

How to use this slide template:

1. We have marked in **bright red** all the parts of the template that need to be updated with your information.
2. Consult the Lesson Plan for detailed information on the content.
3. We include places to put Slido polls; remove these slides if you're not using them.
4. Update the schedule (slides 6, 21, 35, 60) if you are adding/removing content.
5. If you are not doing breakout sessions after the presentation, remove the last slide (slide 61) before Recap & Closing.
6. Feel free to move the acknowledgments slide to the end, but please don't remove it ☺

WELCOME TO:

A slide template for: Explaining scientific findings through figures in publications, presentations, and posters
By Nataliya Rokhmanova & Andrew Schulz

INSERT Slido Poll Question:
What is the biggest challenge you have when creating a figure?

Who created these materials?



MPI – IS / CARNEGIE MELLON UNIVERSITY

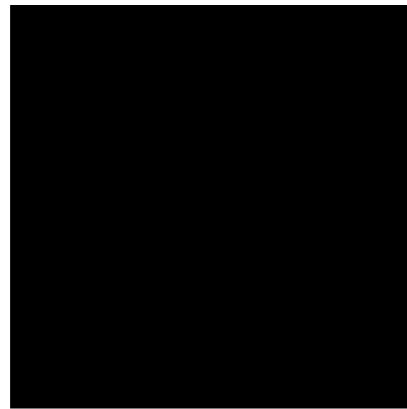
Nataliya Rokhmanova
PhD Candidate



MPI - IS

Dr. Andrew Schulz
Postdoctoral Researcher
IMPRS-IS Associated Scientist

Who are we?



UNIVERSITY HERE

Your Name Here
Title Here



UNIVERSITY HERE

Your Name Here
Title Here

Workshop Outcomes

TAKE-HOME

Participants will learn how to critically review their figures using:

- The Figure Spectrum
- The Figure Rubric

Participants will learn about open tools available, such as:

- Inkscape
- Link Sheet

LEARNING

Participants will understand key differences between:

- Figures for publications
- ... presentations (e.g. TAC meetings)
- ... and posters

Schedule for Today

09:55 – 10:10 - Intro of presenters & purpose of workshop

10:10 – 10:28 - Figure Activity, Spectrum of Figures shown

10:28 – 10:30 - Q&A Break

10:30 – 10:43 - Rubric introduction

10:43 – 10:50 - Q&A Break

10:50 – 11:05 - Posters, presentations, publications, give link sheet out

11:05 – 11:20 - Q&A break & transition to breakouts

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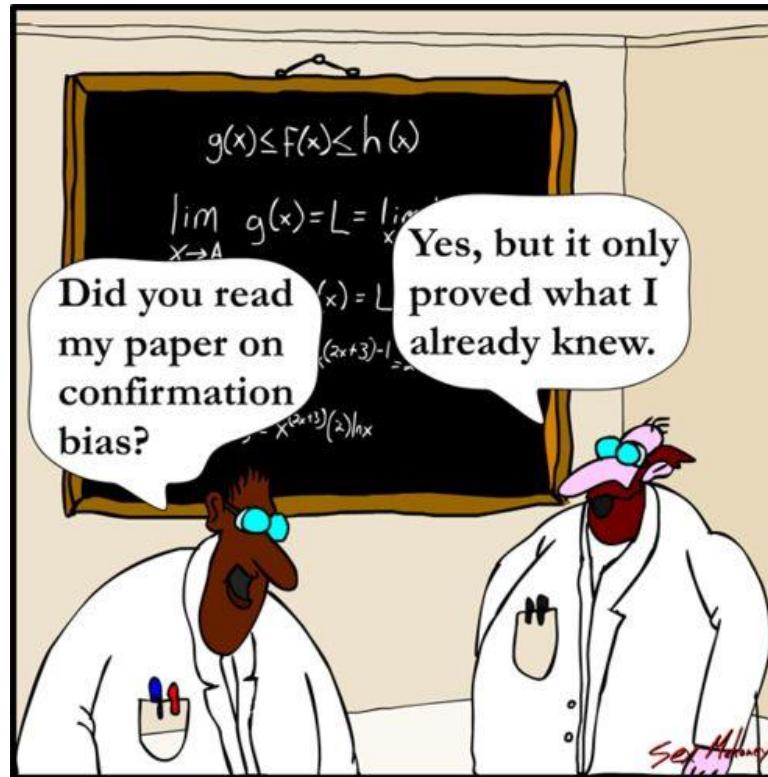
11:50 – 11:55 - Recap, GitHub discussion

11:55 – 12:00 - End

INSERT Slido Word Cloud

Question: What words are often associated with good figures?

Why bother making a nice figure?



Your audience, forever*



JOURNAL EDITOR

Doing 5 things at once.
Deciding whether to send
your paper out for review.



1ST YEAR

Wants to replicate your
work. Doesn't understand
the field's conventions.



HIRING COMMITTEE

Sleep-deprived.
Deciding whether to
offer you an interview.



REPORTER

Told to write an article
about advances in your
field. Still learning.



REVIEWER 2

Undercaffeinated. Expert
in your field. Wants to
find flaws in your paper.

*except in cases of paper retraction, scientific obsolescence, and/or heat death of the universe

A (typical) timeline:

Generating hypotheses
and research questions;
collecting data;
processing and analysis;
writing and revising

Making sure your
figures match paper
requirements

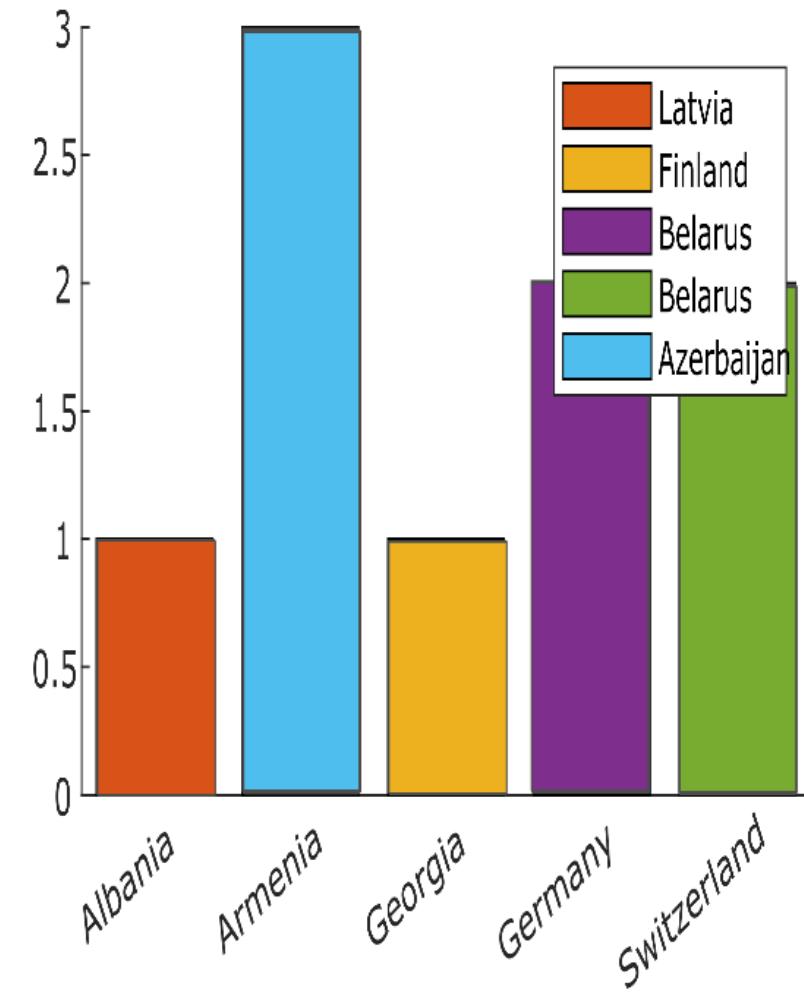
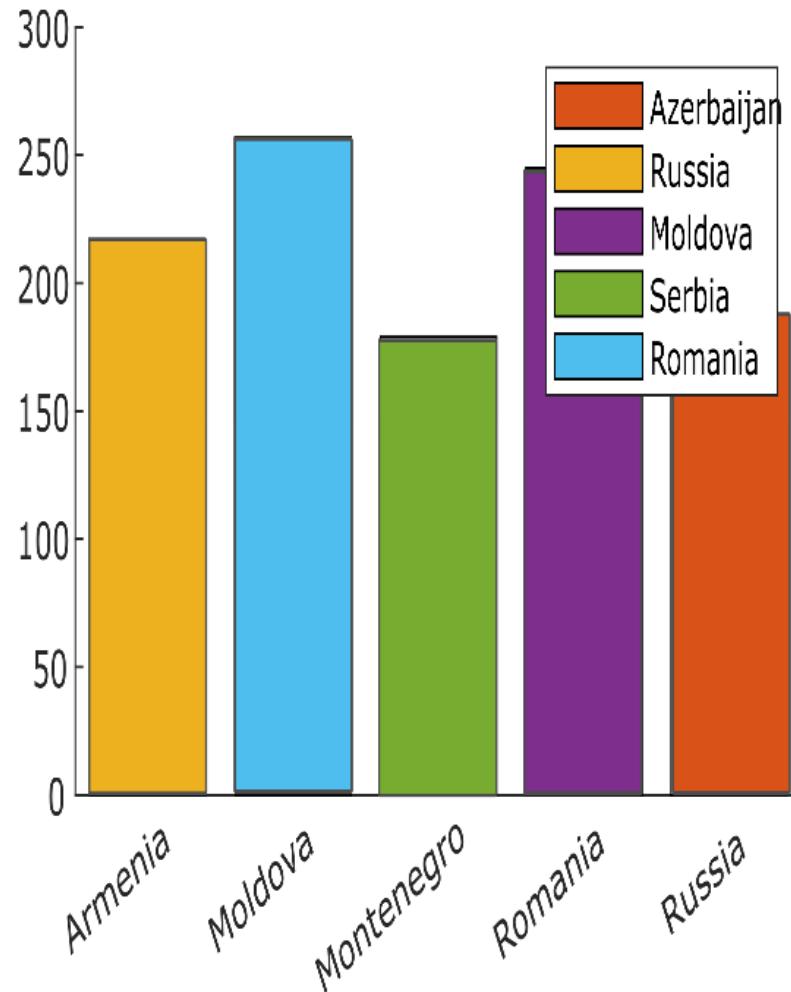
- Referring back to your findings in:
- Posters and talks
 - Committee meetings or thesis defense
 - Meetings with potential collaborators
 - Job talks



What is the main point of this figure?

Figure Spectrum visualizations made using data from Kaggle data set: Eurovision Song Contest Scores 1975-2019

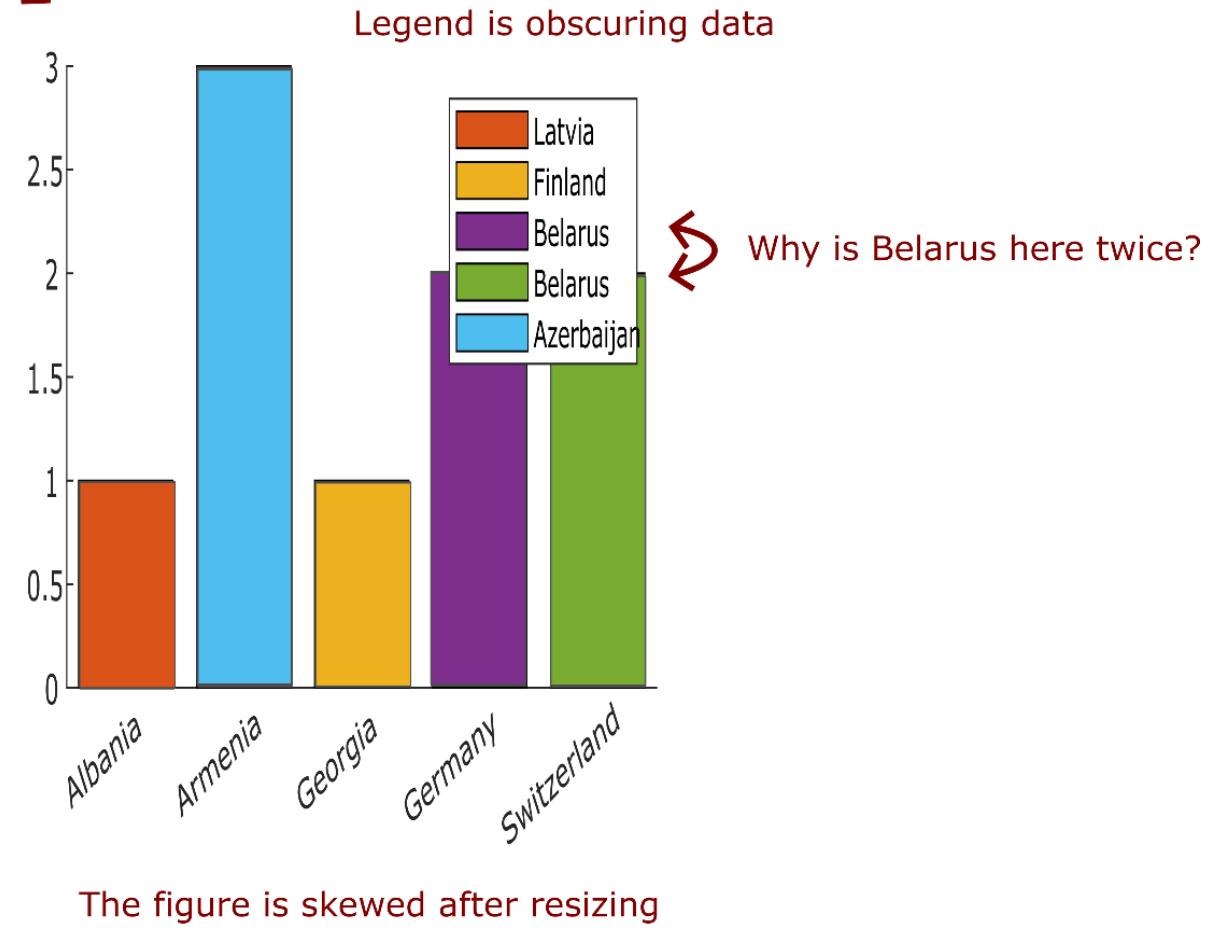
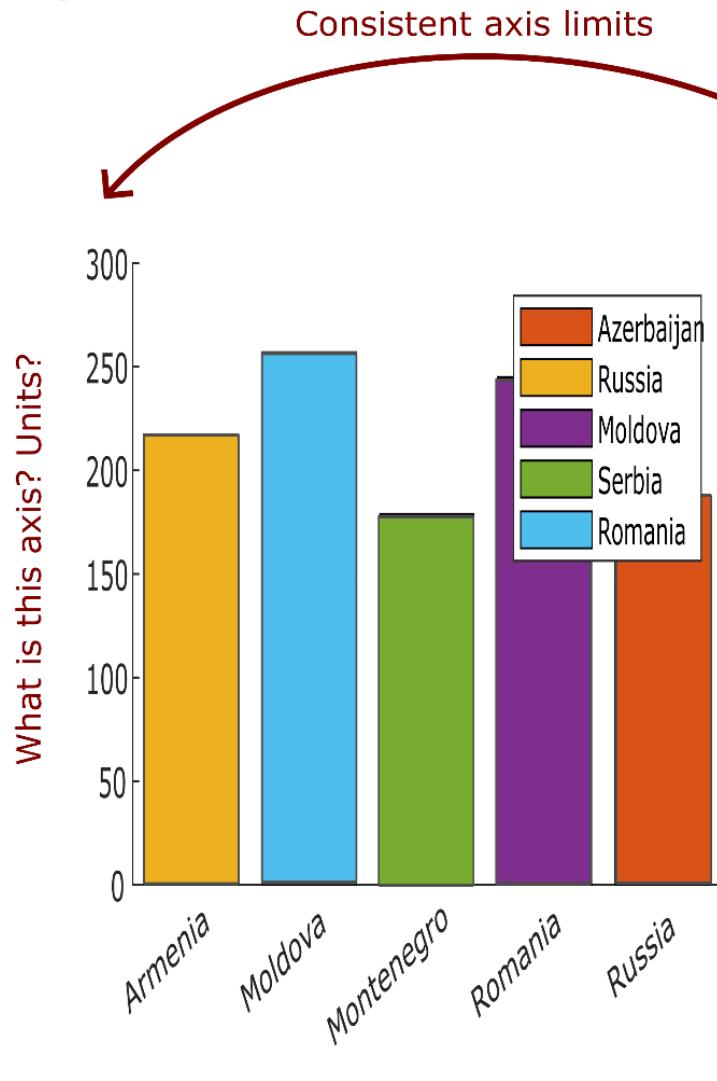
What is the main point of this figure?



INSERT Slido Poll

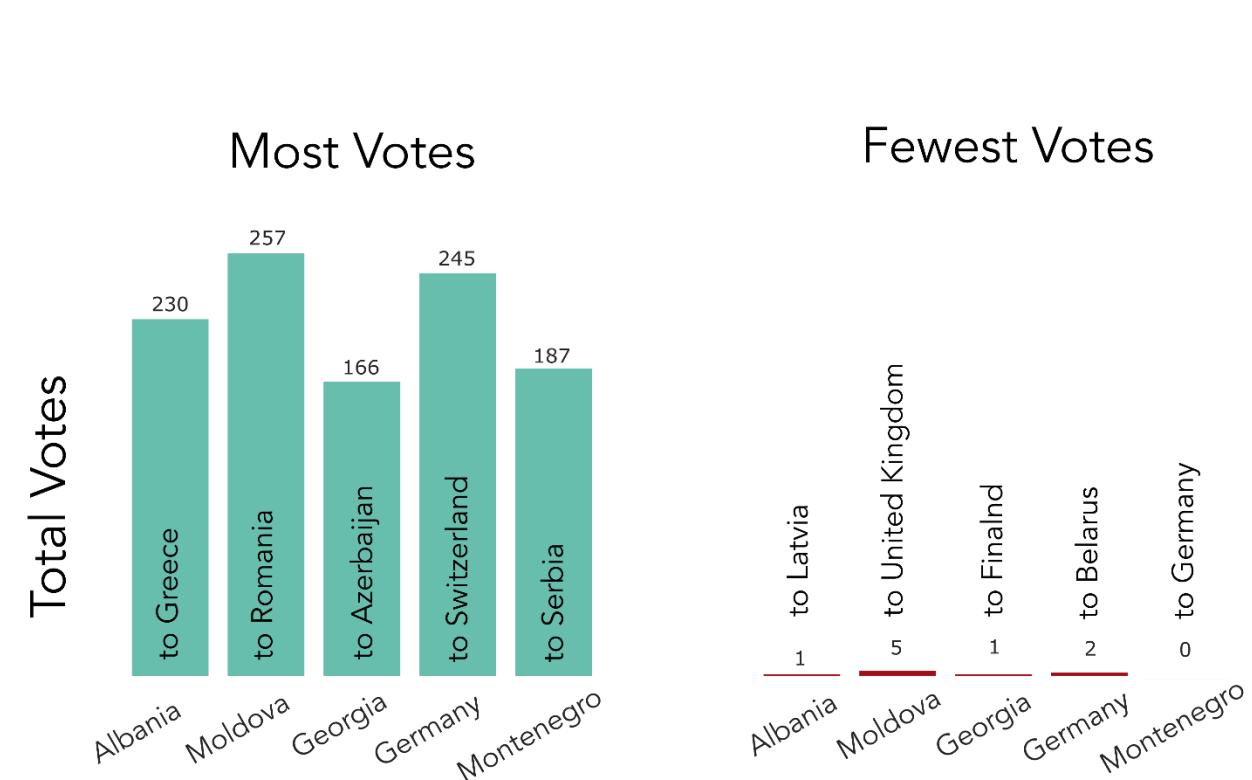
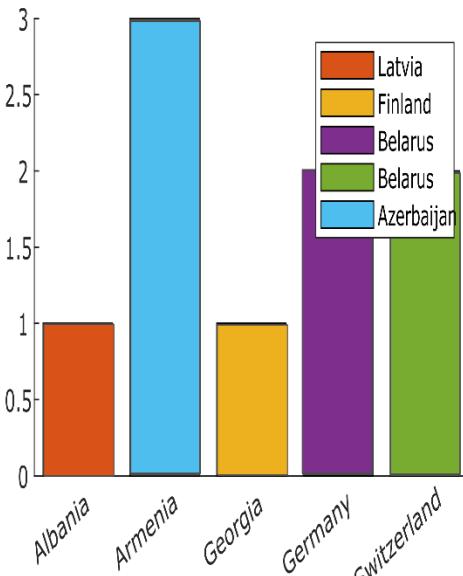
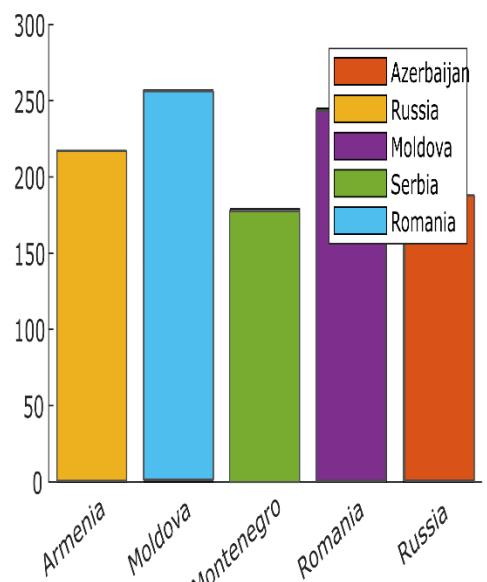
Question: What is the
main point of this figure?

