University

About myself...

- Academic qualifications
 - BSc (Hons) Physiotherapy
 - PhD in Biomechanics
 - Postdoctoral Fellow in Physical Medicine and Rehab
- Achievements
 - Grant success (total grant size > HK\$50m)
 - Owner of 5 patents (2 more under review)
 - Winner of international invention awards
 - Journal Editor / Associate Editor of multiple top-tier journals
 - Mentor of >50 postgraduates (e.g., MD, physio, engineers, sonographers, computer scientists, sports scientists, etc.)





Croucher Summer Course 2026



Which stage are you in?

Researchers' challenges

Junior PhD (1-2 years)

Senior PhD (3-4 years)

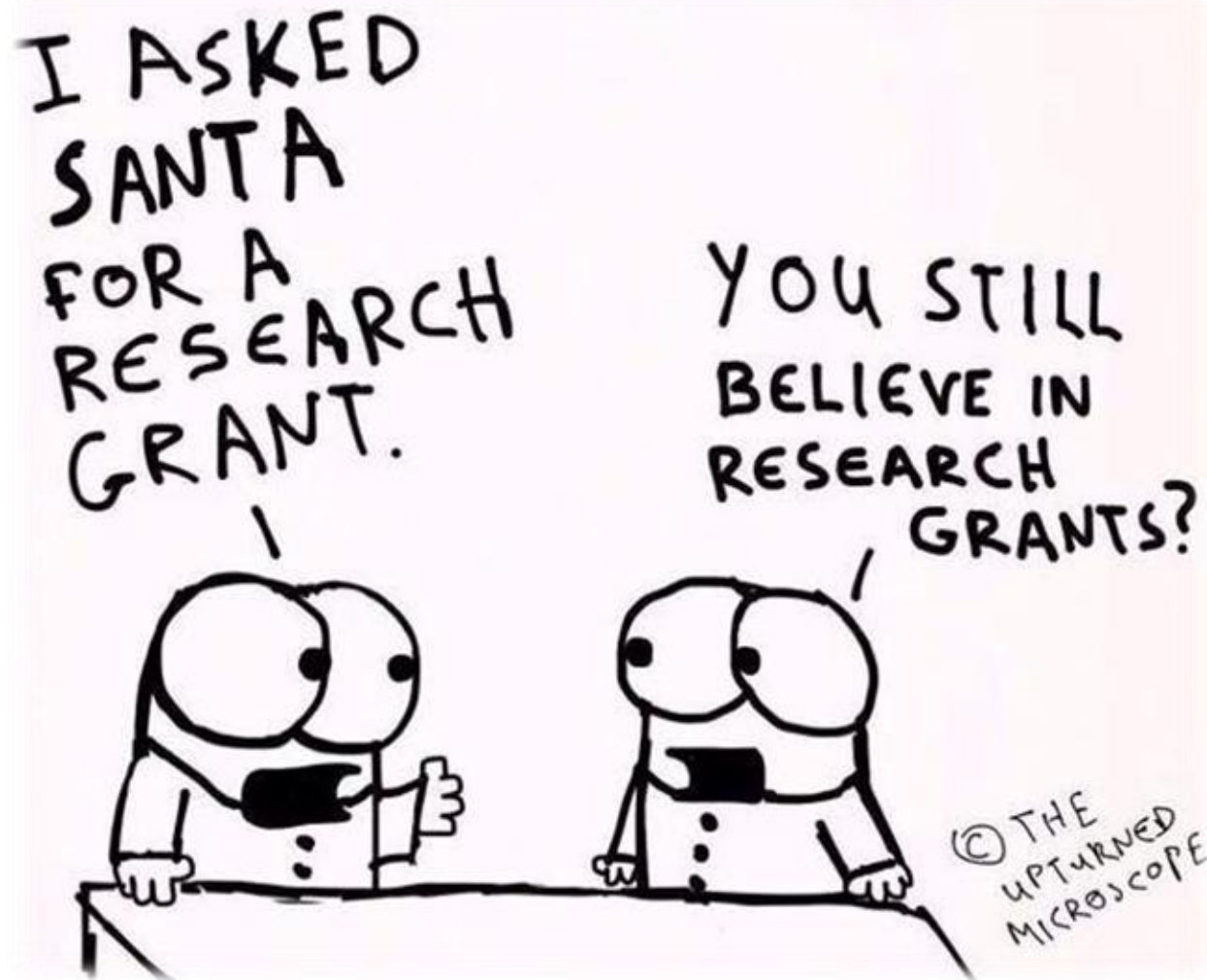
Postdoc



+



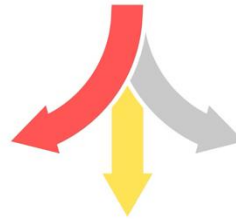
Faculty



Why early-career grant outcomes matter



Junior NIH R01 applicants
561 narrow wins vs 623 near misses
Statistically identical at baseline



Funding

Narrow wins received +0.29M USD
in the first 5 years

Attrition

Near misses: 12–13%
more likely to leave

Research impact

Narrow wins:
+50% papers, +20% citations

Wang et al. 2019 @ Nature Communications

Common reasons for grant rejection

1. Lack of novelty / research impact
2. Absence of track-record
3. Poor writing quality
4. Missed deadline
5. Incorrect formatting
6. Unrealistic / Math errors in budget
7.
8.