Fixing up the basics:

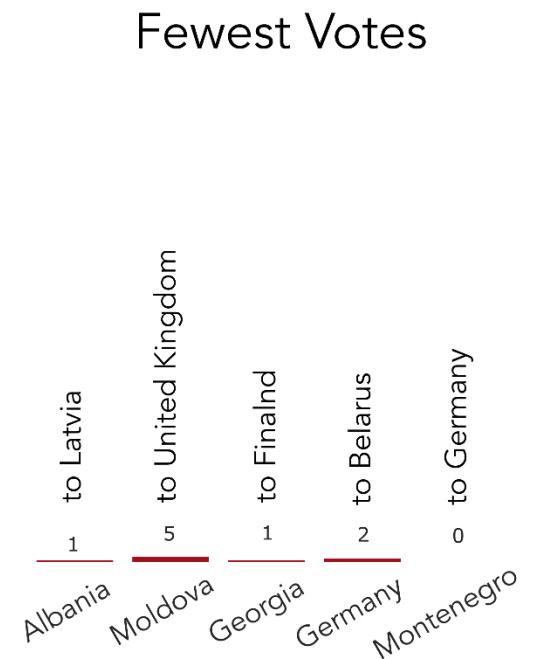
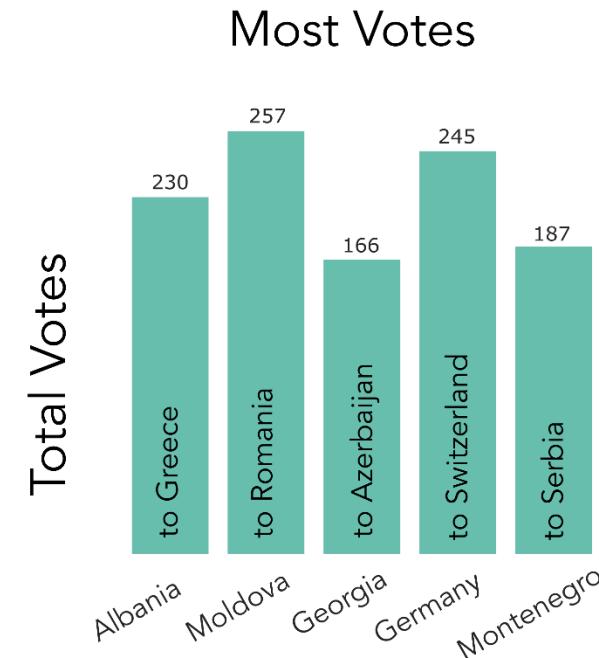
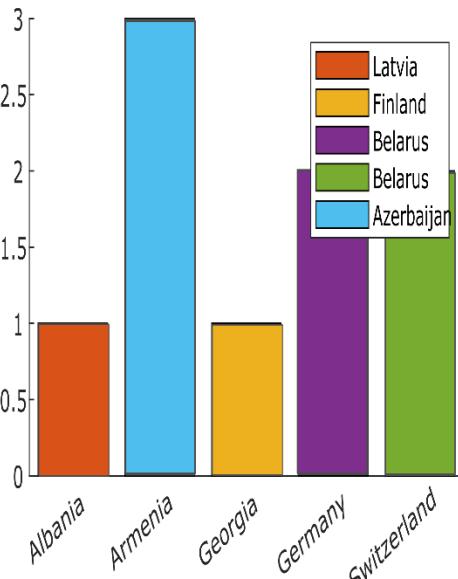
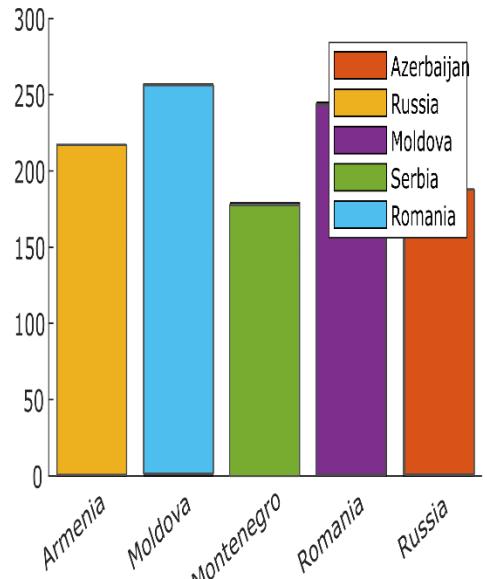


Be deliberate and consistent to show the difference between the left and right data

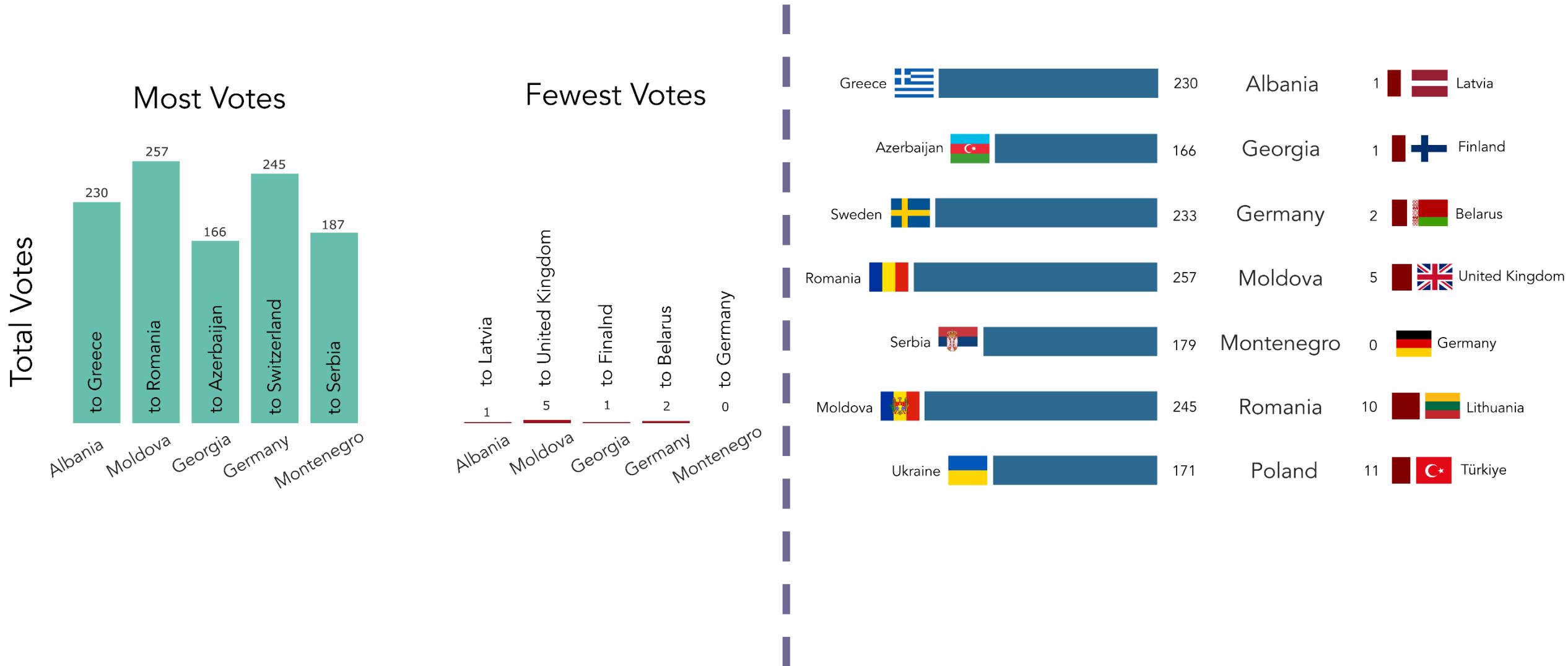
What changed? What is missing?



Content vs. format

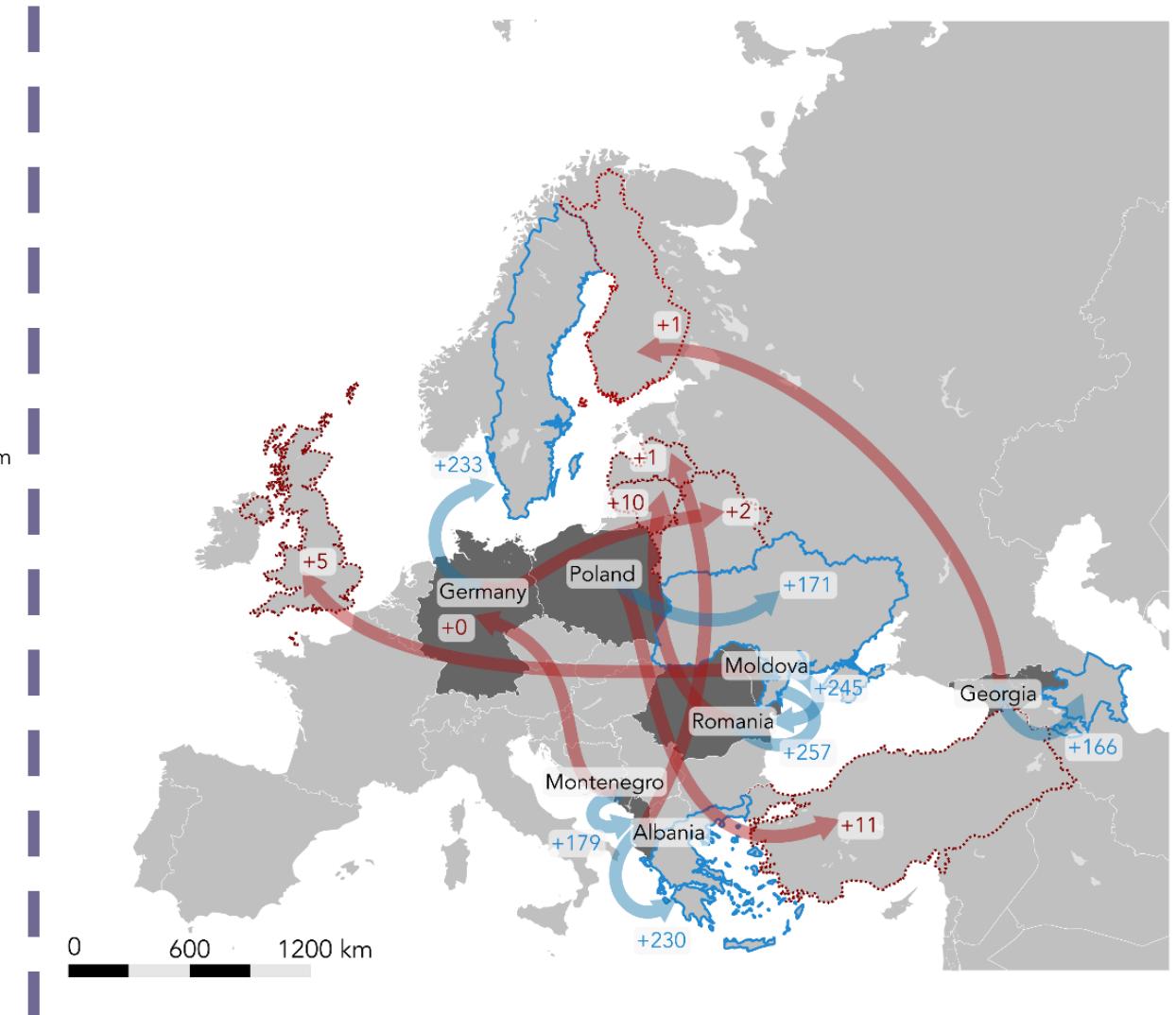


What changed? What is missing?



What changed? What is missing?

Greece		230	Albania	1		Latvia
Azerbaijan		166	Georgia	1		Finland
Sweden		233	Germany	2		Belarus
Romania		257	Moldova	5		United Kingdom
Serbia		179	Montenegro	0		Germany
Moldova		245	Romania	10		Lithuania
Ukraine		171	Poland	11		Türkiye



How do the needs of a figure change...

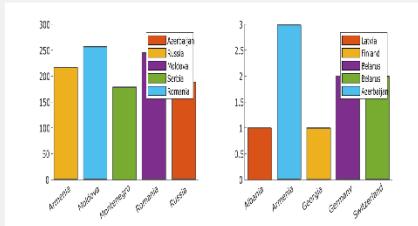
FOR A PAPER,
POSTER, OR
PRESENTATION?



Handout:

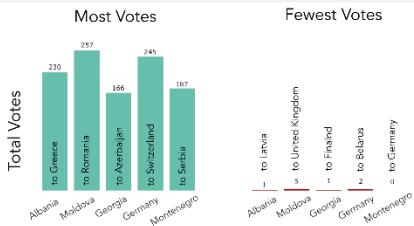
THE FIGURE SPECTRUM

Fig. 1



NEVER

Fig. 2



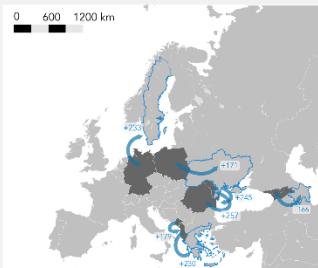
1-on-1 meetings with advisor,
supplemental material

Fig. 3



Meetings with lab group or
collaborators, publication

Fig. 4C



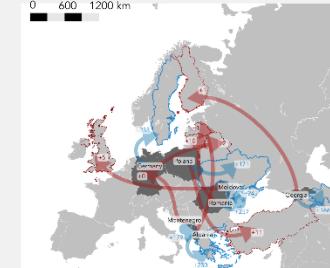
PRESERVATION

Fig. 4B



POSTER

Fig. 4A



PUBLICATION

Layer the content in stages

Consider readability

Use the Figure Rubric

Distill your findings

Pick an intuitive
visualization

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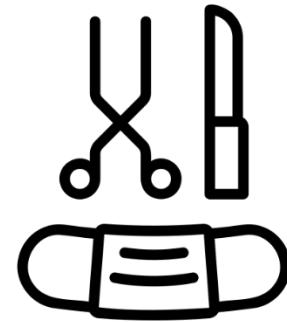
11:50 – 11:55 - Recap, GitHub discussion

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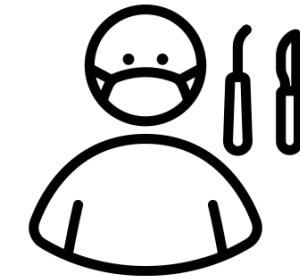
We will become figure surgeons today:



ERROR FLAGGING:
Realizing something
doesn't look right

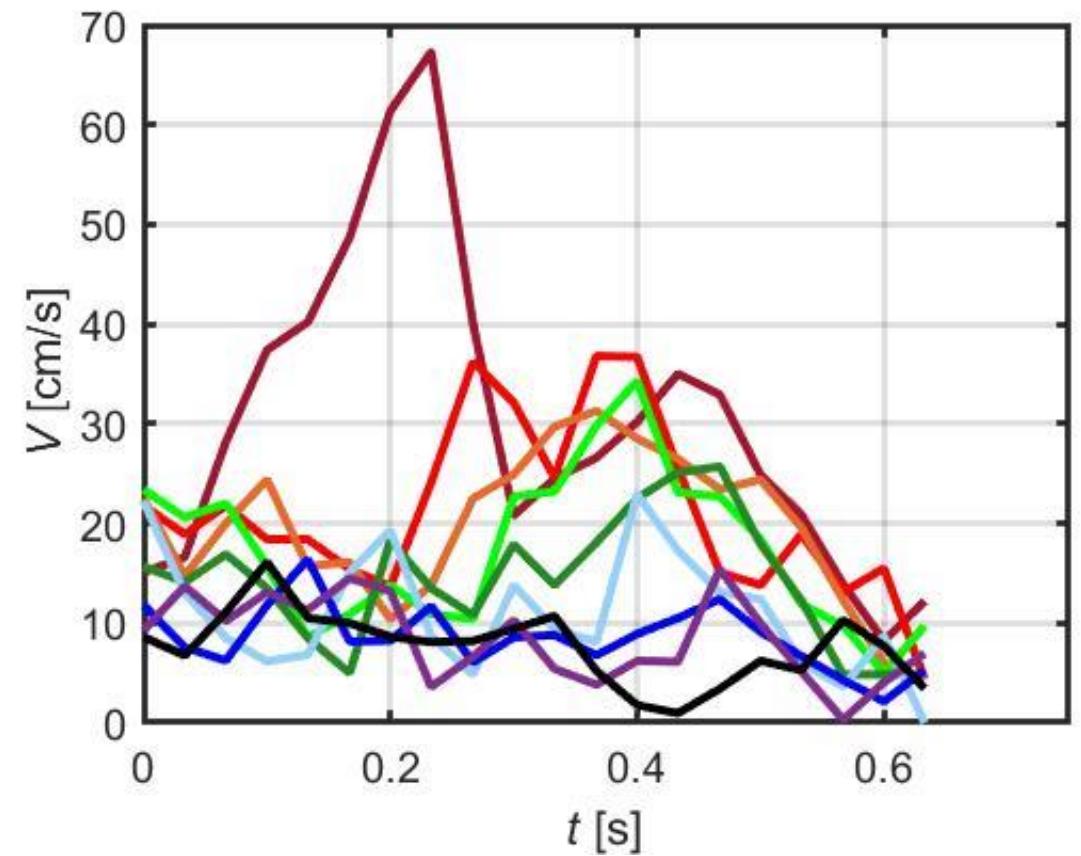
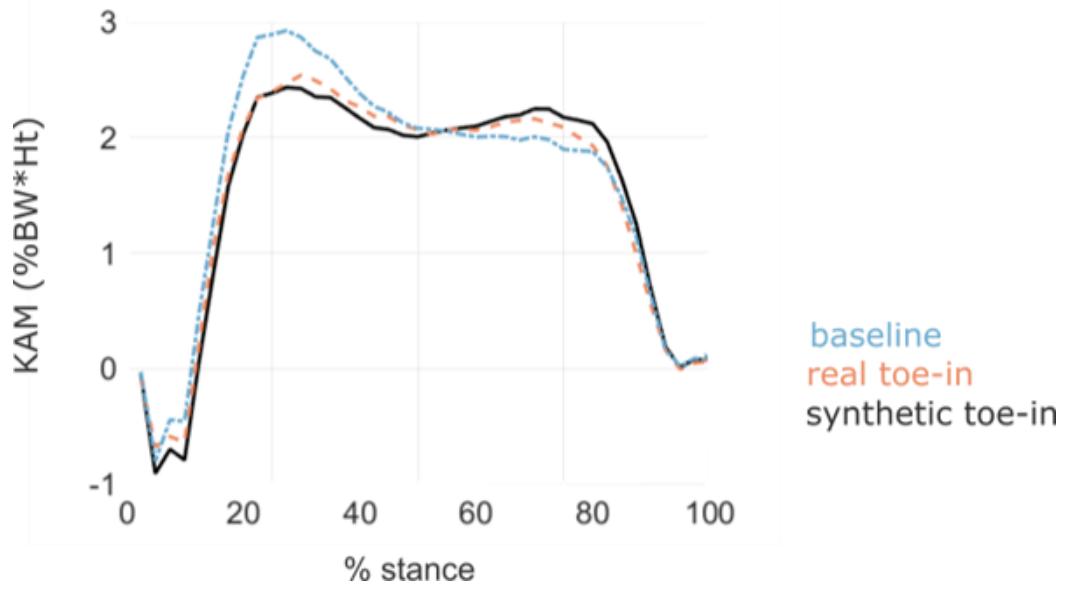


DOMAIN KNOWLEDGE:
Finding possible
solutions



TECHNICAL SKILLS:
Being able
to fix it

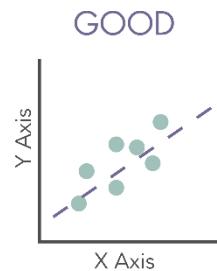
Surgical training takes time and repetition



Handout:

THE FIGURE RUBRIC

Scale & Resolution
Units & Labels
Colors

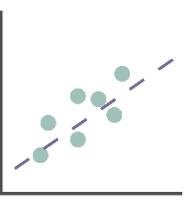
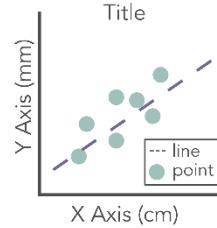


Scale

- All elements should be the right size for where they are in the figure
- Readability will be different for a paper, publication, or poster
- Ensure all data, text, and visual elements are consistently sized

Resolution

- Save and export all data and completed figures in high-resolution
- Work with lossless formats, such as: SVG, PNG, TIFF, RAW



Units

- Every axis needs a unit label, even if the measure is unitless
- If there are two plots side-by-side, make the axis limits consistent

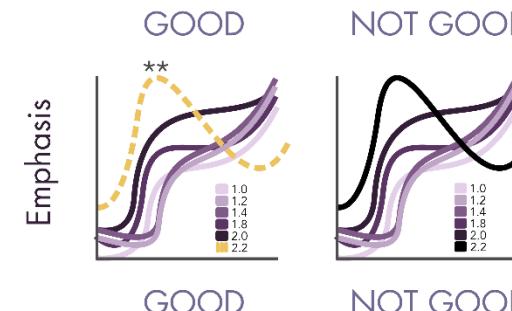
Labels

- All axes need to be labeled (this may not apply for grouped sub-figures)
- Identify figure elements in the legend and/or the caption
- Titles should clarify the take-away message of the figure



Colors

- Pick a color palette to use throughout the paper/poster/presentation
- Learn the color wheel: split-complementary colors pair well
- Muted colors look more professional; saturated colors draw attention
- Vary color lightness to show changes across an independent variable
- Ensure a color-blind reader can interpret the figure (see Accessibility)



Emphasis

Emphasis

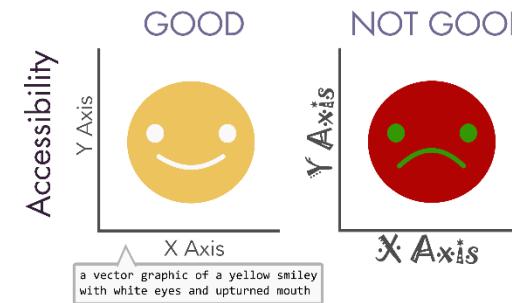
- Visual changes can show the reader what is important in the data
- Use annotations, callouts, highlights, or changes in line style
- Define and use markers (*) for statistical significance
- Have integrity: do not create a trend that isn't already there



Ink:Content

Ink:Content

- Minimize the ratio of ink (plotting elements) to content (your data)
- Be merciless when removing "chart junk" such as grid lines
- Anything not essential to understanding the data can be removed



Accessibility

Accessibility

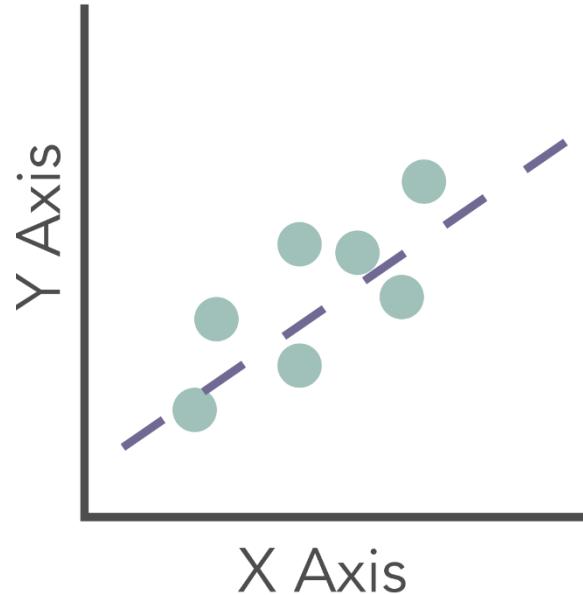
- Choose fonts without serifs, decoration, or complex ligatures
- Red-green color-blindness is common (1 in 12 men, 1 in 200 women)
- Some submissions require alt text, which is not the same as a caption
- Some submissions require accessible PDF files

a vector graphic of a yellow smiley with white eyes and upturned mouth

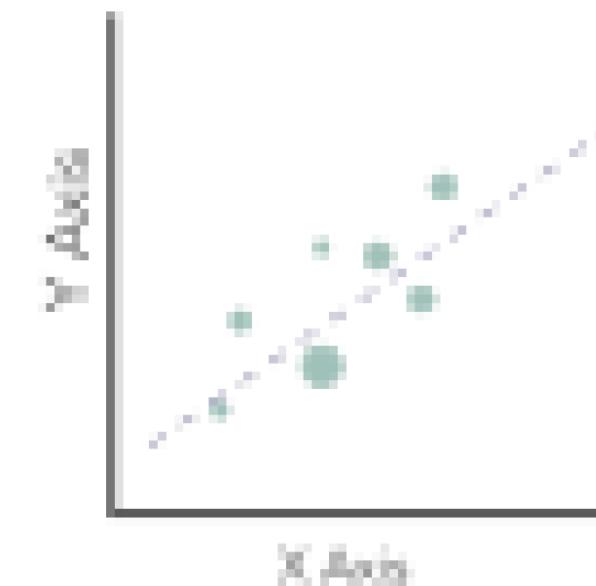
SCALE & RESOLUTION

Low-hanging fruit: is your figure readable?

GOOD



NOT GOOD



Work in lossless formats; version control matters here, too

SCALE & RESOLUTION

“Readability” depends on context

PAPERS

- Figure font should not be *much* smaller than body font size

POSTERS

- Readable at all distances/levels of engagement

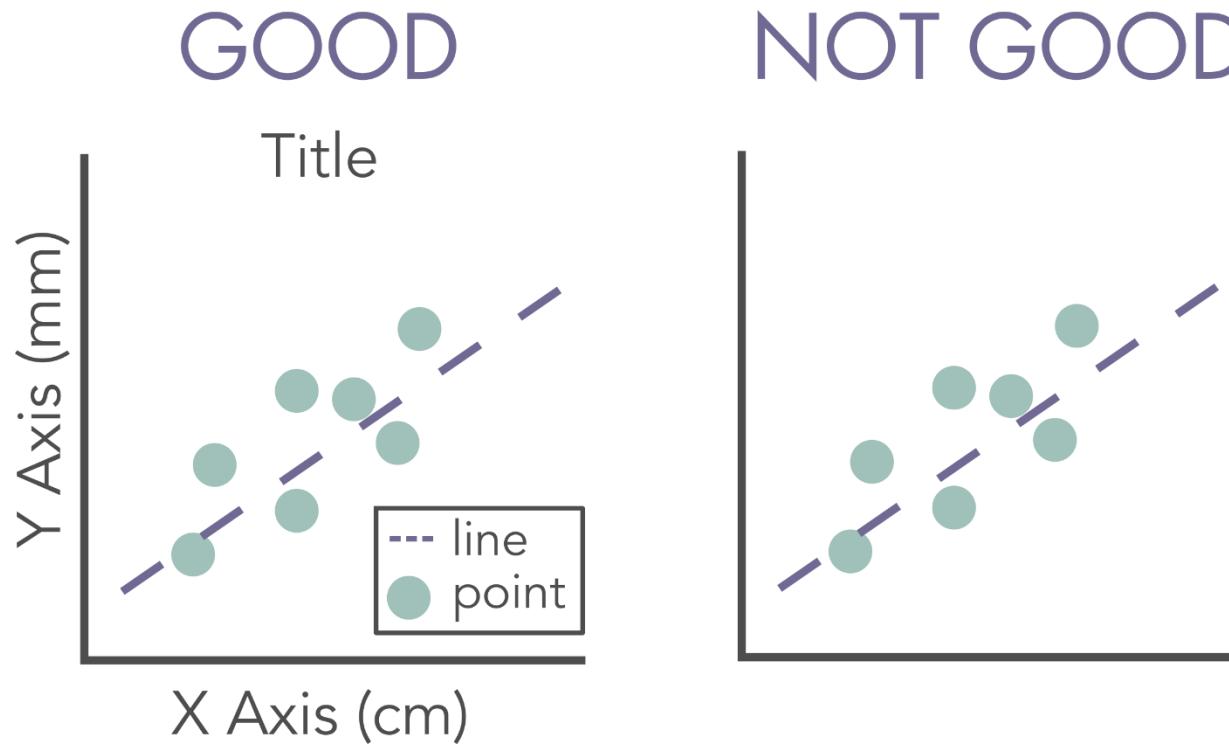
PRESENTATIONS

- Usually need to increase size

Save your figures in an editable format!

UNITS & LABELS

Low hanging fruit: is your figure interpretable?

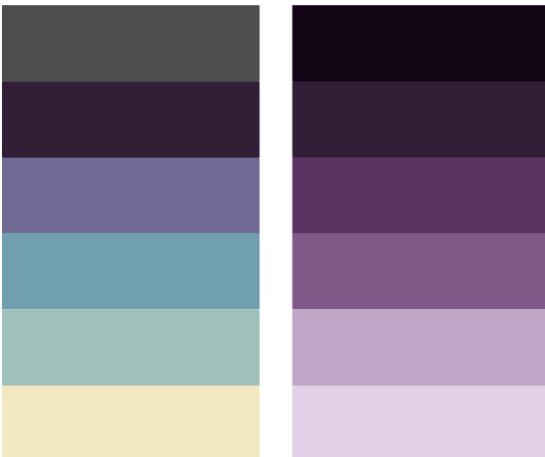


What's obvious to you might not be obvious to everyone

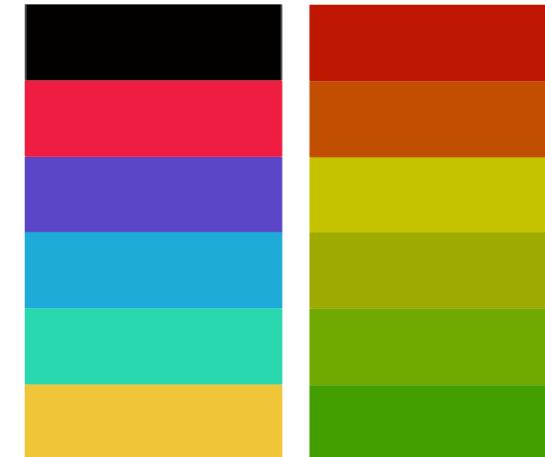
COLORS

“Color is a power which directly influences the soul” - Wassily Kandinsky

GOOD

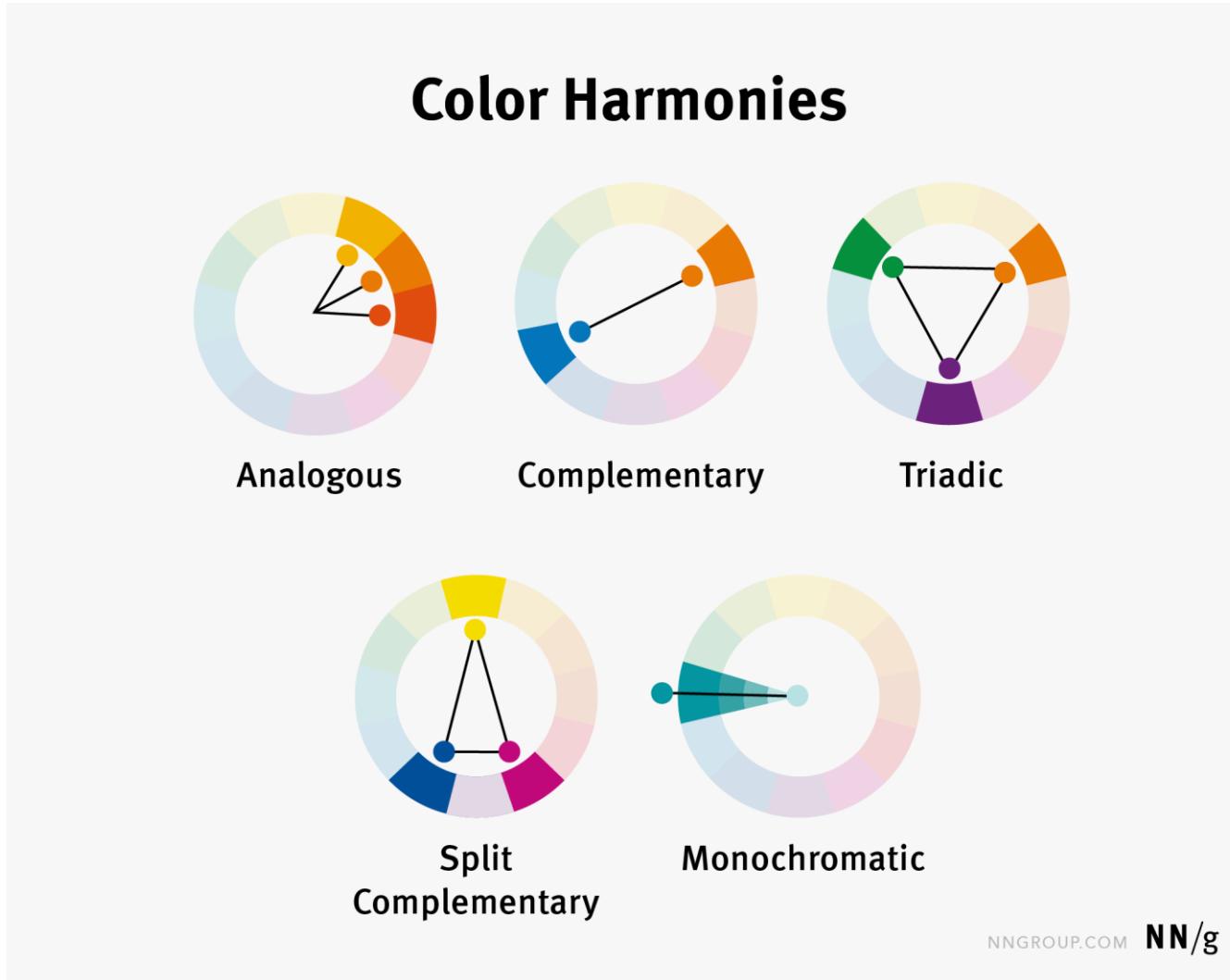


NOT GOOD



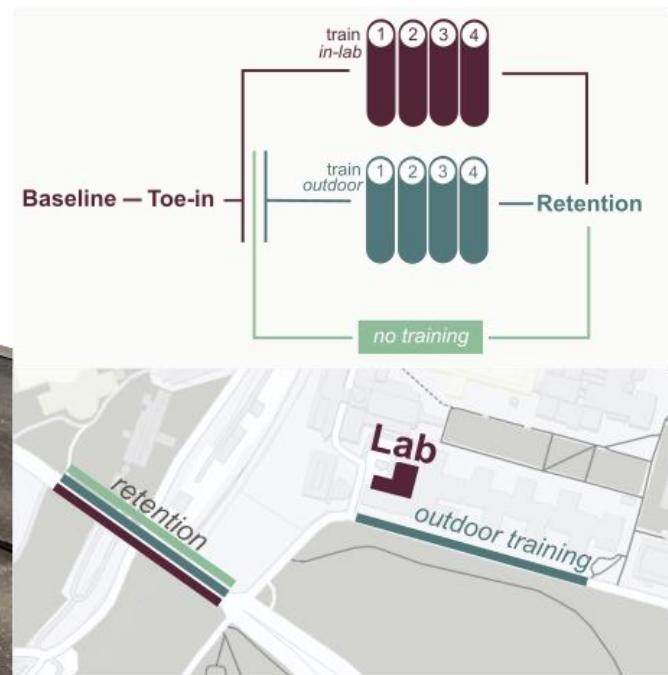
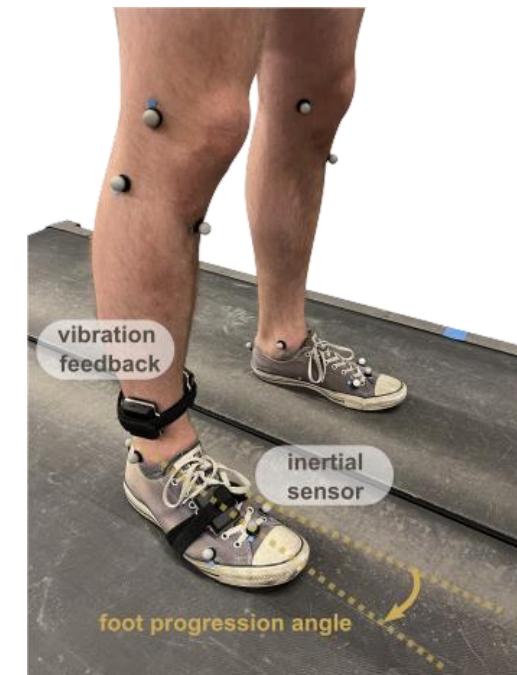
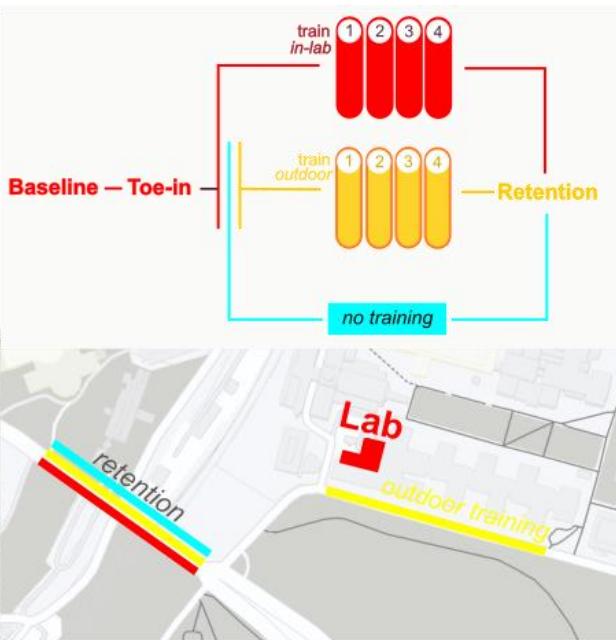
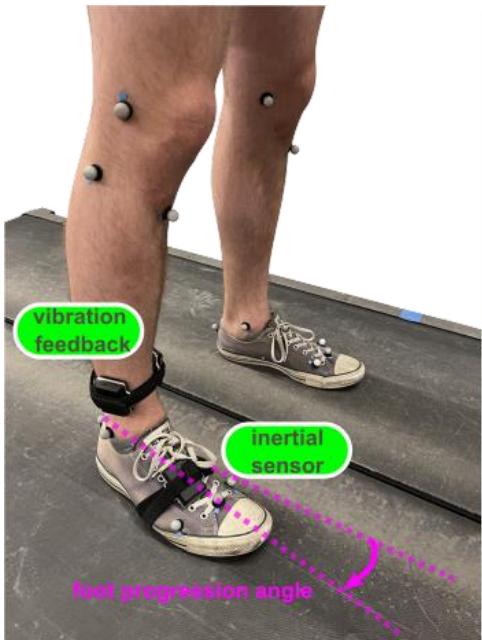
COLORS

You CAN and SHOULD learn color theory



COLORS

Pick your paper palette



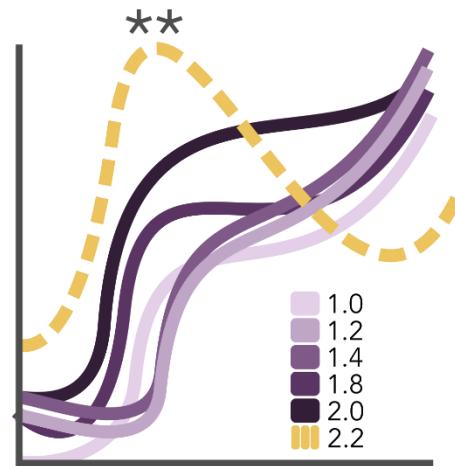
Unpleasant to look at

Much better

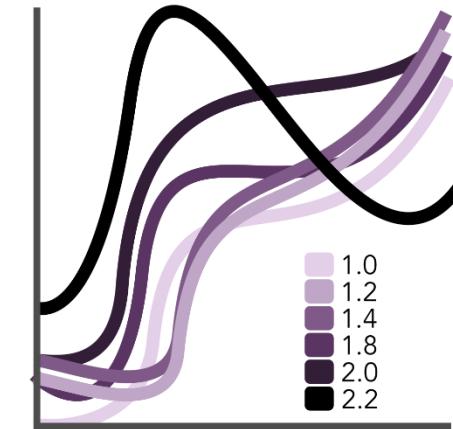
EMPHASIS

Be nice: help your viewer understand

GOOD



NOT GOOD



Be ethical: don't highlight trends where there are none

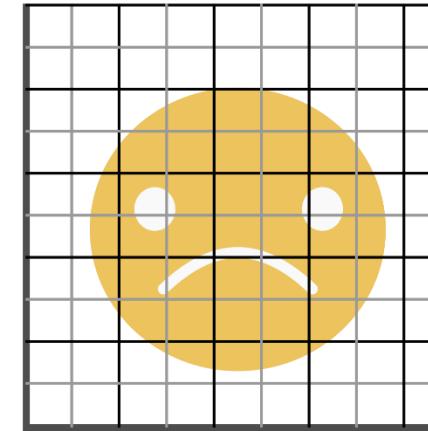
INK:CONTENT

Minimize “chart junk” and maximize content

GOOD



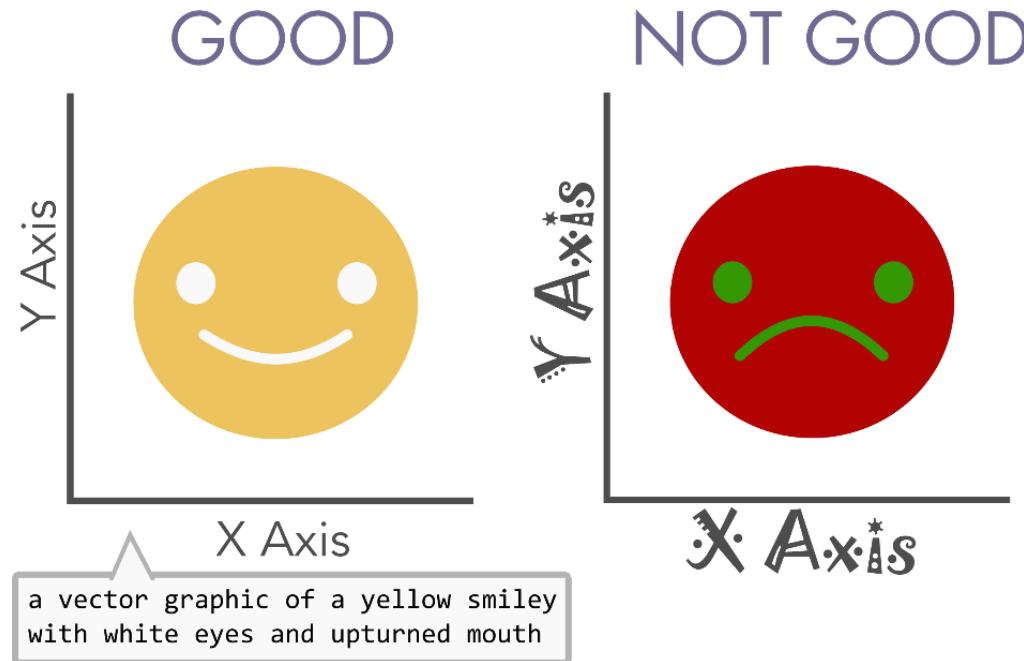
NOT GOOD



Ruthlessly eliminate anything that does not serve you

ACCESSIBILITY

Increasing accessibility, always evolving



Examples include alt text, color choices, readability...