Infinite number of rabbits



- Publications being a common KPI for multi-layers in any university system
- How do we keep generating new and good research ideas?
- Are those ideas meaningful to the real world?



How would you describe the ownership of your PhD research idea?

Not an uncommon problem

“PhD students in science often apply for scholarships that are connected to their supervisor's project as they may not have sufficient knowledge to construct their own research project at the beginning of their doctorate. They also need time to be integrated into the research work, to create a sense of belonging, and most of the time this implies “fitting the mold” and at the same time forging scholarly identity.”

“So, the development of creativity, originality, and novelty in this context is difficult, as students are “encapsulated” in the supervisor’s project or research team project, and achieving doctorateness in these conditions is challenging.”



Case sharing



Ampongan et al., under review

Karen Kwong



@k.a.r.e.n_physio

Visiting Kitchee Centre



Traditional fatigue protocol



- Max effort x 40 reps

$$\text{Fatigue Index (\%)} = \left[1 - \frac{\text{Average Peak Torque (Last 5 Reps)}}{\text{Average Peak Torque (First 5 Reps)}} \right] \times 100$$

- Usually 2 test speeds (slow vs. fast)

Not a pleasant experience



It affects my
training plan!



The test spends
me a lot of time

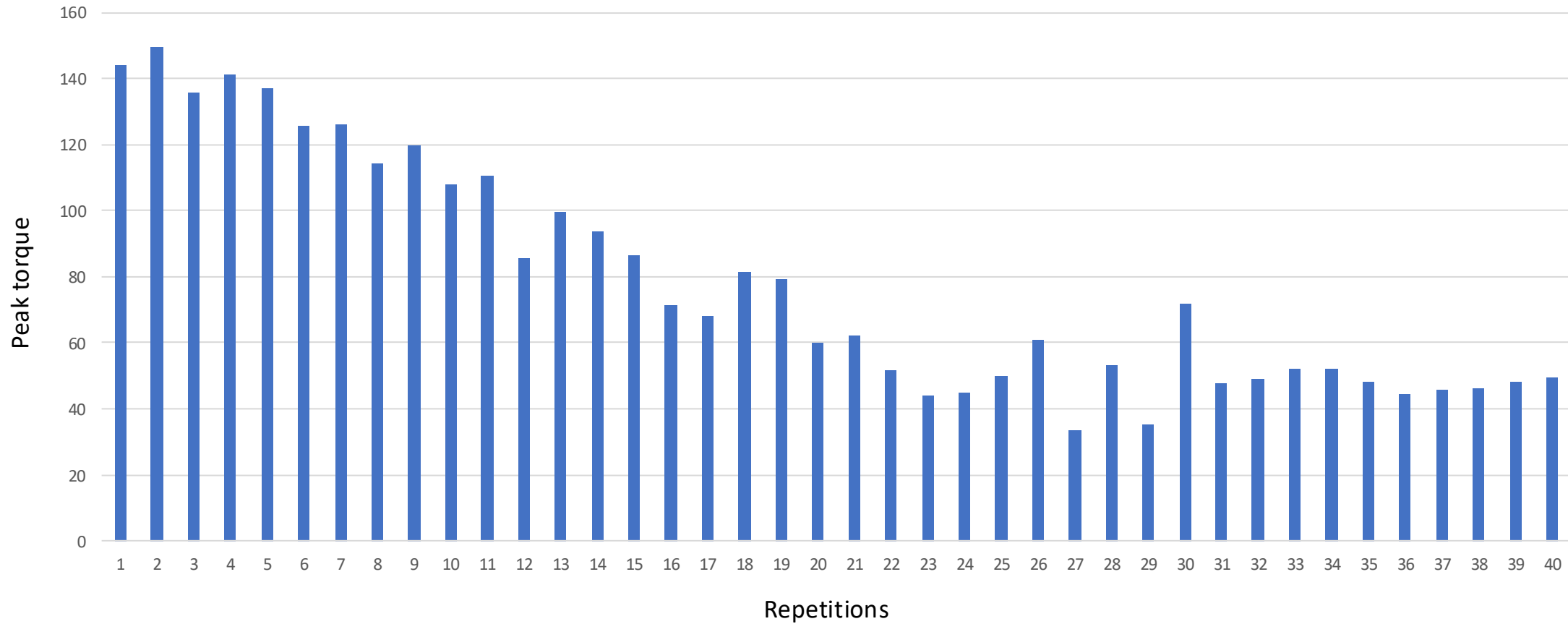


DOMS hurts



WESTERN SYDNEY
UNIVERSITY

Can we shorten the protocol?

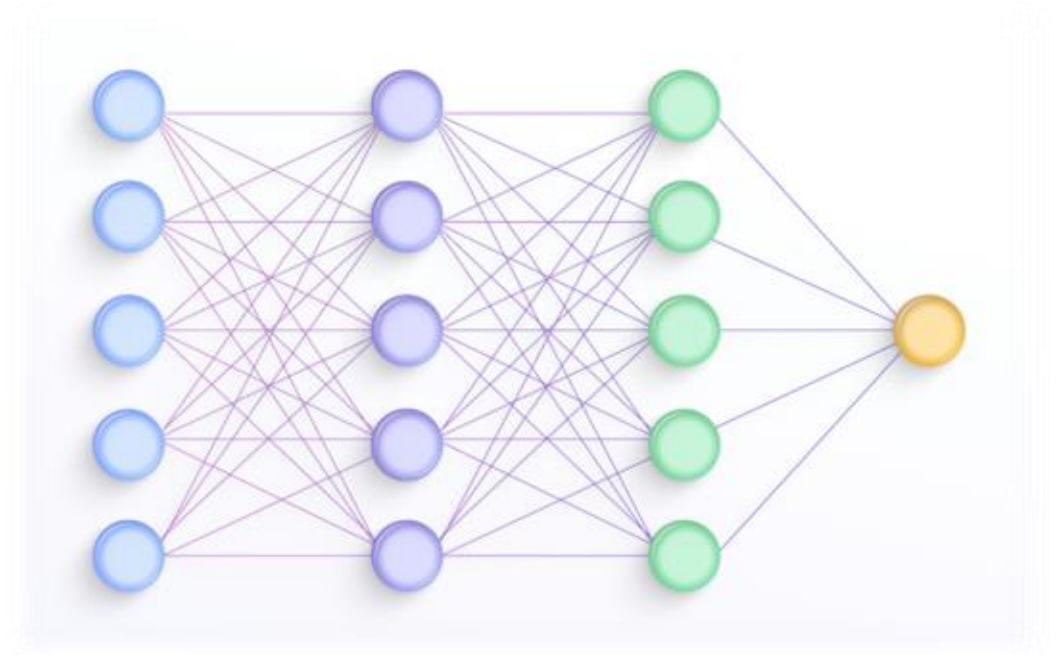
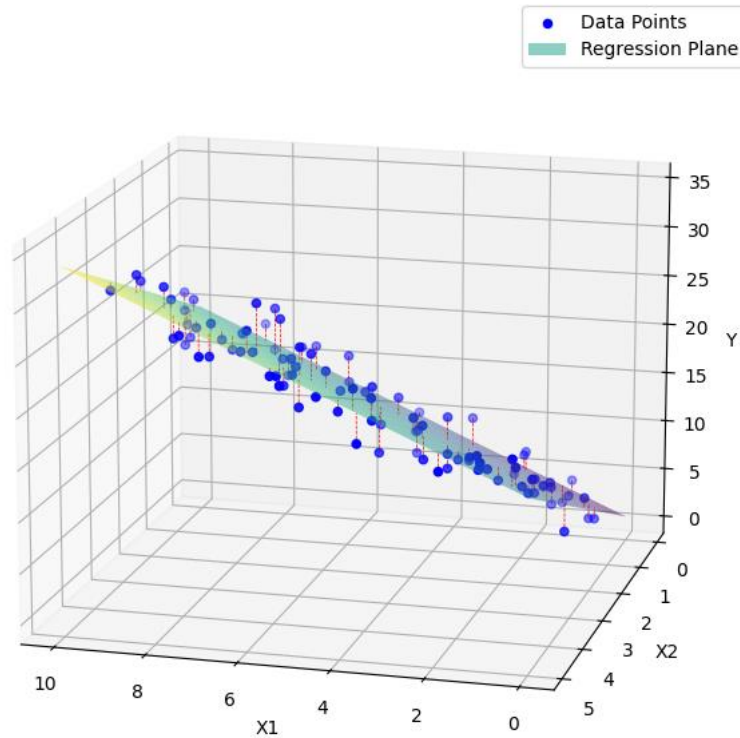


ANY THOUGHTS?