SCI FIG



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Questions?



Illustration from Undraw.co

One size does not fit all: Posters vs. Presentations vs. Publications



This workshop/GitHub is NOT: Designing a poster, presentation, publication...



Illustration from Undraw.co

A well designed poster paints a scientific story with or without you



Early Outcomes from an Interdisciplinary VIP Course

Andrew Schulz, School of Mechanical Engineering, Georgia Institute of Technology

WHAT IS CONSERVATION?

For counting, we adjusted color, sharpness, and contrast of the photographs in Adobe Photoshop (Adobe Systems Incorporated) for maximum visibility of wrinkles. The trunks were divided into zones: base, lateral shaft, dorsal part of the shaft, and tip (Figure S1). Wrinkles were identified as either "major" or "minor" wrinkle, with the first being deeper, mostly regularly spaced, and transversing the whole dorsal or ventral part of the shaft (Figure 2A and B). Deep skin folds as described previously¹⁷ were only observed in the African elephants and for our analysis counted as "major" wrinkles. "Minor" wrinkles were defined as obviously shallow, sometimes not crossing all of the dorsal part of the shaft, but always at least 50 %, and few of them had gaps and were only counted if it was clear where they continued. Trunk zones (Figure S1) and wrinkles (Figure 2A, B, F) were drawn on the photographs using Adobe Photoshop and then counted manually using the multi-point tool in ImageJ (Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA).

PROJECTS

1. Human Elephant Conflict Mitigation (Ongoing)
2. Elephant Re-Identification (Ongoing)
3. Captive Gorilla Foraging Improvements (Ongoing)
4. Invasive Bermese Python reduction in Everglades (Ongoing)
5. Giant Panda Reintroduction (Ongoing)
6. Andean Bear Conservation (New)

Possibility for additional projects to start in the future – if you have ideas let us know!



HUMAN ELEPHANT CONFLICT REDUCTION & ELEPHANT RE-IDENTIFICATION

To determine if the observed difference in wrinkles number between the longer whiskers side ($n = 15$) and the shorter side ($n = 15$) was significant a Wilcoxon Signed-Rank tests was performed (Figure 3B). It revealed that the difference was indeed significant ($z\text{-value} = -2.1583$, $w\text{-value} = 22$, $p = 0.03078$, $d = -0.55727$). A second Wilcoxon Signed-Rank tests revealed that there is no favored left or right preference in African and Asian elephant ($z\text{-value} = -1.1927$, $w\text{-value} = 39$, $p = 0.23404$, $d = -0.30795$) (Figure 3C).

BEAR CONSERVATION PROJECTS (GIANT PANDA & ANDEAN BEAR)

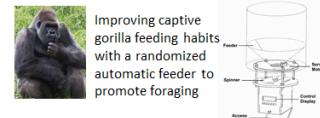
To determine the difference in numbers of major trunk wrinkles between adult Asian elephants ($n = 7$, out of these 5 females and 2 males) and adult African elephants ($n = 7$, all females) a two-sample t-test (Welch's t-test) was performed (Figure 2C). Adult Asian elephants ($\bar{x} = 126$, $SD = 25$) have more major trunk wrinkles than adult African elephants ($\bar{x} = 83$, $SD = 13$; two-sample t-test (12) = 4 , $p = 0.003$, $d = 2.16$). There is no significant difference in minor wrinkles between the two species. When testing with numbers from only females a two-sample t-test (Pooled variance) revealed an even stronger difference between Asian ($n = 5$, $\bar{x} = 124$, $SD = 21$) and African elephants (two-sample t-test (10) = 4 , $p = 0.002$, $d = 2.51$). When looking at wrinkle numbers in different trunk zones (Figure S1C) no differences between species were found in the numbers of wrinkles on trunk shaft or tip, independently of pooling or not pooling major and minor wrinkles or female and male elephants. A two-sample t-test (Pooled variance) revealed a difference in major wrinkles on the trunk shaft, with adult Asian elephants ($n = 7$, out of these 5 females and 2 males) having more major trunk shaft wrinkles ($\bar{x} = 115$, $SD = 26$) than adult African elephants ($n = 7$, $\bar{x} = 70$, $SD = 13$; two-sample t-test (12) = 4 , $p = 0.002$, $d = 2.18$). When again comparing only numbers of the female elephants the effect was slightly bigger (two-sample t-test (10) = 4 , $p = 0.002$, $d = 2.45$). Additionally, when looking at a possible difference between dorsal and ventral trunk wrinkles a two-tails paired t-test was performed (Figure 2F). The dorsal part of the trunk ($M = 77$, $SD = 12$) has significantly more wrinkles than the ventral part ($M = 47$, $SD = 7$; two-tails paired t-test (4) = 5.1 , $p = 0.007$, $d = 2.27$).

BURMESE PYTHON REDUCTION



Finding new ways beyond the current Judas technique to reduce python population while maintaining other native species

CAPTIVE GORILLA FORAGING



Improving captive gorilla feeding habits with a randomized automatic feeder to promote foraging

Designing an easy to use and maintain feeder for primates with Zoo Atlanta

CLASS LEARNING OUTCOMES/GOALS

1. Identify ways humans can aide in the conservation of species
2. Describe the North American Conservation Model & how it relates to your project
3. Design and conduct ethical experiments with various species
4. Identify different ethical research organizations in the area and review their missions (ex. Zoo Atlanta)
5. Effective recording of detailed scientific methodology and project outcomes in a notebook
6. Review and Critique conservation related literature and media
7. Communicate with international leaders in species conservation

MAJORS/INTERESTS

- Willingness to work with animals
- Projects move slowly – large component is understanding the problem
- Travel interests to locations where species are present
- Ability to think outside the box
- Open Ended Projects
- Majors (Any & All Majors Accepted)

WE'D LOVE TO HAVE YOU JOIN!

IF INTERESTED EMAIL:
AKSCHULZ@GATECH.EDU

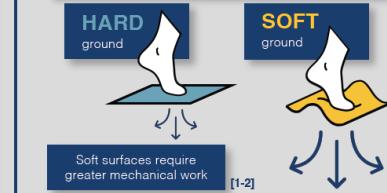


ENERGY REGULATION IN RESPONSE TO SUBSTRATE ENERGY LOSS

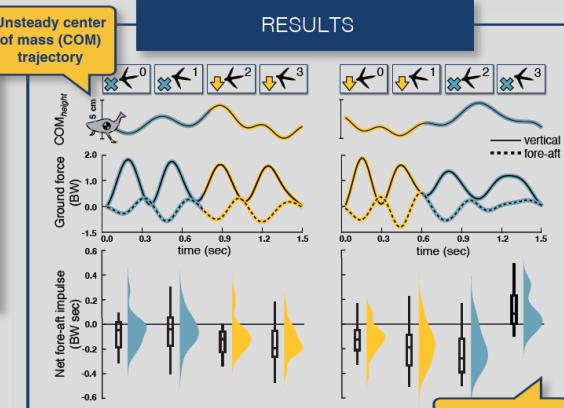
Brooke A. Christensen¹, and Monica A. Daley¹

¹University of California, Irvine; ¹brooke1@uci.edu

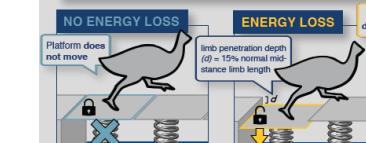
How do animals regulate limb and body mechanical energy during substrate energy dissipation?



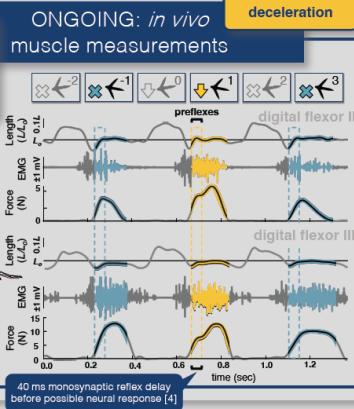
RESULTS



AIM: perturb mechanical energy in stance without altering flight phase or initial contact dynamics



In vivo force-length dynamics of digital flexor (DF) muscles suggest intrinsic mechanics govern rapid energy regulation at the leg-substrate interface



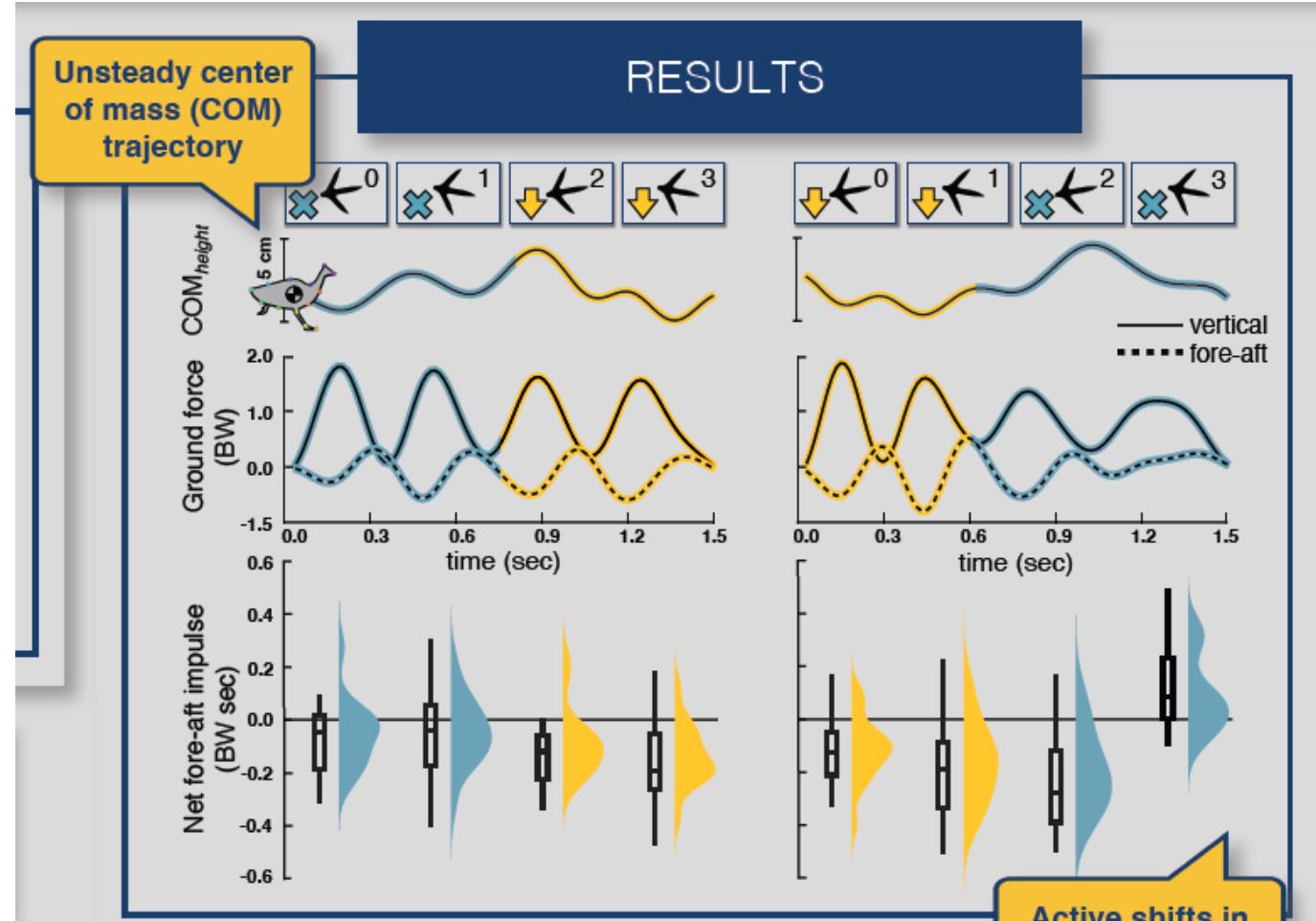
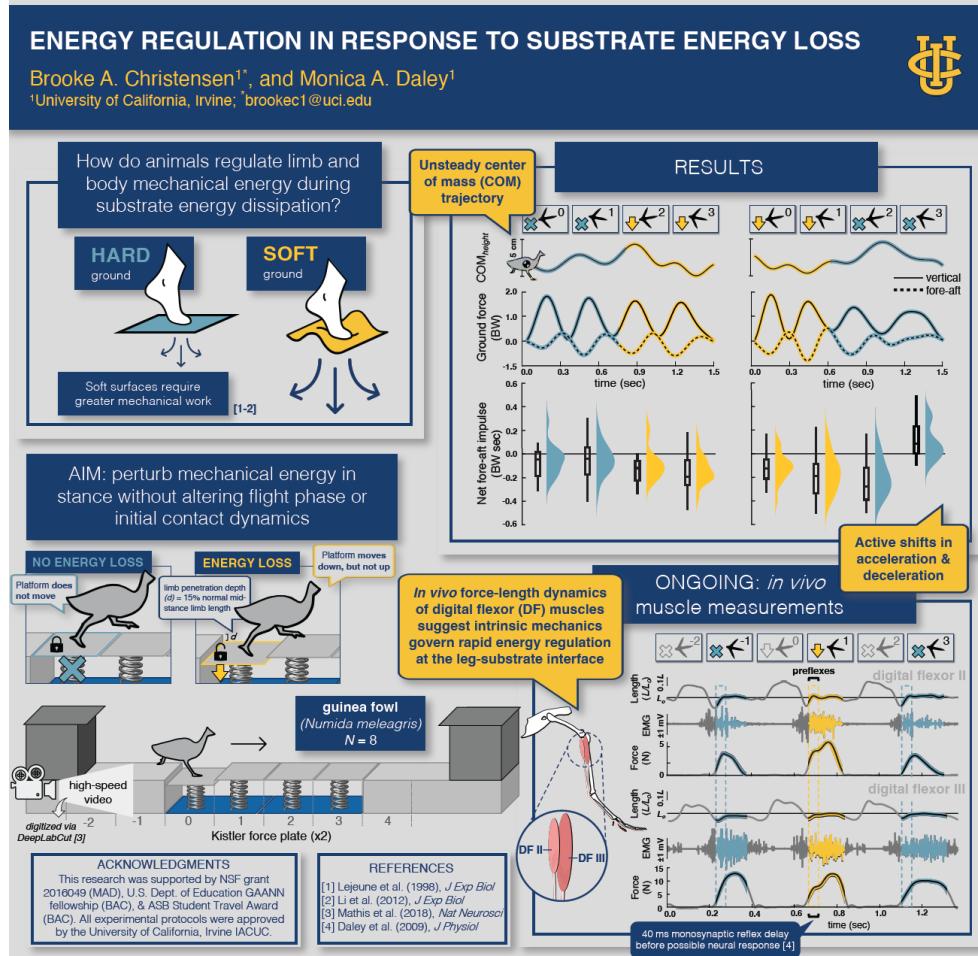
Size matters: when creating posters think aggressively about size