WESTERN SYDNEY

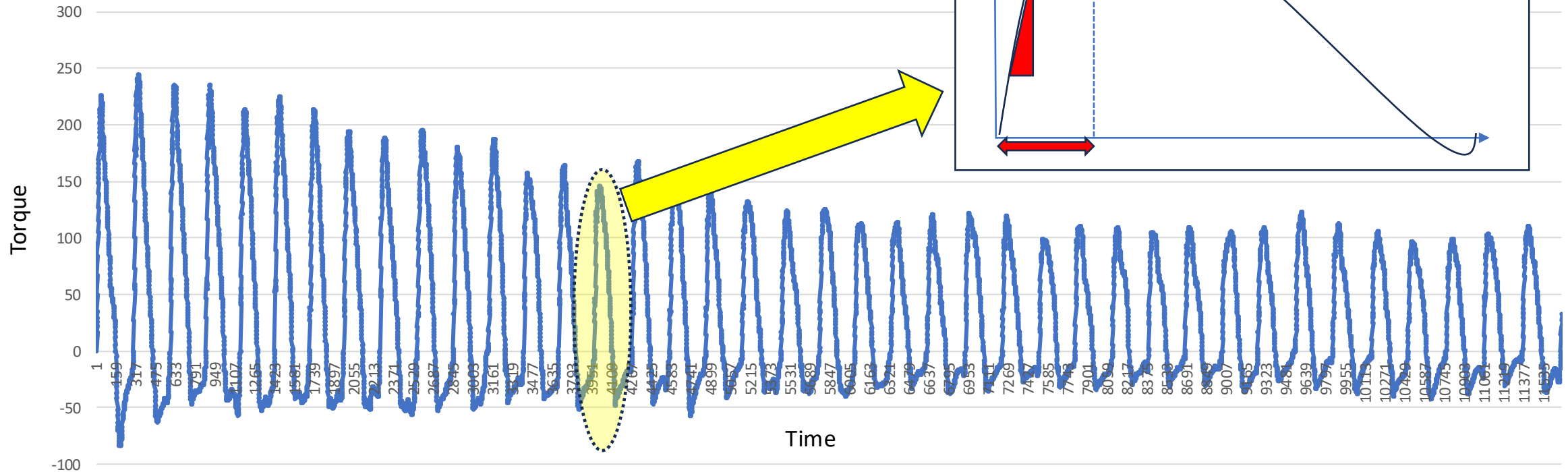
Possible solutions



Regression vs. XCM

Regression	XCM
 Strength	 Strength
Full transparency Built-in statistical inference Efficient with small datasets Strong theoretical foundation	Automatic non-linearity detection Visual interpretability High predictive accuracy while remaining interpretable Robust to correlated features
 Weakness	 Weakness
Rigid assumptions Fragile with collinearity Poor with complex patterns	No built-in statistical inference Computationally heavier than regression Less suitable for formal causal claims

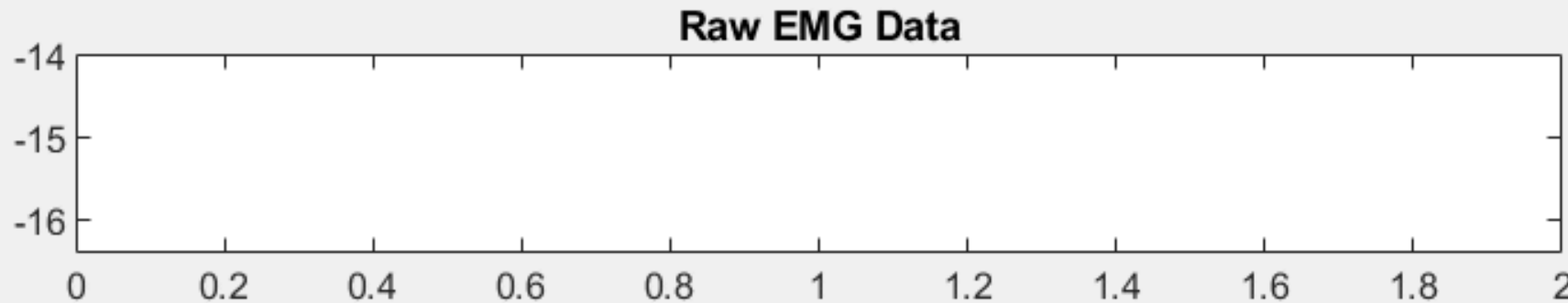
Additional input #1



Rate of torque development and time to peak torque ~
Muscle fatigue and associated compensatory motor strategies

Hamanda et al., 2003; Langford et al., 2024

Additional input #2



Fatigue related EMG parameters:

- Time-domain: RMS, iEMG, ARV, etc.
- Frequency-domain: Mean freq, Median freq, etc.
- Others: Wavelet or spectrogram measures

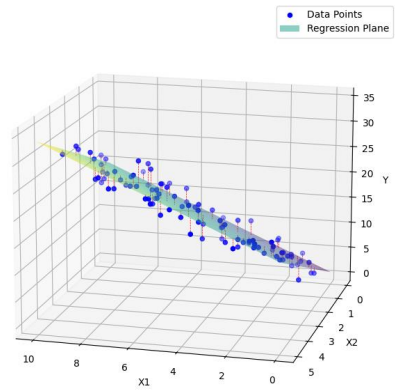
Experiment



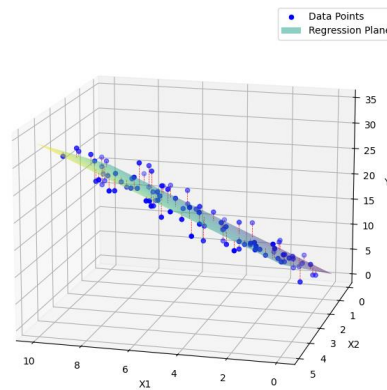
- Healthy adults (n=40)
- Right knee concentric extension
- EMG on RF
- Full fatigue protocol i.e., 40 reps
 - Slow (60 deg/s)
 - Fast (180 deg/s)
- Fatigue index calculated using traditional method (i.e., FI_{40})

Comparing models

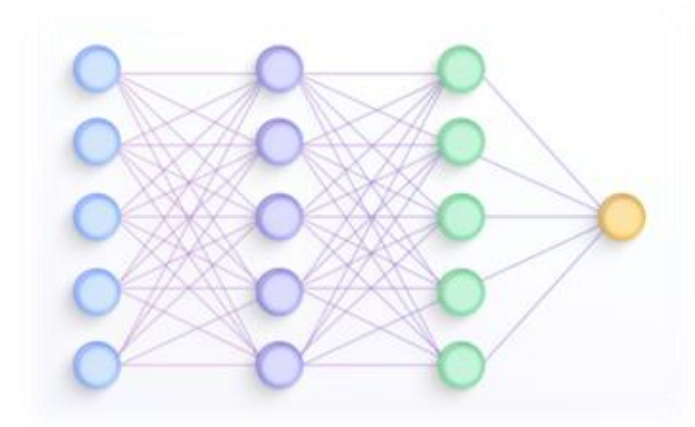
Peak-Torque LR



Time-Series LR



XCM



Input parameters

Peak torque values

Peak torque values

Peak torque values

Output parameters

FI_{40}

FI_{40}

FI_{40}

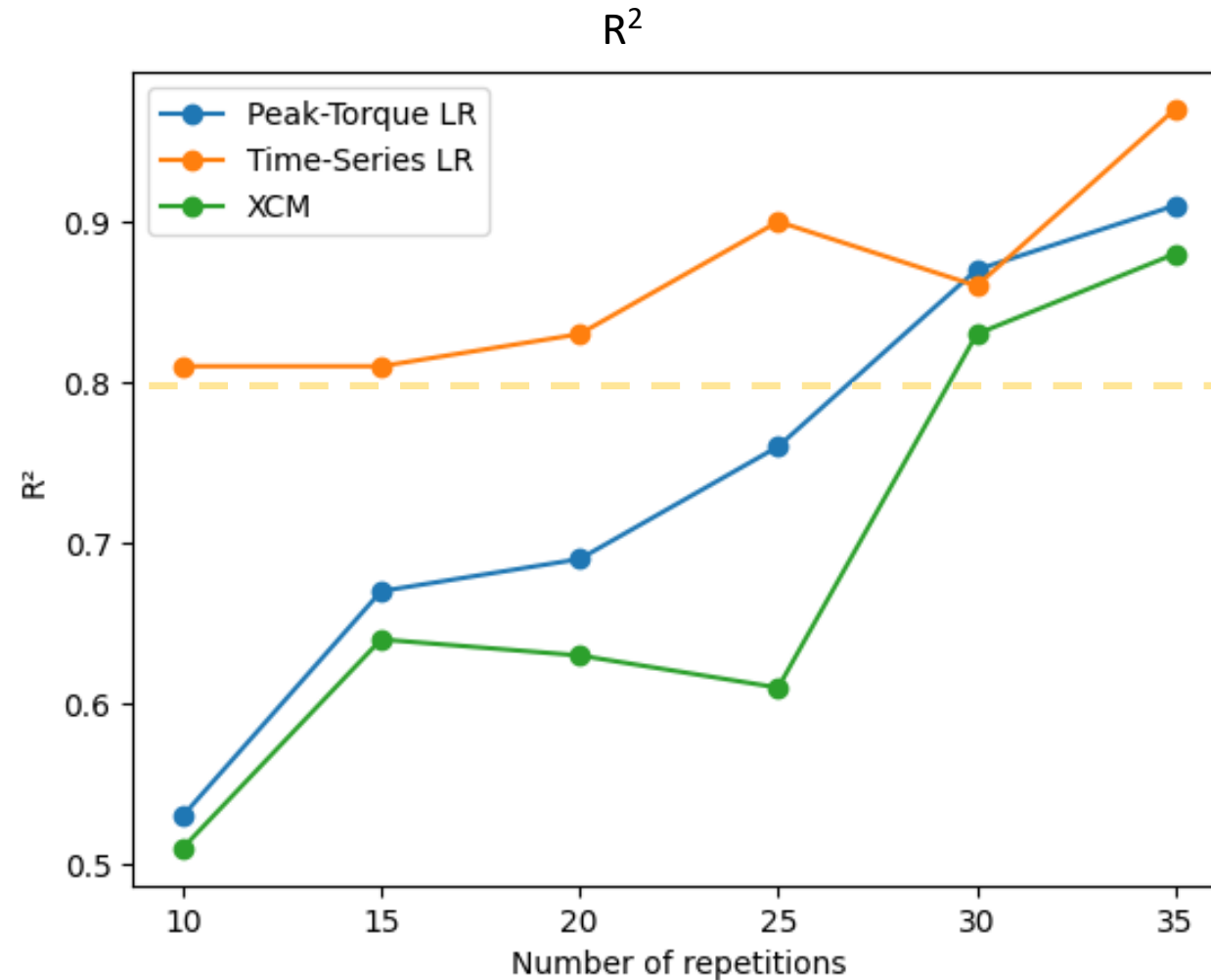
Time series info

EMG info



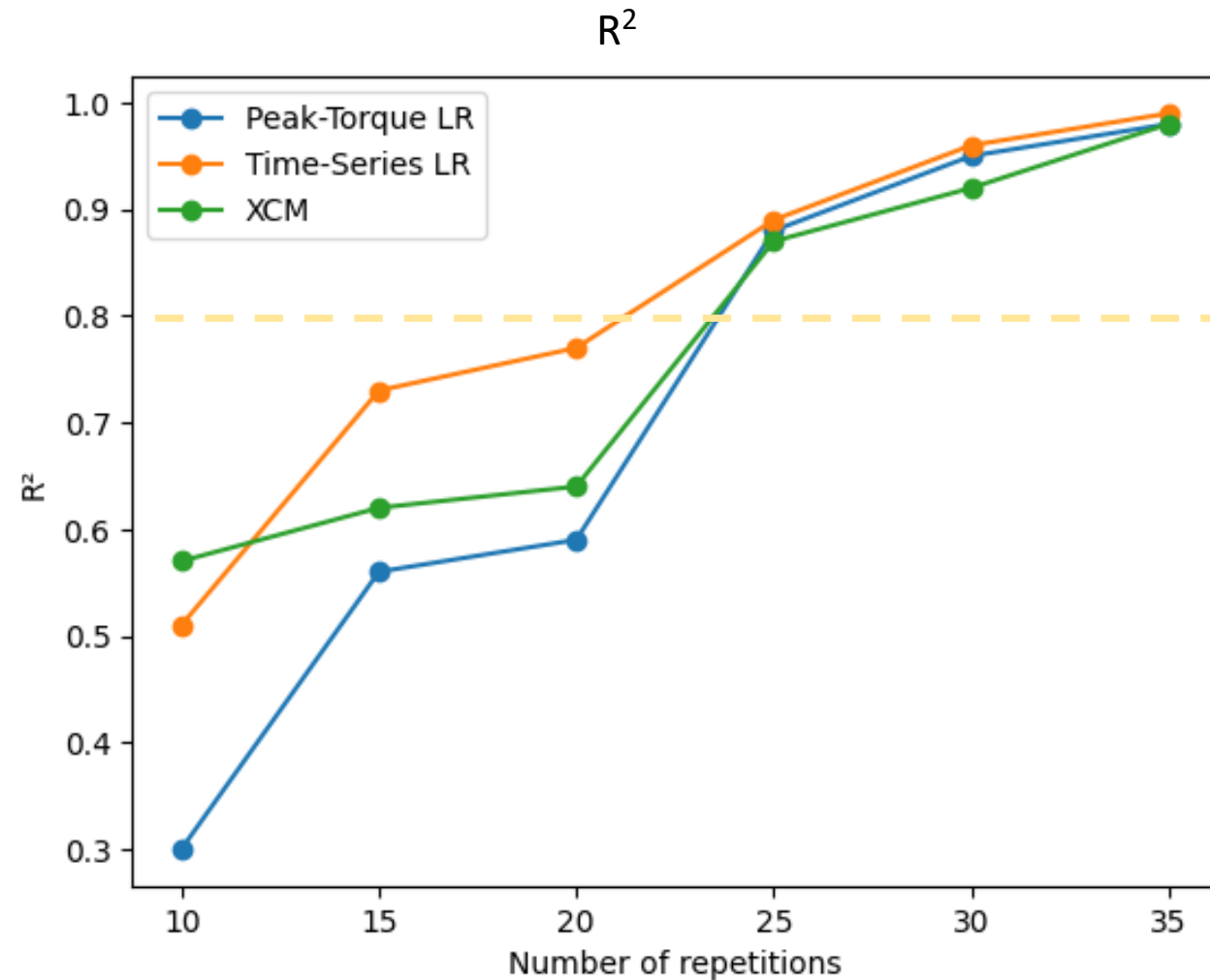
Which model wins?