Minimum Font Size for A1 Poster

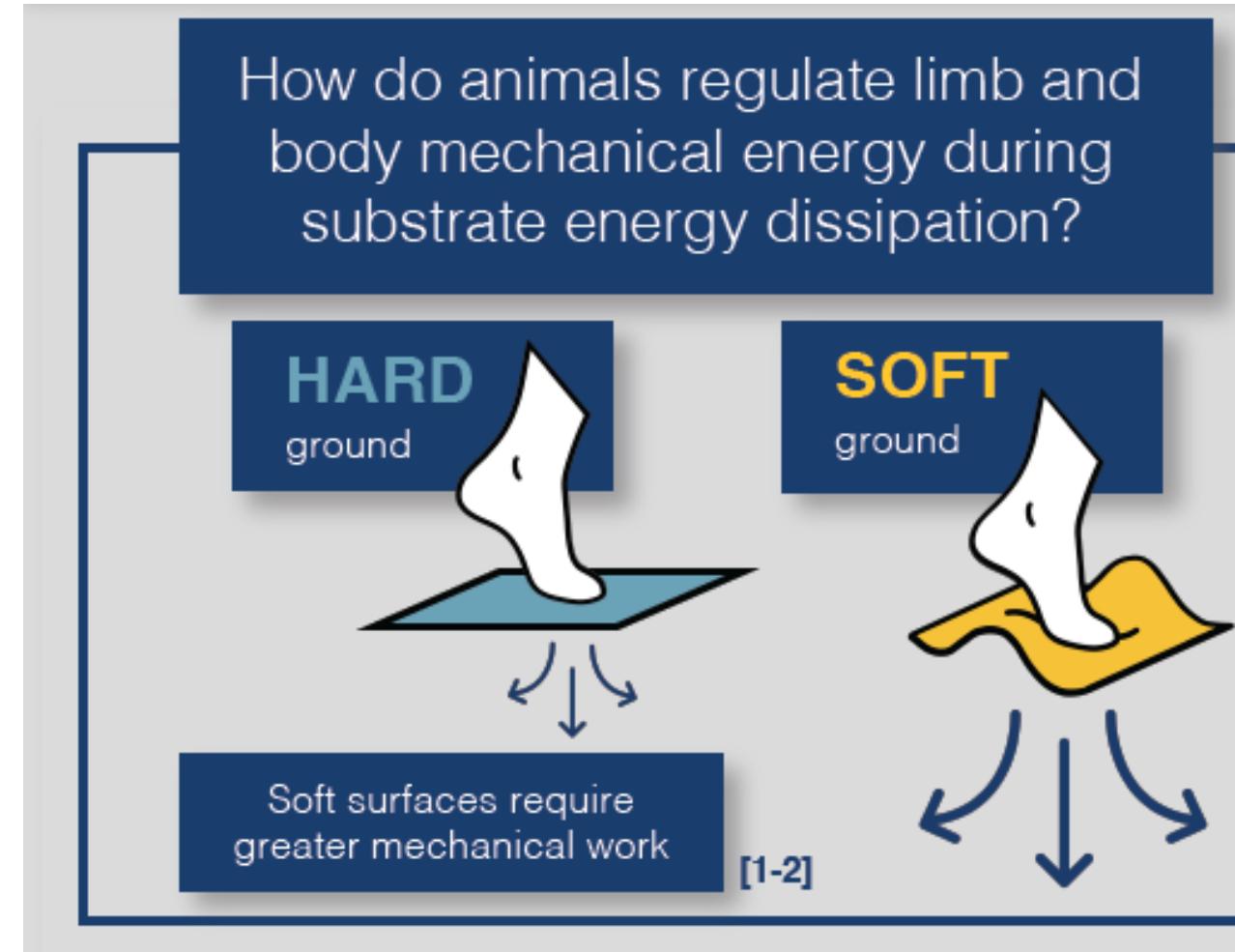
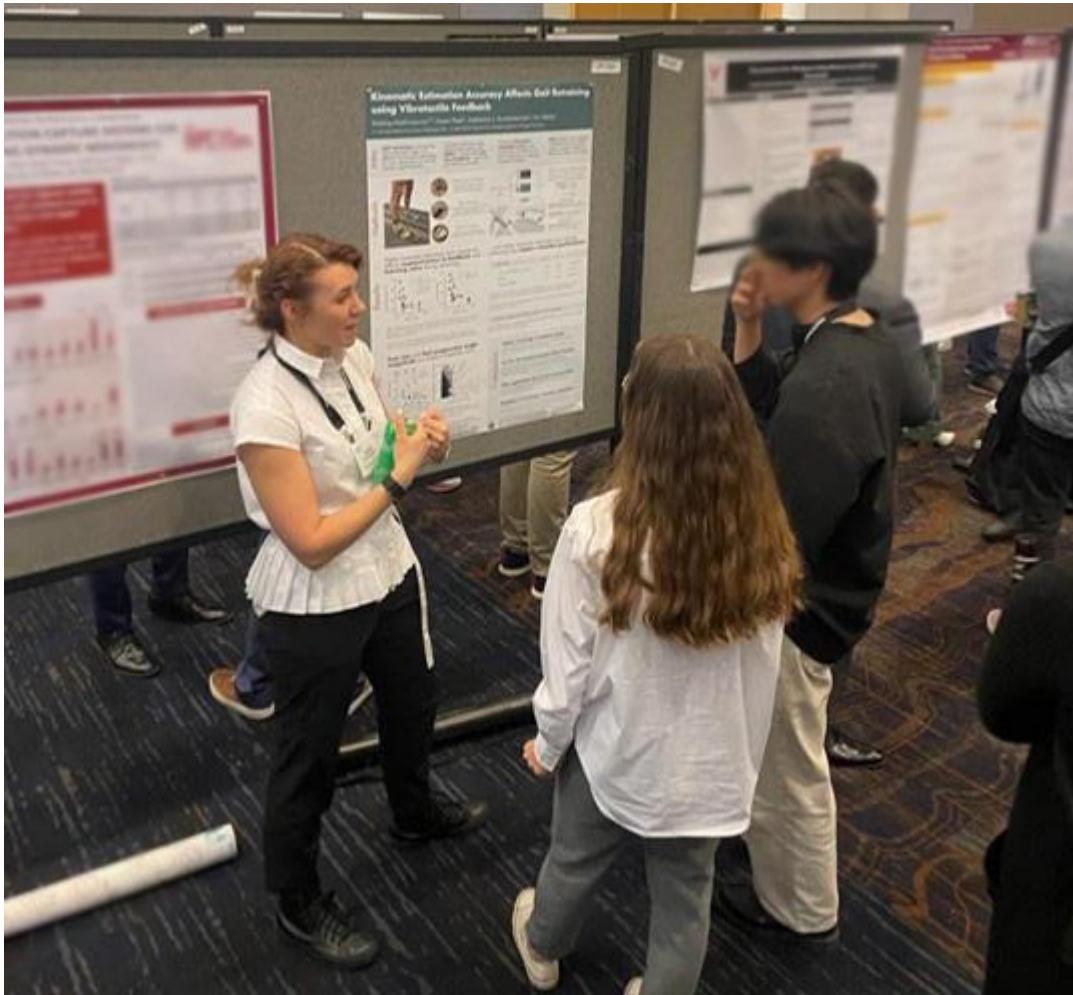
Visual hierarchy
correlates with
size

Main Title: 65+ pt
Headings: 48+ pt
Subheadings: 34+ pt
Body text: 24+ pt
Captions: 16+ pt

One color scheme: keeping consistent color schemes – logos can be a nice reference



You are not always in front of the poster, provide audience with figure interpretations



Less is more: simplify publication/presentation figs – no animations available

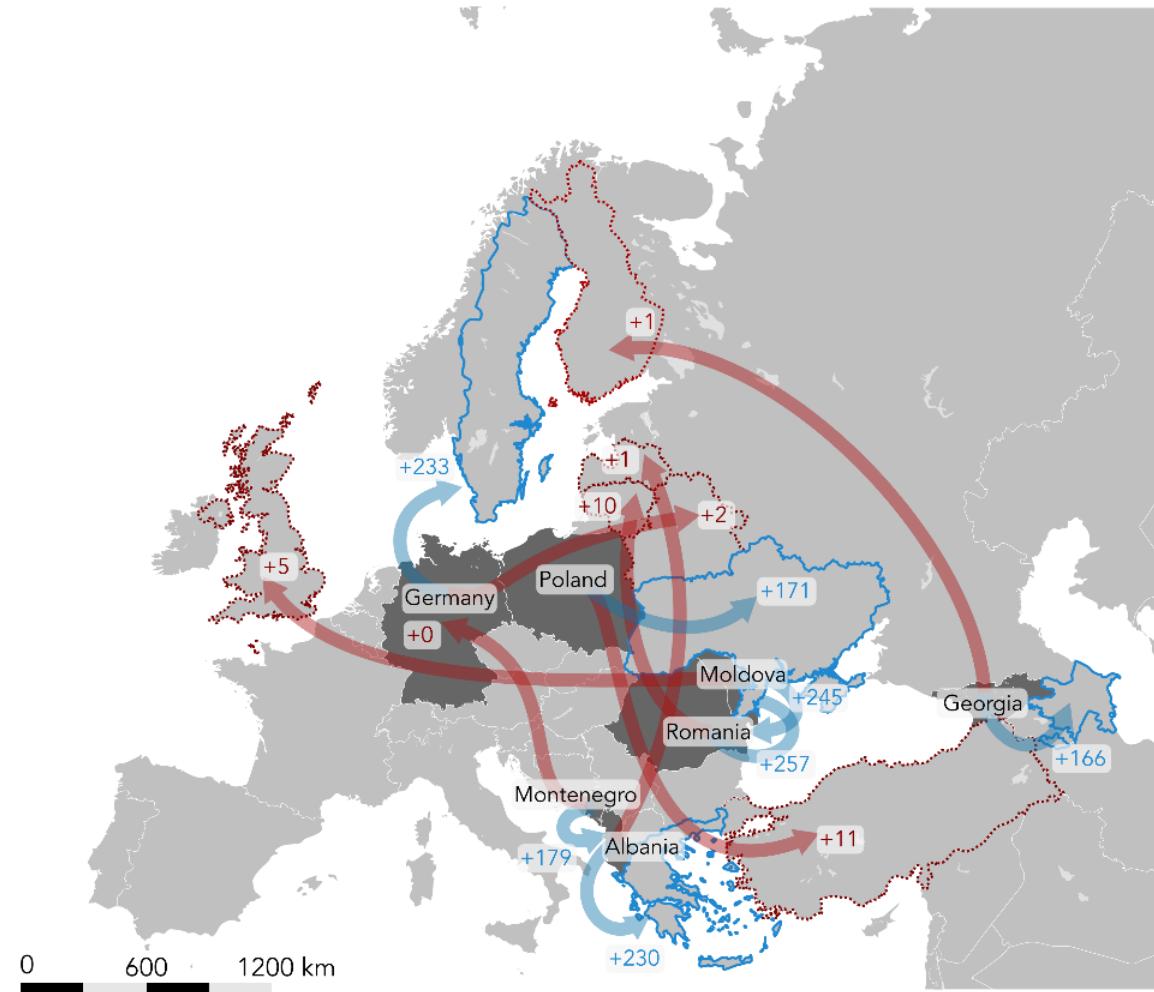
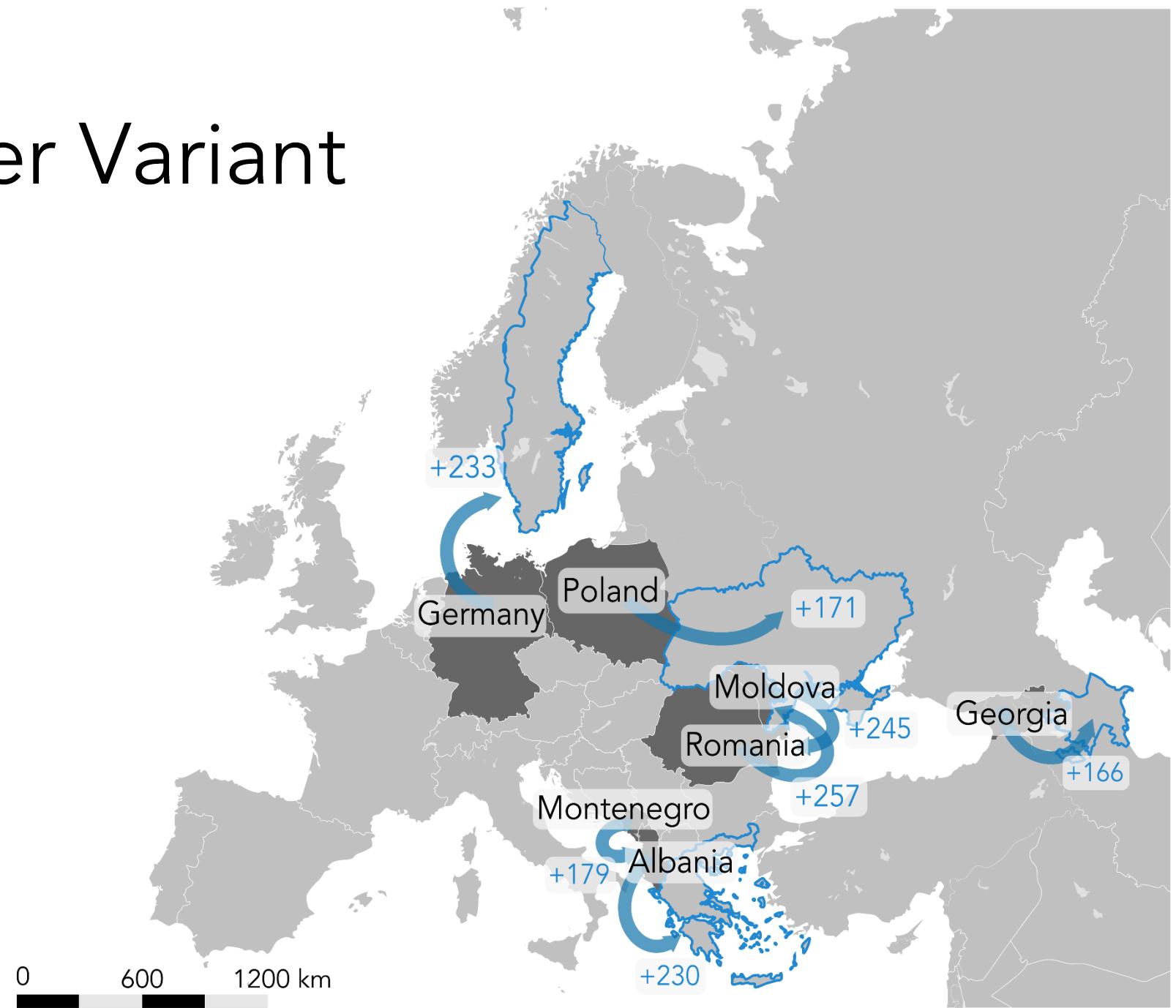