Results – Slow contraction



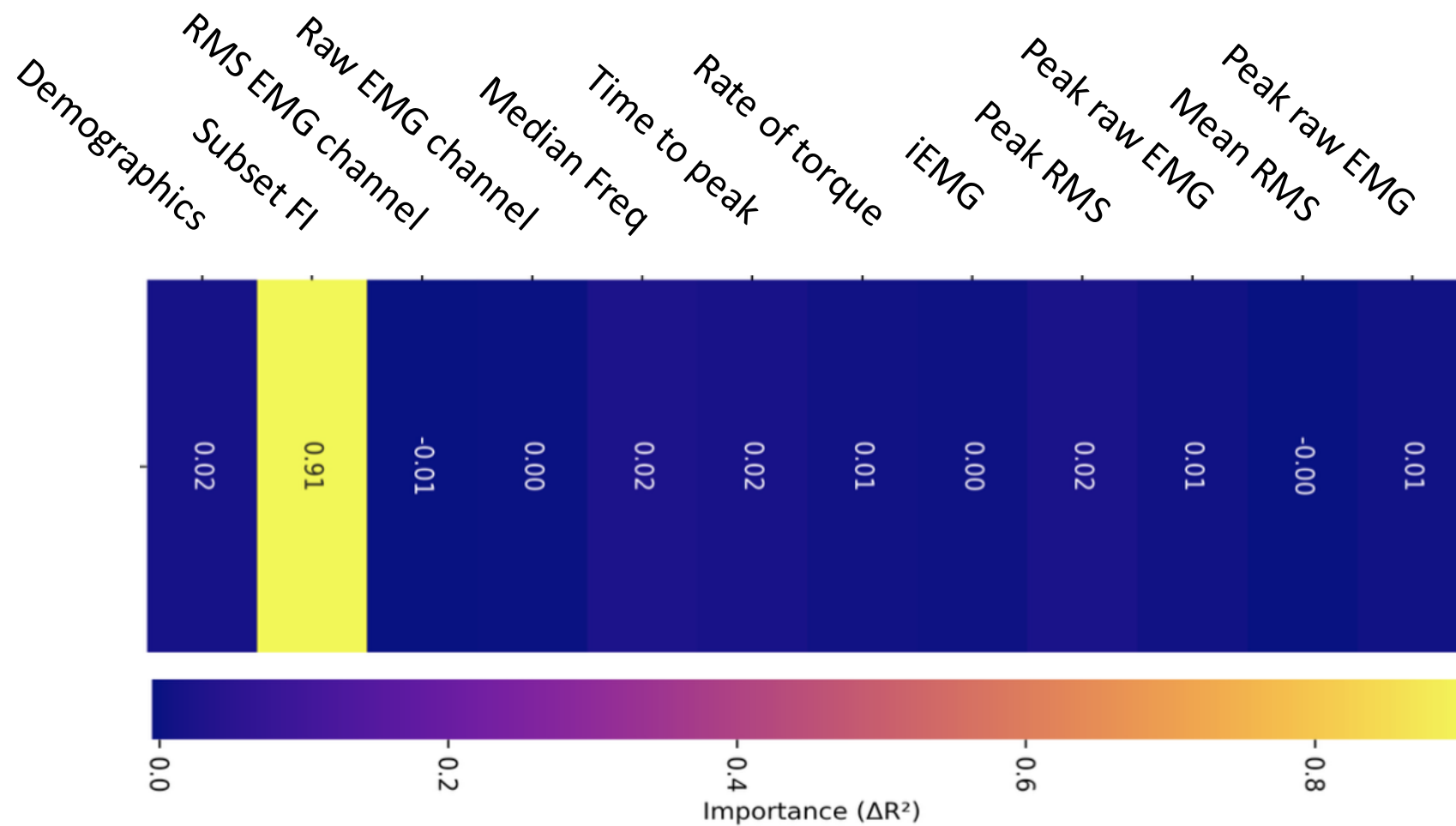
No. of reps	RMSE		
	Peak-Torque Logistic Regression	Time-Series Logistic Regression	XCM
10	19.87	12.67	17.07
15	16.70	15.56	15.60
20	16.06	11.83	15.85
25	14.24	9.24	13.88
30	10.48	11.04	9.75
35	8.54	4.75	8.88