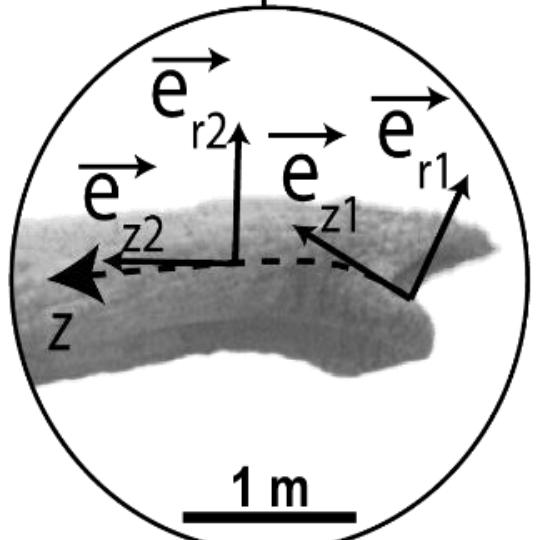
Figure 4 – Poster Variant

- Size matters (fonts)
- Keep consistent
- Less is more
- Stands on its own

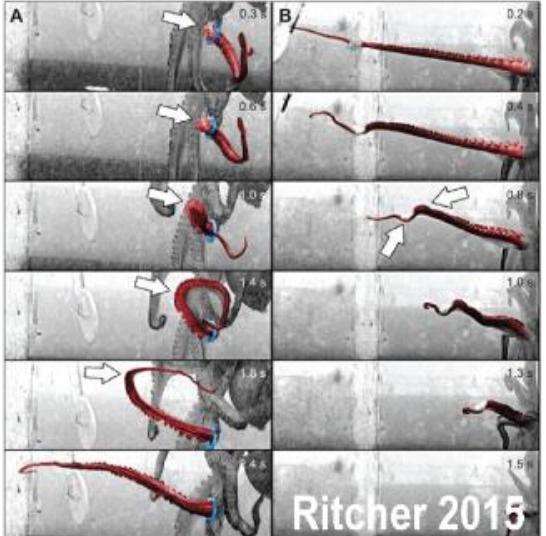


We can gain bio-inspiration across different scales of the trunk

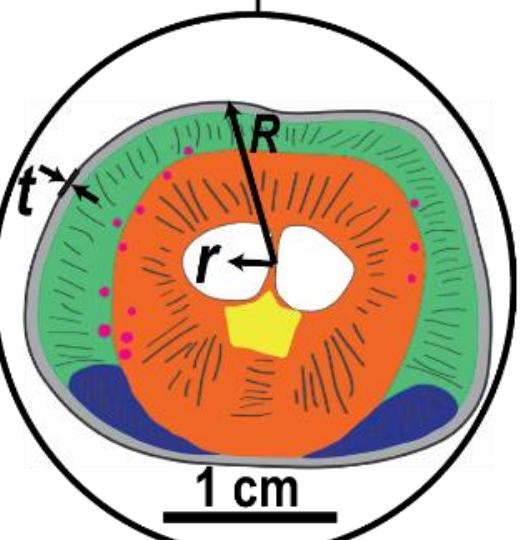
Degrees of Freedom



MOTOR PRIMATIVES



Muscular Hydrostat

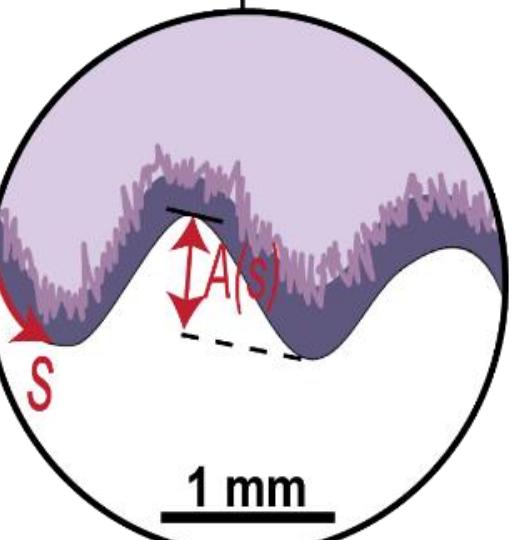


SOFT ROBOTICS



Truby 2018

Composite Skin

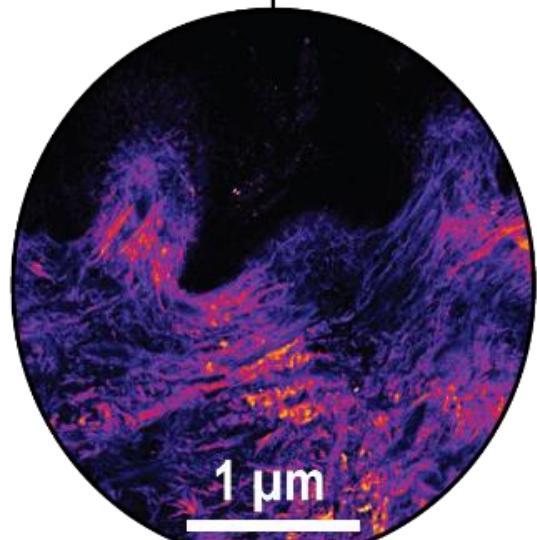


ROBOTIC SKINS

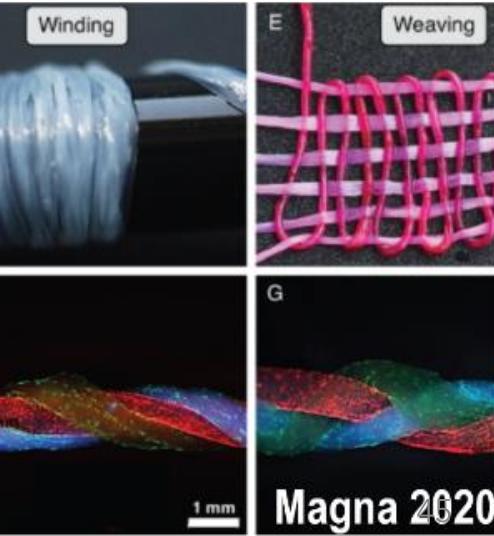


Booth 2018

Woven Fibers



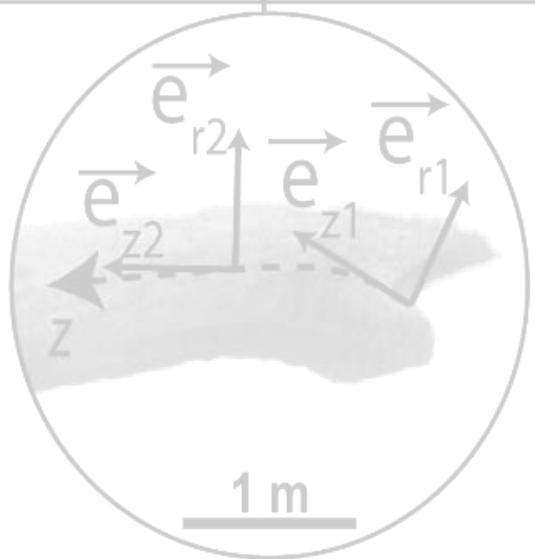
TISSUE ENGINEERING



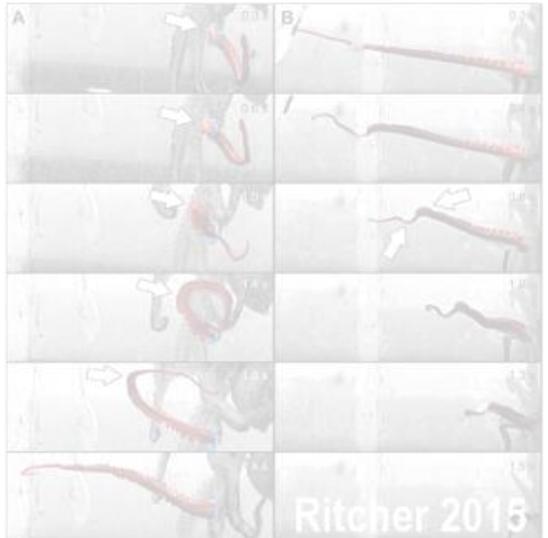
Magna 2020

We can gain bio-inspiration across different scales of the trunk

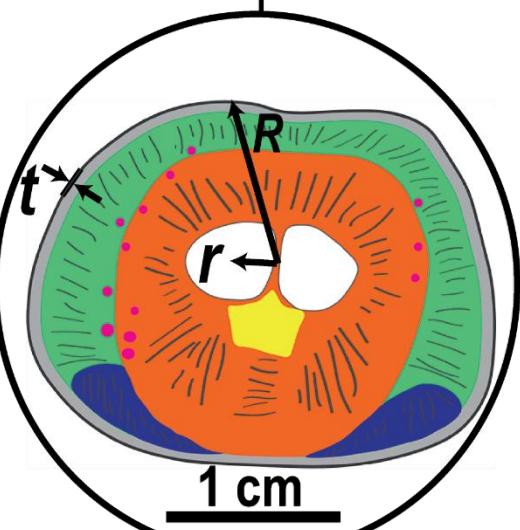
Degrees of Freedom



MOTOR PRIMITIVES



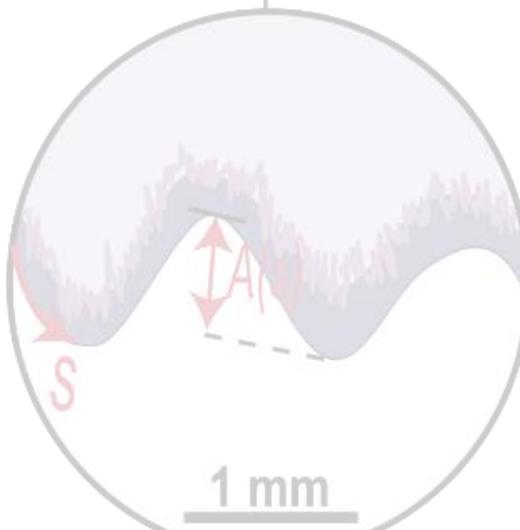
Muscular Hydrostat



SOFT ROBOTICS

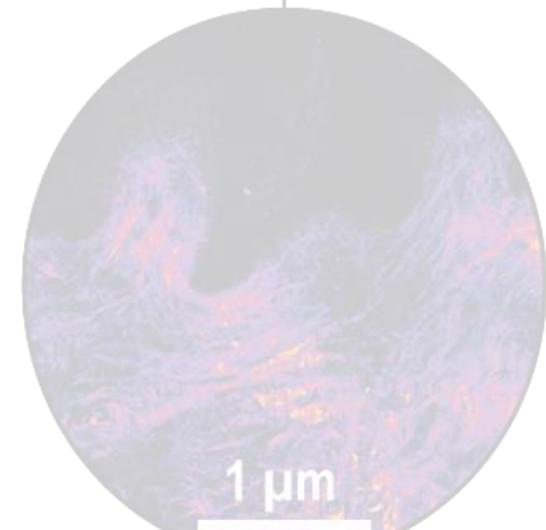


Composite Skin



ROBOTIC SKINS

Woven Fibers

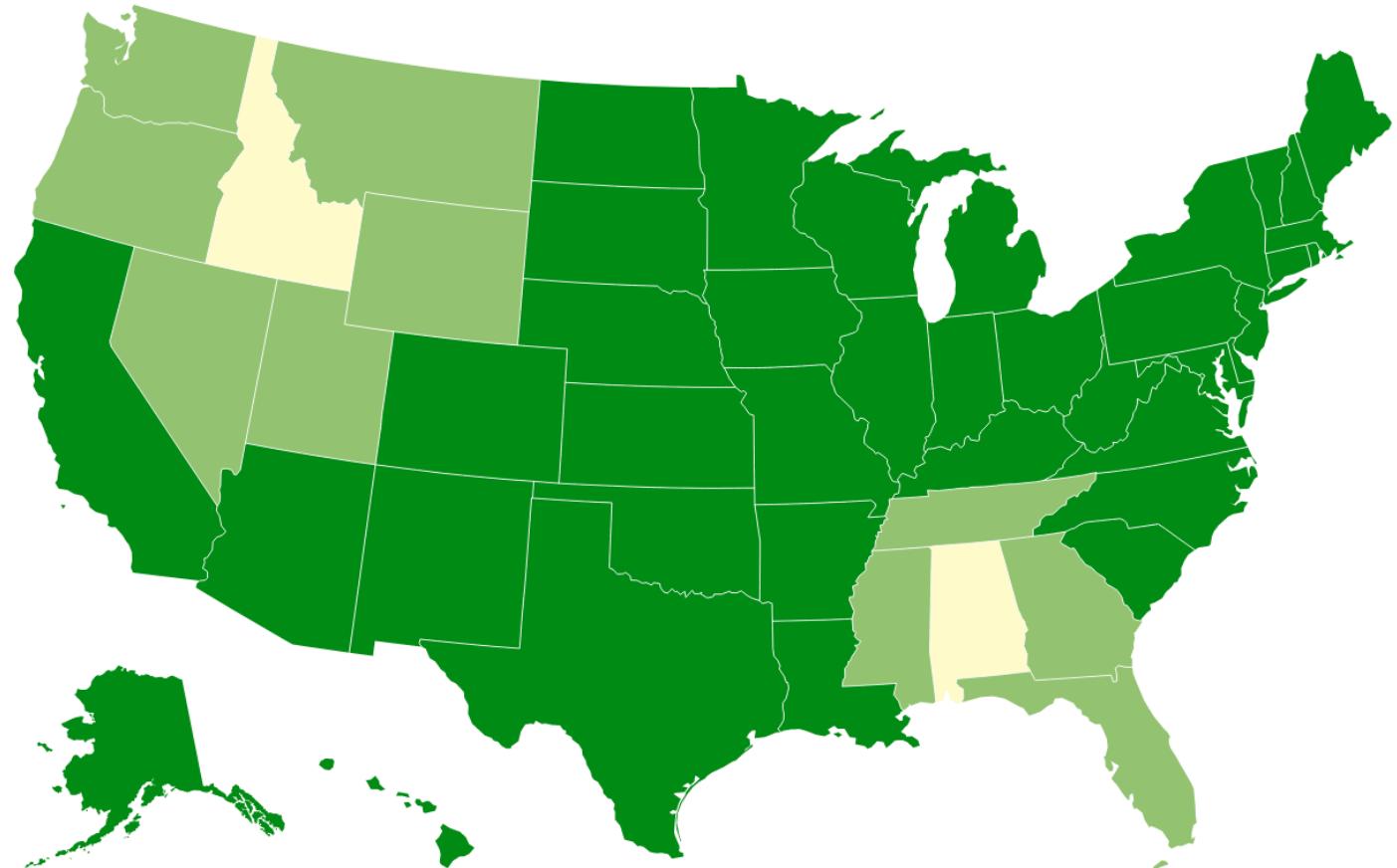


TISSUE ENGINEERING

Use the tools at your disposal for a presentation...but don't overdo it

- Visualizations
- Animations
- Highlighting
- Transitions

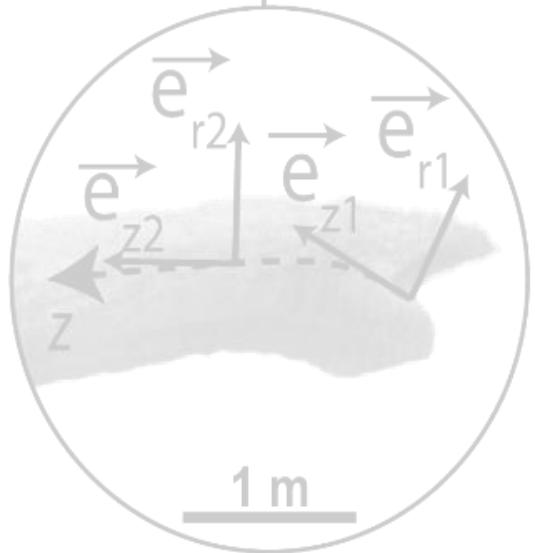
Data Clustering of Wildlife Needs In America



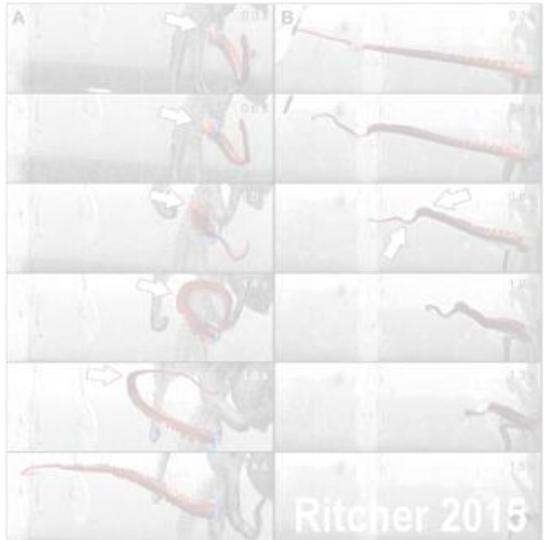
Created with Datawrapper

We can gain bio-inspiration across different scales of the trunk

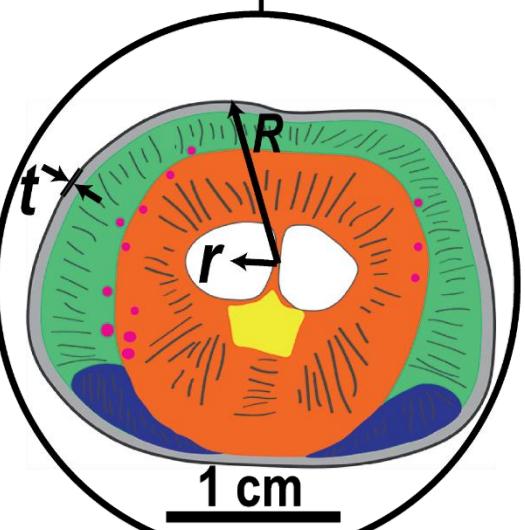
Degrees of Freedom



MOTOR PRIMITIVES



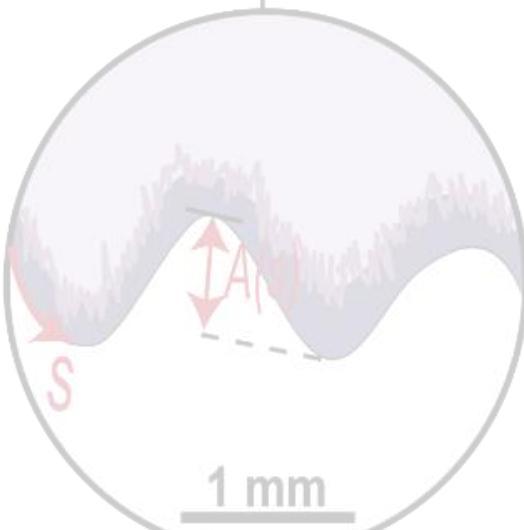
Muscular Hydrostat



SOFT ROBOTICS



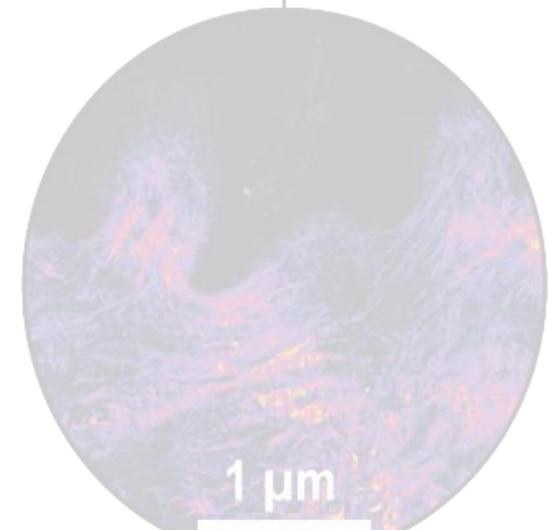
Composite Skin



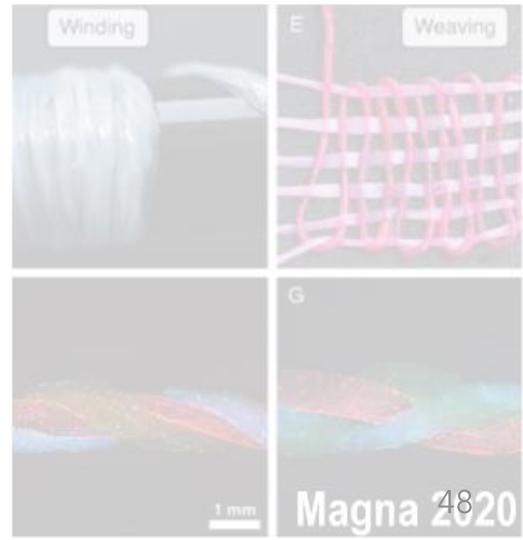
ROBOTIC SKINS



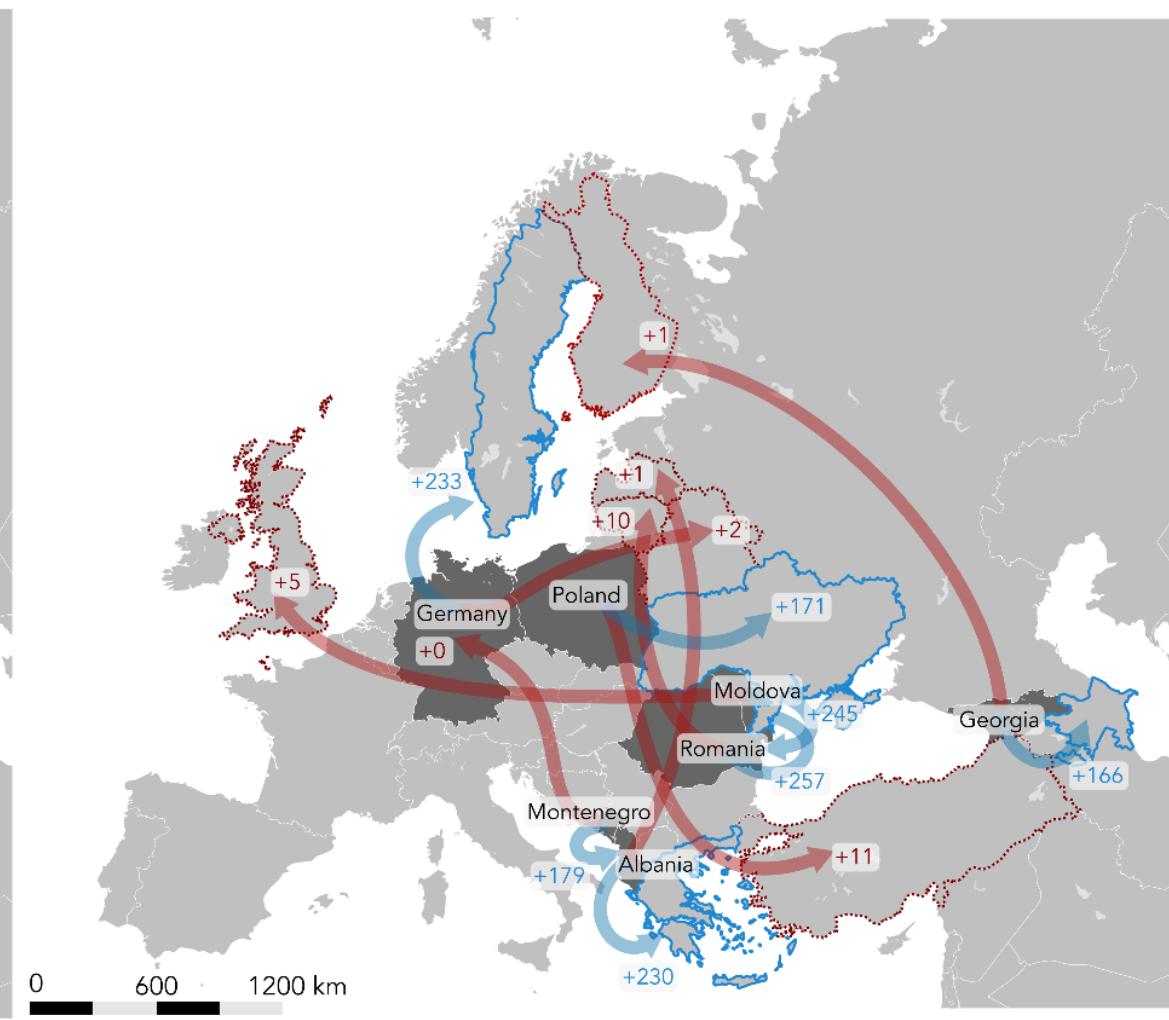
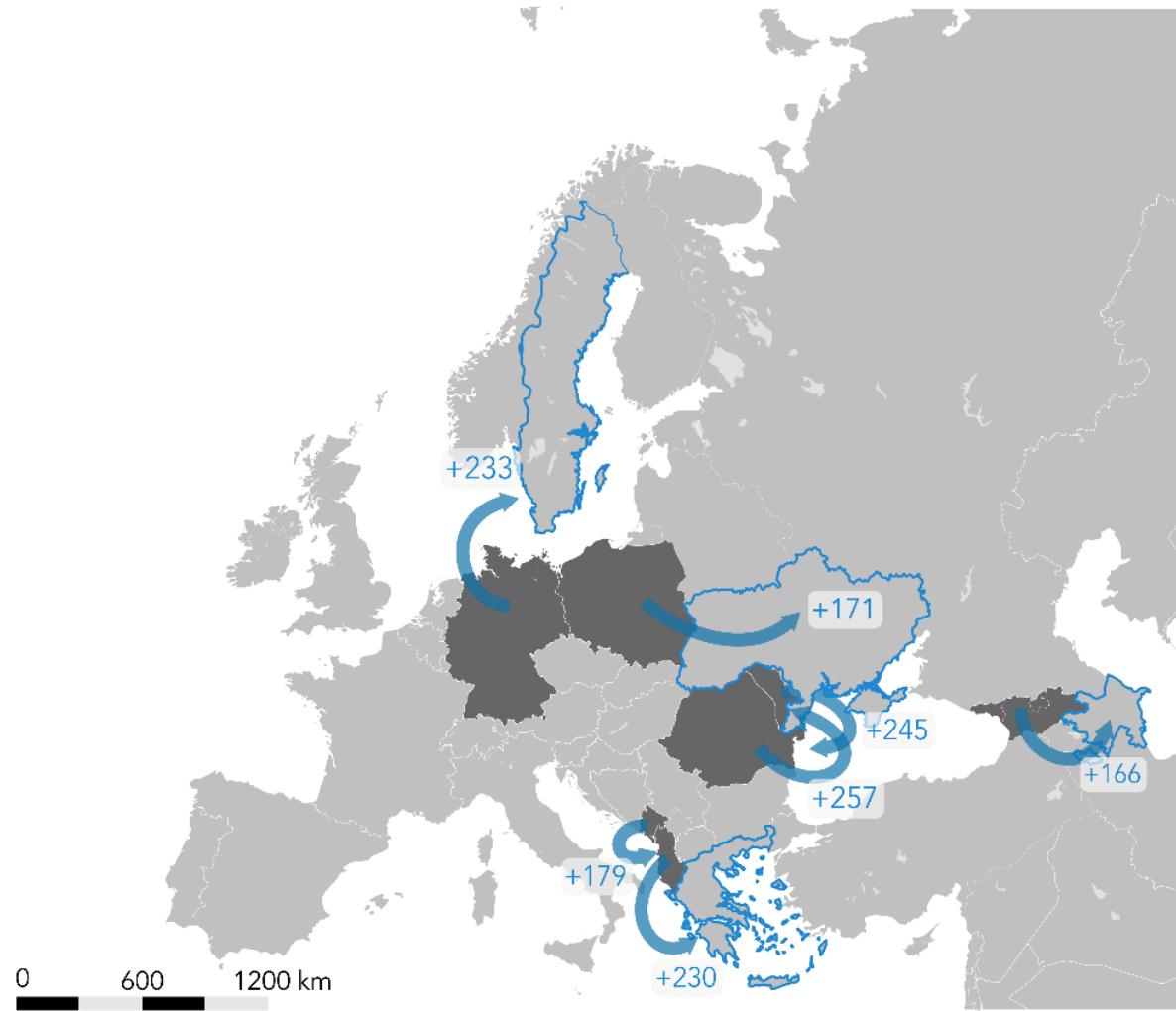
Woven Fibers



TISSUE ENGINEERING



But I have to show all of the data. All of it!?