Results – Fast contraction



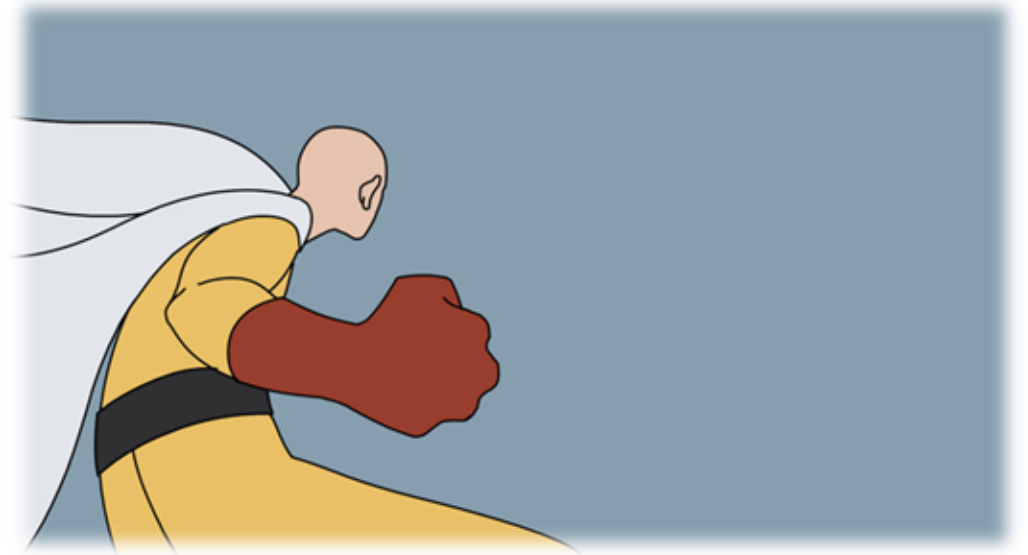
No. of reps	RMSE		
	Peak-Torque Logistic Regression	Time-Series Logistic Regression	XCM
10	44.20	36.85	29.75
15	34.90	27.36	29.47
20	32.28	24.43	28.53
25	17.95	17.73	13.89
30	12.32	10.56	12.51
35	6.86	6.54	5.60

XCM Feature Importance



Clinical implications

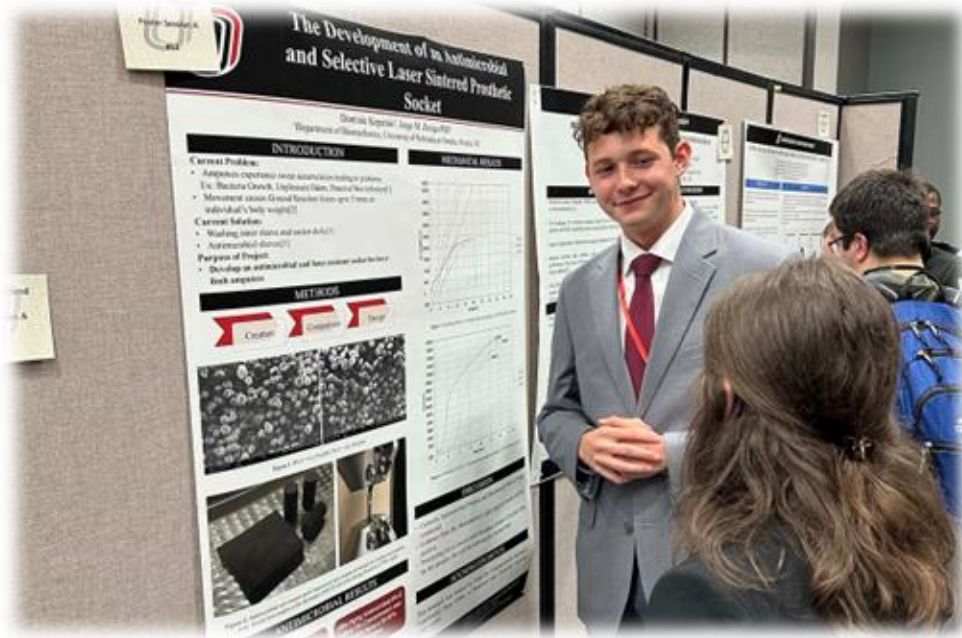
- Main outcomes
 - 10 reps required x slow mode
 - 21-22 reps required x fast mode
- Benefits
 - Players – Lesser DOMS
 - Physio / Trainers – Shorter Ax time
 - Coaches – Reduced impact on training
- Potential commercialisation
 - Integrating time-series LR into FI_{40} prediction



Research ideas



Common misconception



$\Leftarrow$



Research people



Research deliverables



Impact

Strengthen your CV



financial theoretical
anxiety fatigue writer's confusion analysis
hurdles high time data stagnation
ambiguity motivation worries criticism crisis future
procrastination funding seeking publication
poverty **pressure** dilemmas mental imposter syndrome
struggles comparison work-life supervision
expectations isolation ethical imbalance burnout deadlines
identity overwork lonely uncertainty exhaustion loss loneliness
health complexity competition decline perfectionism
rejection validation issues scope block
paralysis self-doubt strain creep methodology



Personal message



The brachistochrone curve

- Research informs practice; practice (gap) informs research too
- Discuss your research with stakeholders
- Be prepared to be an independent researcher
- Best of luck!



Acknowledgements

- Funding bodies
 - Department of Foreign Affairs & Trade, Australian Government, Australia
 - National Institute of Health (NIH), USA
 - Western Sydney University, Australia
 - Translational Health Research Institute, Australia
 - University Grants Committee, HK
 - Food & Health Bureau, HK
 - Innovation & Technology Commission, HK
 - HK Sports Institute, HK
- Collaborators, teammates and students





Thank you



WESTERN SYDNEY