Only a few data points?! Just use a table! NOT

Spine Size Differentiation			
Ball Tip Radii (mm)	Sample size (n)	Angle (deg)	μ_s
1.5	9	-58.23 ± 6.31	1.61 ± 0.11
2	10	-62.57 ± 7.78	1.93 ± 0.14
2.5	10	-65.25 ± 6.51	2.17 ± 0.11
3	10	-59.35 ± 6.52	1.67 ± 0.11
3.5	10	-59.76 ± 5.96	1.71 ± 0.10

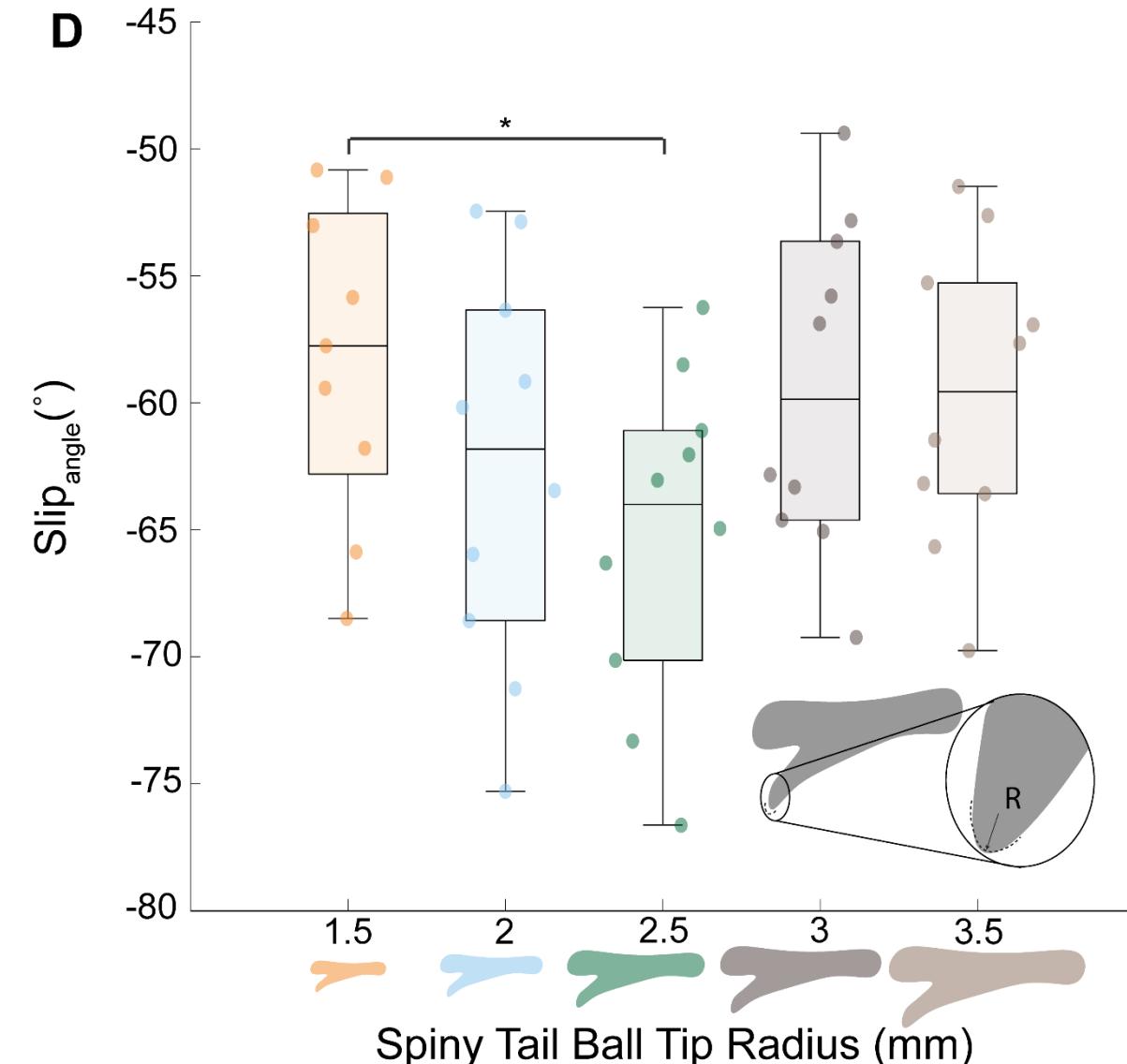
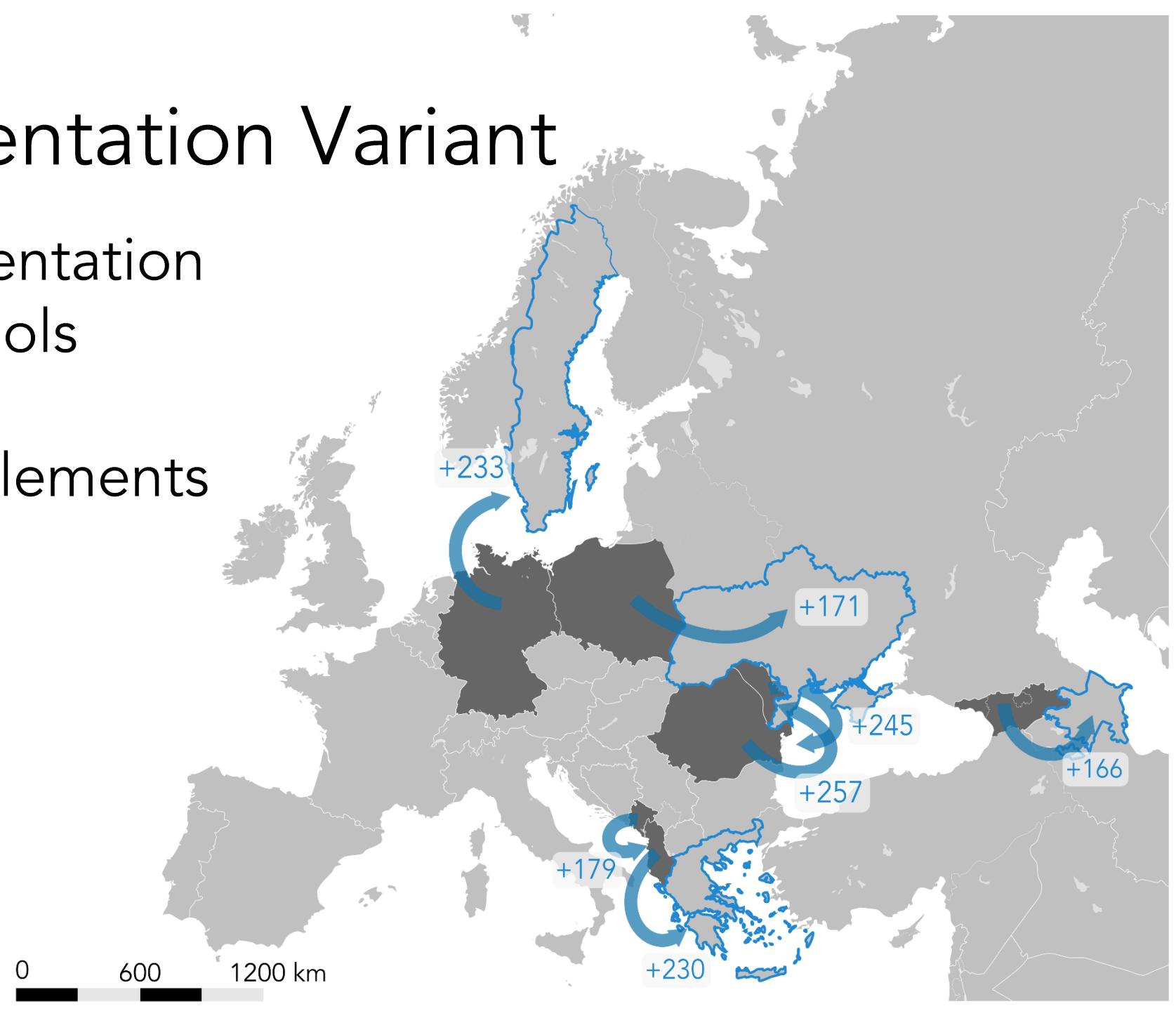


Figure 4 – Presentation Variant

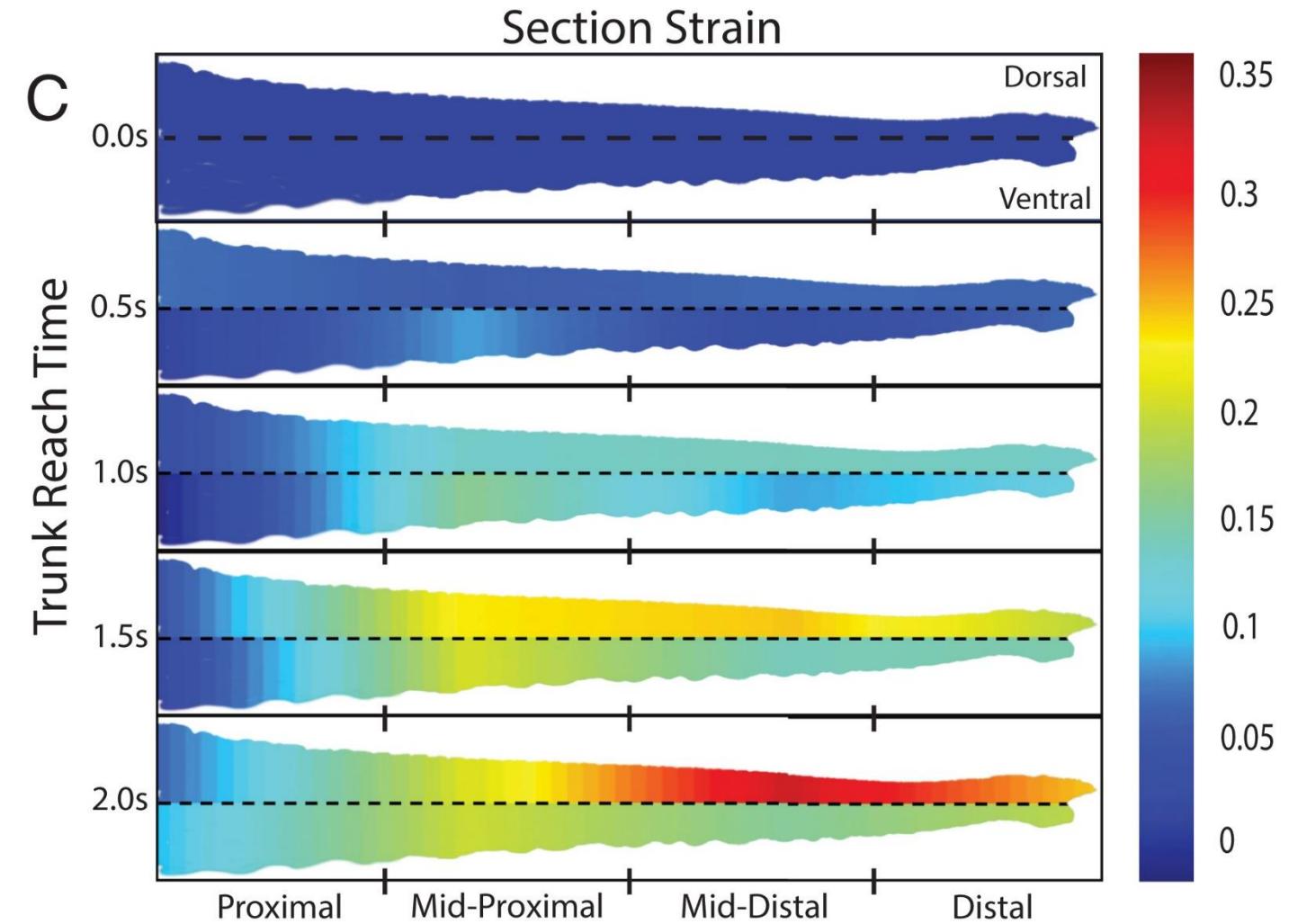
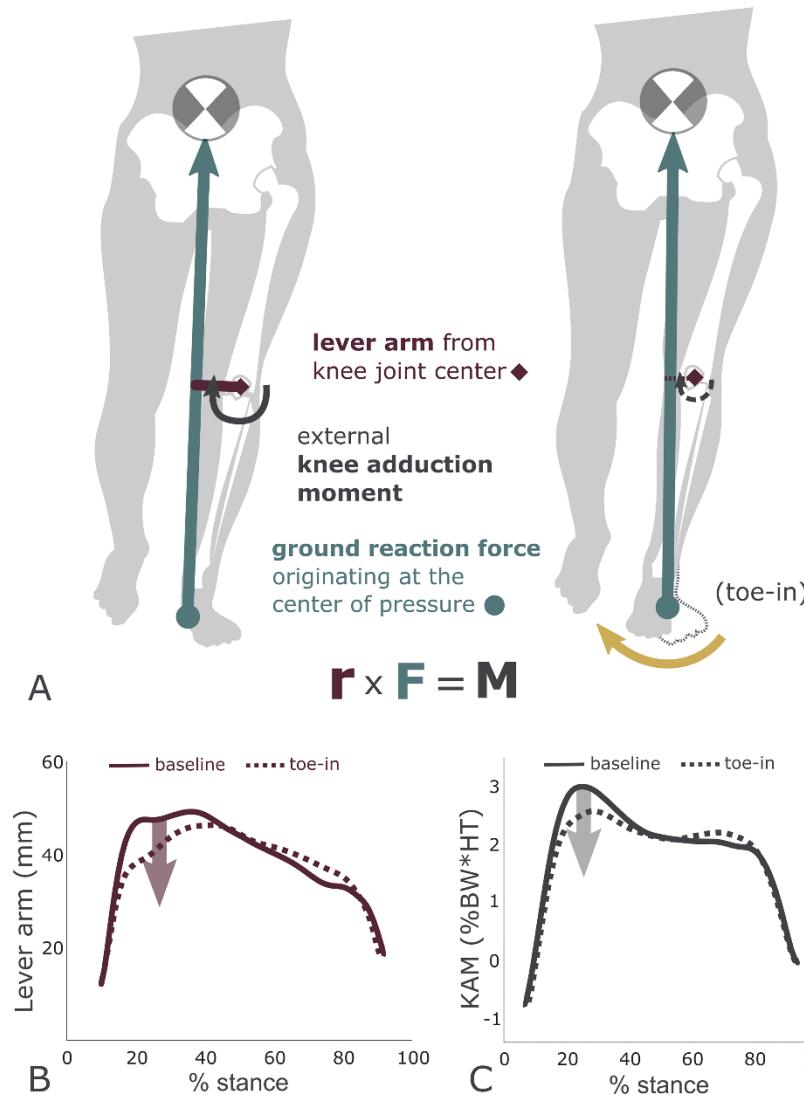
When making a presentation

- Use presentation tools
- Modify visuals
- The presenter supplements the figures



What are the primary differences you see with posters versus presentations?

Creating the best currency: visualizations in publications



The first figure (the screenshot figure)

BITE: Beyond Priors for Improved Three-D Dog Pose Estimation

Nadine Rüegg^{1,2}, Shashank Tripathi², Konrad Schindler¹, Michael J. Black², and Silvia Zuffi³

¹ETH Zürich, Switzerland

²Max Planck Institute for Intelligent Systems, Tübingen, Germany

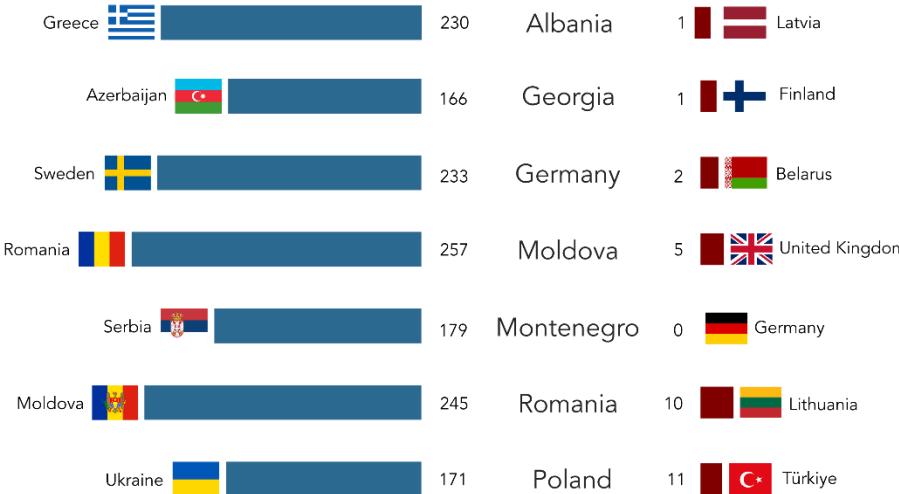
³IMATI-CNR, Milan, Italy



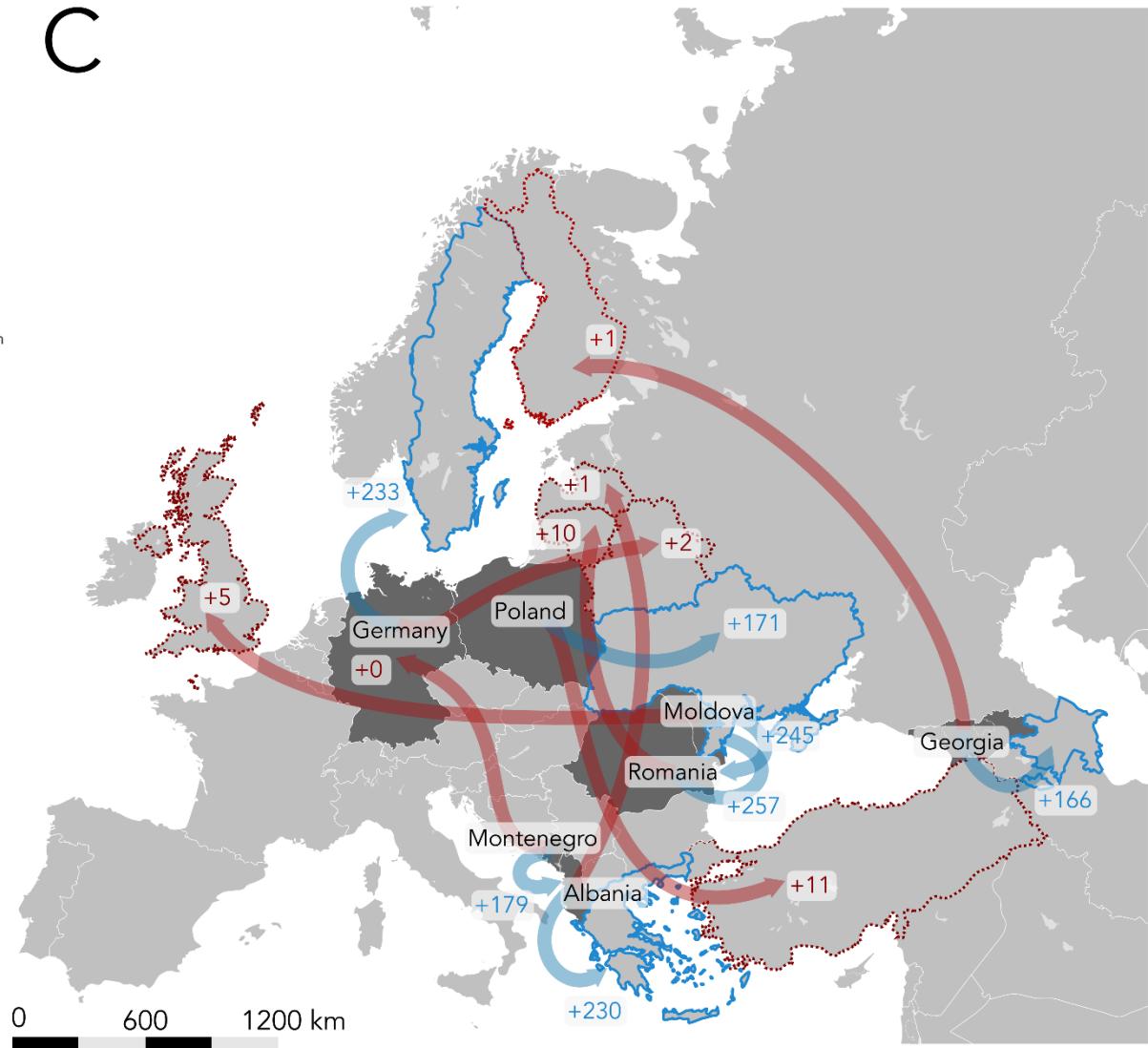
Figure 1. BITE enables 3D shape and pose estimation of dogs from a single input image. The model handles a wide range of shapes and breeds, as well as challenging postures far from the available training poses, like sitting or lying on the ground.

Use your panels

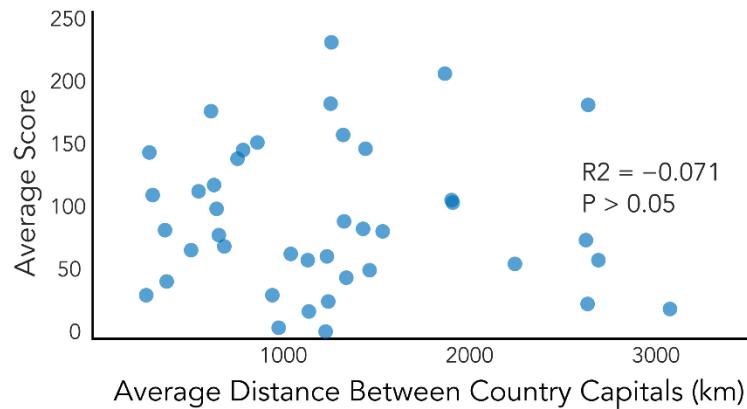
A



C



B



Use schematics to explain findings

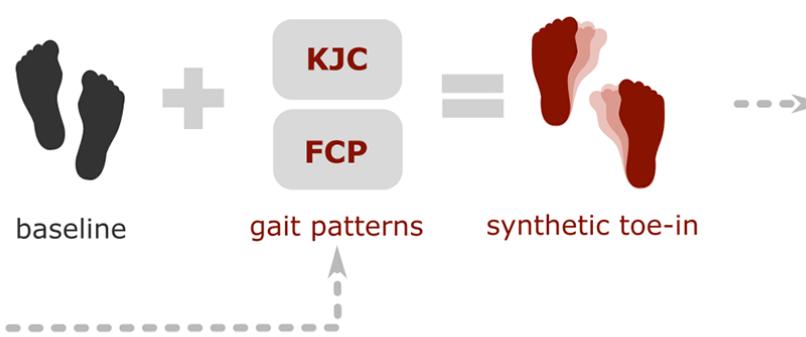
2.1 Learn gait patterns

Stanford University N=12



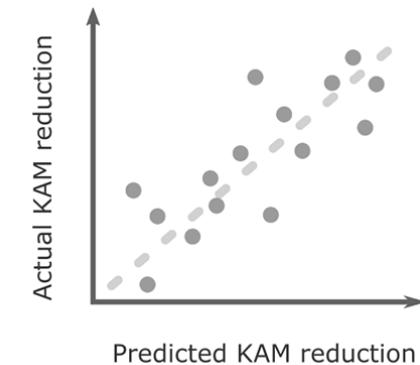
2.2 Synthesize toe-in gait

Calgary Running Injury Clinic N=138



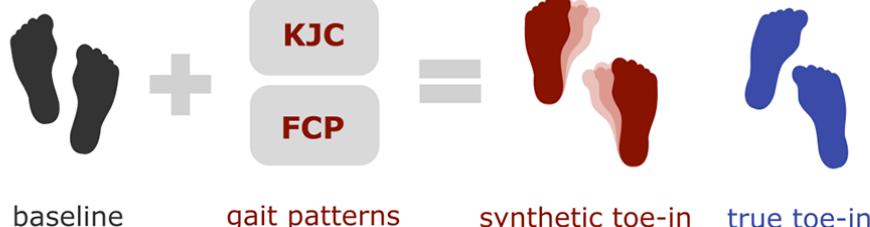
2.3 Train predictive model

Calgary Running Injury Clinic N=138

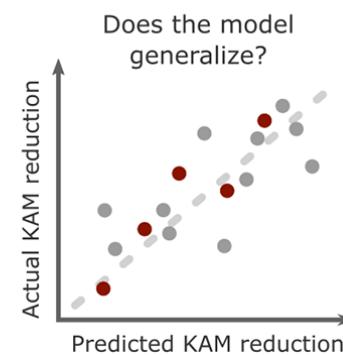


2.4 Independently validate the pipeline

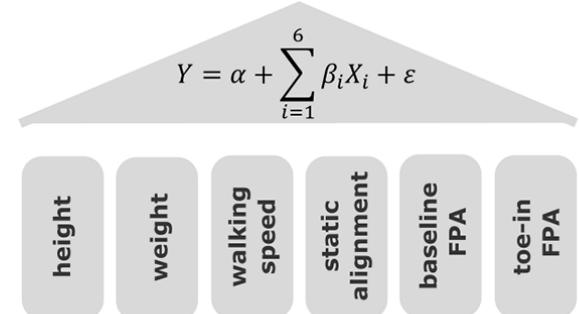
Carnegie Mellon University
N=15



How accurate is
the synthetic gait?



$$Y = \alpha + \sum_{i=1}^6 \beta_i X_i + \varepsilon$$



Keep colors consistent for variables

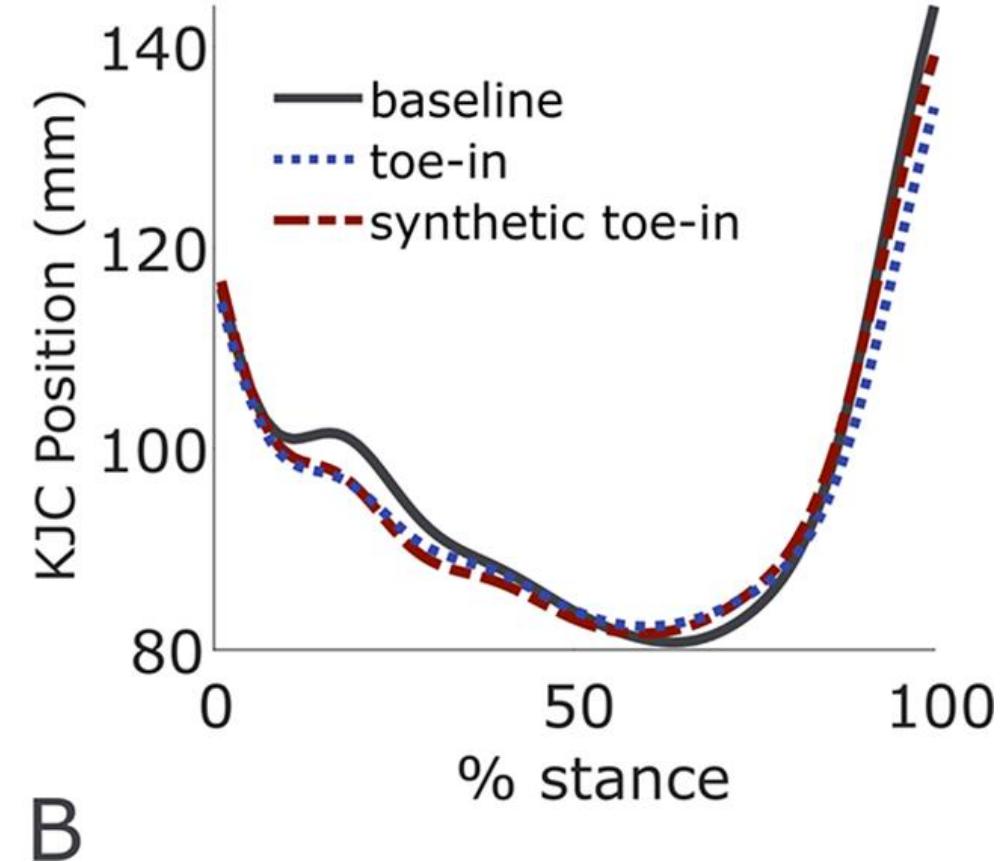
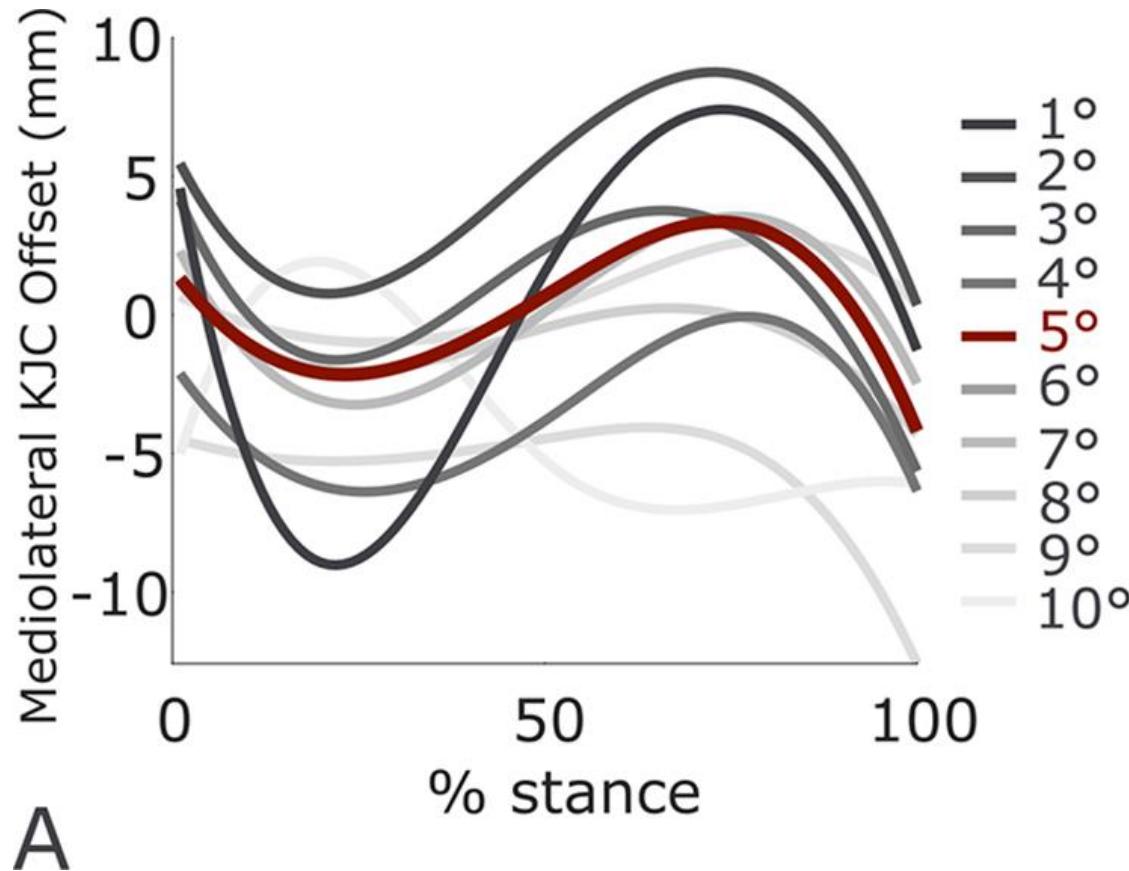
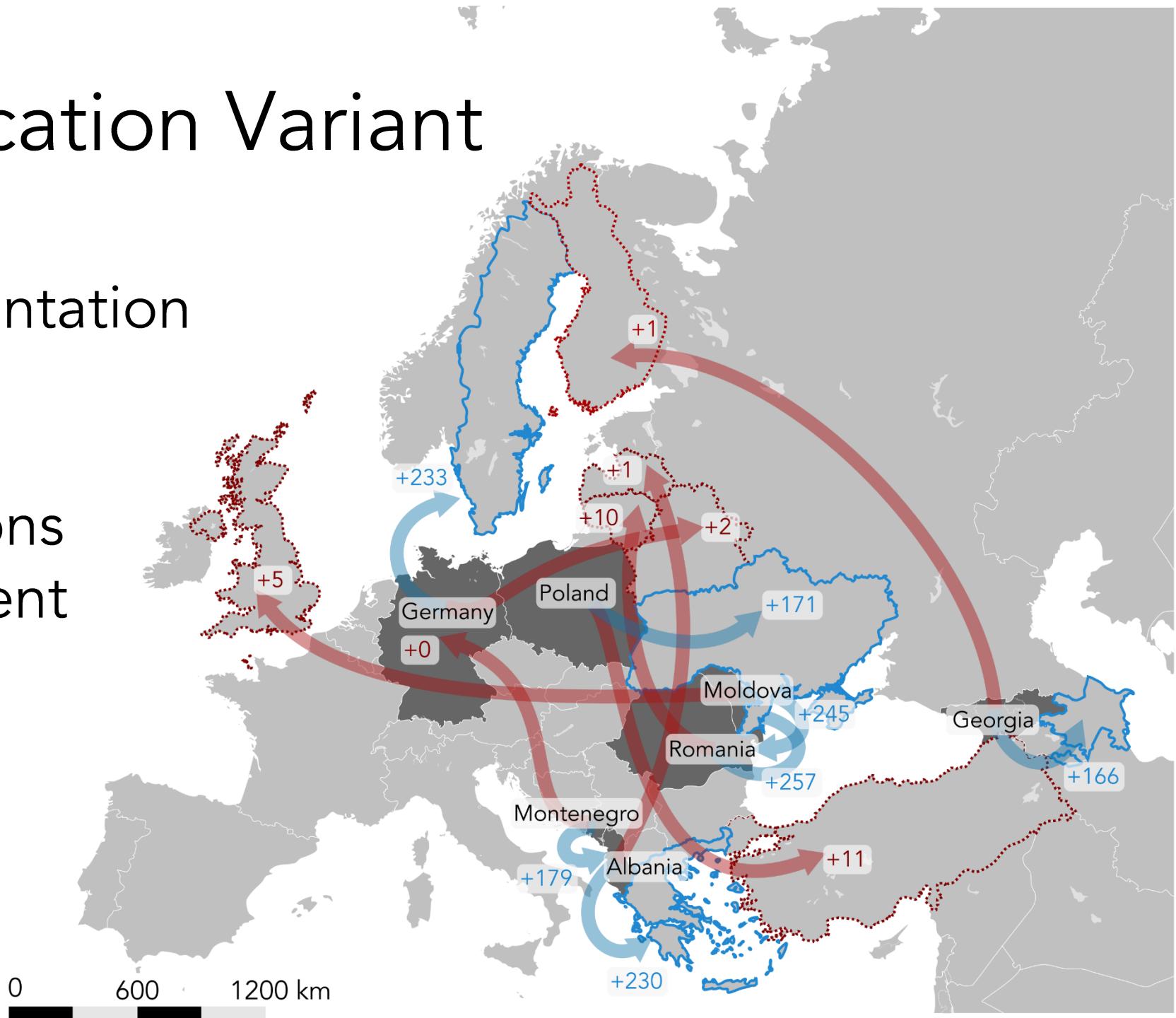


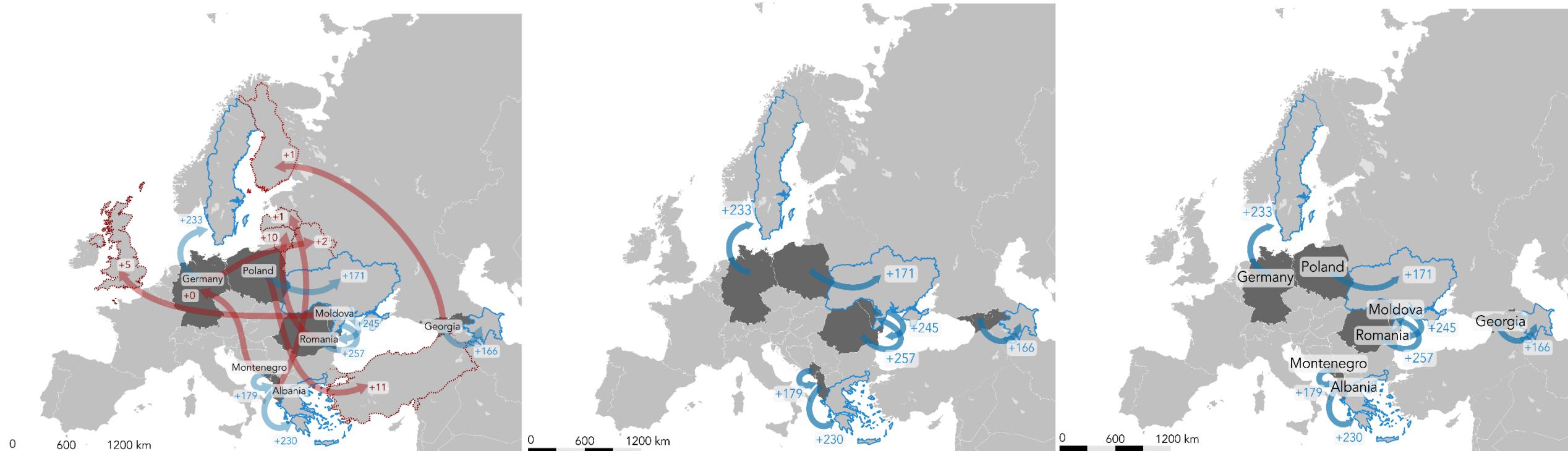
Figure 4 – Publication Variant

When making a presentation

- Use schematics
- Use panels
- Good first impressions
- Keep colors consistent



One size does not fit all: Posters vs. Presentations vs. Publications



Schedule for Today

09:55 – 10:10 - Intro of presenters & purpose of workshop
10:10 – 10:28 - Figure Activity, Spectrum of Figures shown
10:28 – 10:30 - Q&A Break
10:30 – 10:43 - Rubric introduction
10:43 – 10:50 - Q&A Break
10:50 – 11:05 - Posters, presentations, publications, give link sheet out
11:05 – 11:20 - Q&A break & transition to breakouts
11:20 – 11:50 - Breakouts
11:50 – 11:55 - Recap, GitHub discussion
11:55 – 12:00 - LimeSurvey & end

Quick show of hands for the breakout sessions:

1. Inkscape 101

You will learn the basics of:

- What tools are available to you in Inkscape
- How to use (some of) those tools
- How to revise a figure we export from MATLAB
 - (keep your Figure Rubric close at hand)
- How to create a vector illustration by using a photo as a guide

2. Peer review of YOUR figs

You will get to:

- Provide and receive feedback on your figures
- Try implementing what we learned today
- Think more deeply about the best visualization type for your dataset and analysis

Keep and/or update if holding breakout sessions

Recap

TAKE-HOME

Participants will learn how to critically review their figures using:

- The Figure Spectrum
- The Figure Rubric

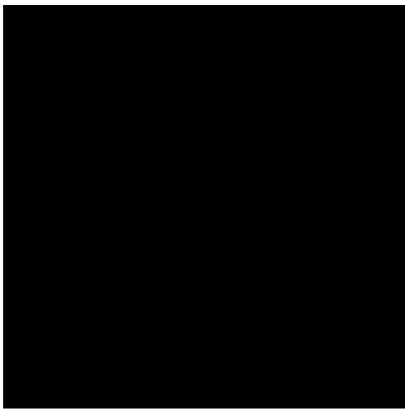
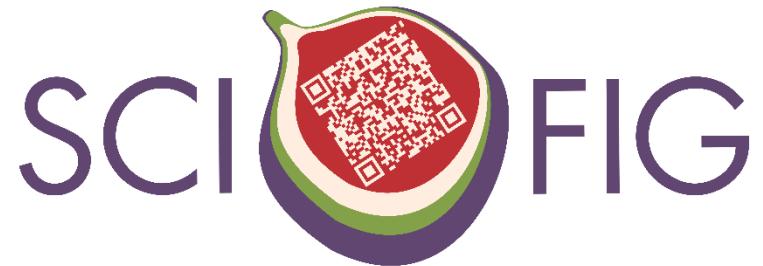
Participants will learn about open tools available, such as:

- Inkscape
- Link Sheet

LEARNING

Participants will understand key differences between:

- Figures for publications
- ... presentations (e.g. TAC meetings)
- ... and posters



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Title Here

Email Here



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Title Here

Email Here

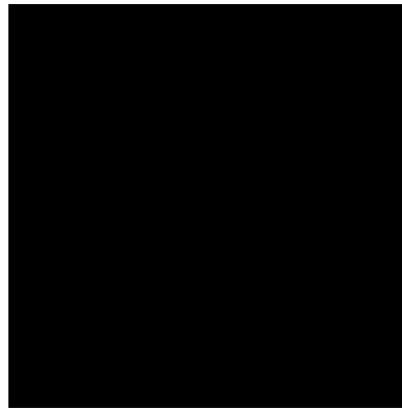
Thanks, y'all!

Bibliography of Figures Used

- A. K. Schulz, N. Schneider, M. Zhang, and K. Singal, "A Year at the Forefront of Hydrostat Motion," *Biology Open*, vol. 12, no. 8, p. bio059834, Aug. 2023, doi: [10.1242/bio.059834](https://doi.org/10.1242/bio.059834).
- N. Ruegg, S. Tripathi, K. Schindler, M. J. Black, and S. Zuffi, "{BITE}: Beyond Priors for Improved Three-{D} Dog Pose Estimation," presented at the IEEE/CVF Conf.~on Computer Vision and Pattern Recognition (CVPR), 2023.
- A. K. Schulz *et al.*, "Conservation tools: the next generation of engineering–biology collaborations," *Journal of The Royal Society Interface*, vol. 20, no. 205, p. 20230232, Aug. 2023, doi: [10.1098/rsif.2023.0232](https://doi.org/10.1098/rsif.2023.0232).
- A. Schulz, "Early Outcomes from an Interdisciplinary VIP Course," presented at the Georgia Tech Teaching Conference, 2021.
- B. Christensen and M. A. Daley, "Energy Regulation in Response to Substrate Energy Loss," presented at the American Society of Biomechanics, 2023.
- N. Rokhmanova, O. Pearl, K. J. Kuchenbecker, and E. Halilaj, "IMU-Based Kinematics Estimation Accuracy Affects Gait Retraining using Vibrotactile Cues," *TNSRE (under review)*, 2023.
- N. Rokhmanova, K. J. Kuchenbecker, P. B. Shull, R. Ferber, and E. Halilaj, "Predicting knee adduction moment response to gait retraining with minimal clinical data," *PLOS Computational Biology*, vol. 18, no. 5, p. e1009500, May 2022, doi: [10.1371/journal.pcbi.1009500](https://doi.org/10.1371/journal.pcbi.1009500).
- A. K. Schulz *et al.*, "Skin wrinkles and folds enable asymmetric stretch in the elephant trunk," *Proceedings of the National Academy of Sciences*, vol. 119, no. 31, p. e2122563119, Aug. 2022, doi: [10.1073/pnas.2122563119](https://doi.org/10.1073/pnas.2122563119).
- A. K. Schulz, M. Chellapurath, P. C. Khandelwal, S. Rezaei, S. Merker, and A. Jusufi, "Spiny Tail Enhances Traction on Diverse Barks in Pel's Scaly Tailed Squirrel," *In Prep*, 2023.
- K. Gordon, "Using Color to Enhance Your Design," Nielsen Norman Group. Accessed: Nov. 23, 2023. [Online]. Available: <https://www.nngroup.com/articles/color-enhance-design/>

*Authors have provided consent to share their figures; all papers included are open-access

Insert a QR Code here if you have
a survey for participants



Example question: What could be improved?