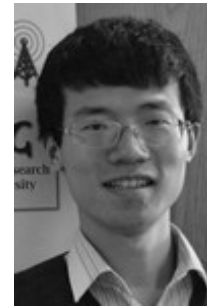


WalkCompass: I am a Smartphone and I can Tell my User's Walking Direction

MobiSys 2014, Bretton Woods, NH



Nirupam Roy

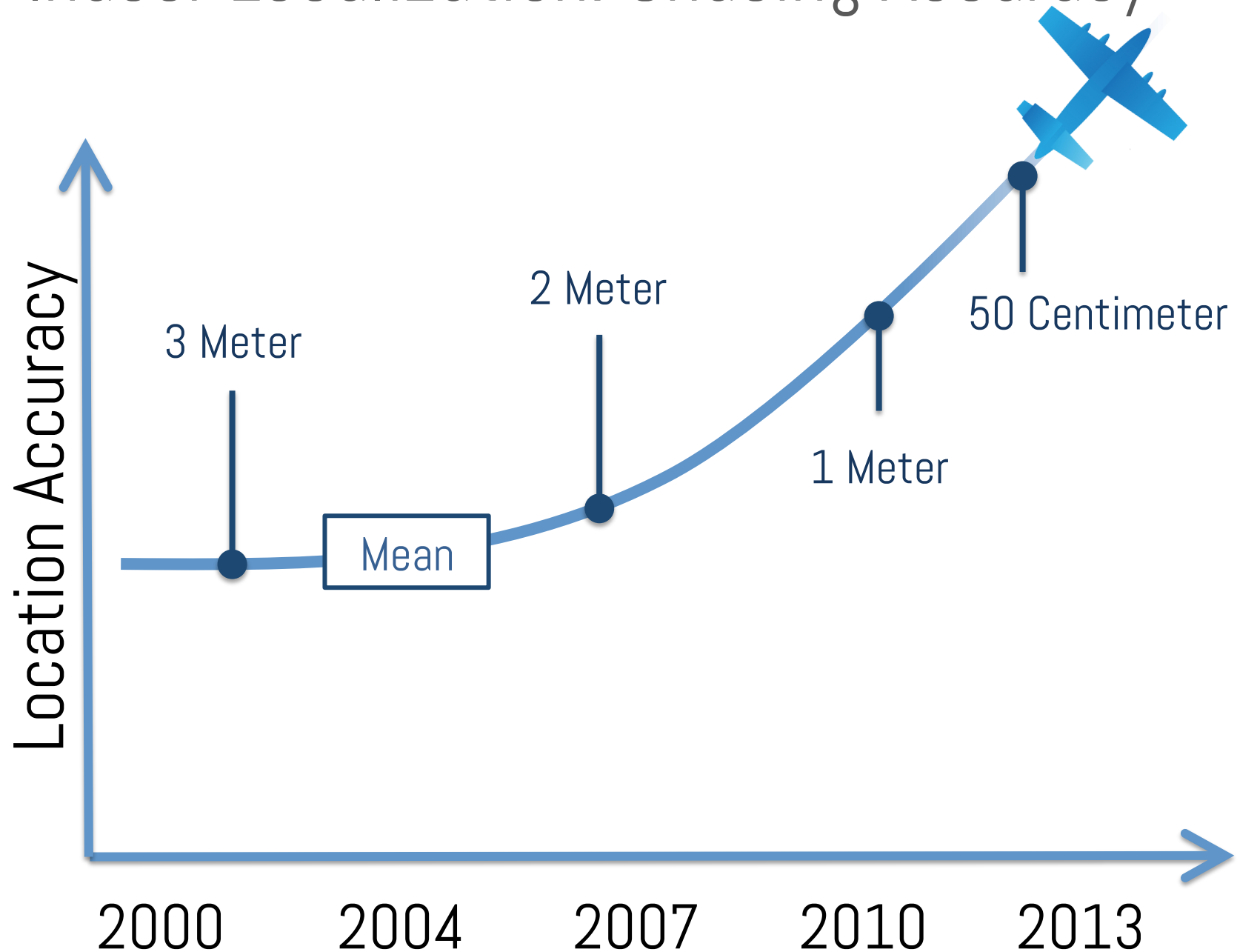


He Wang

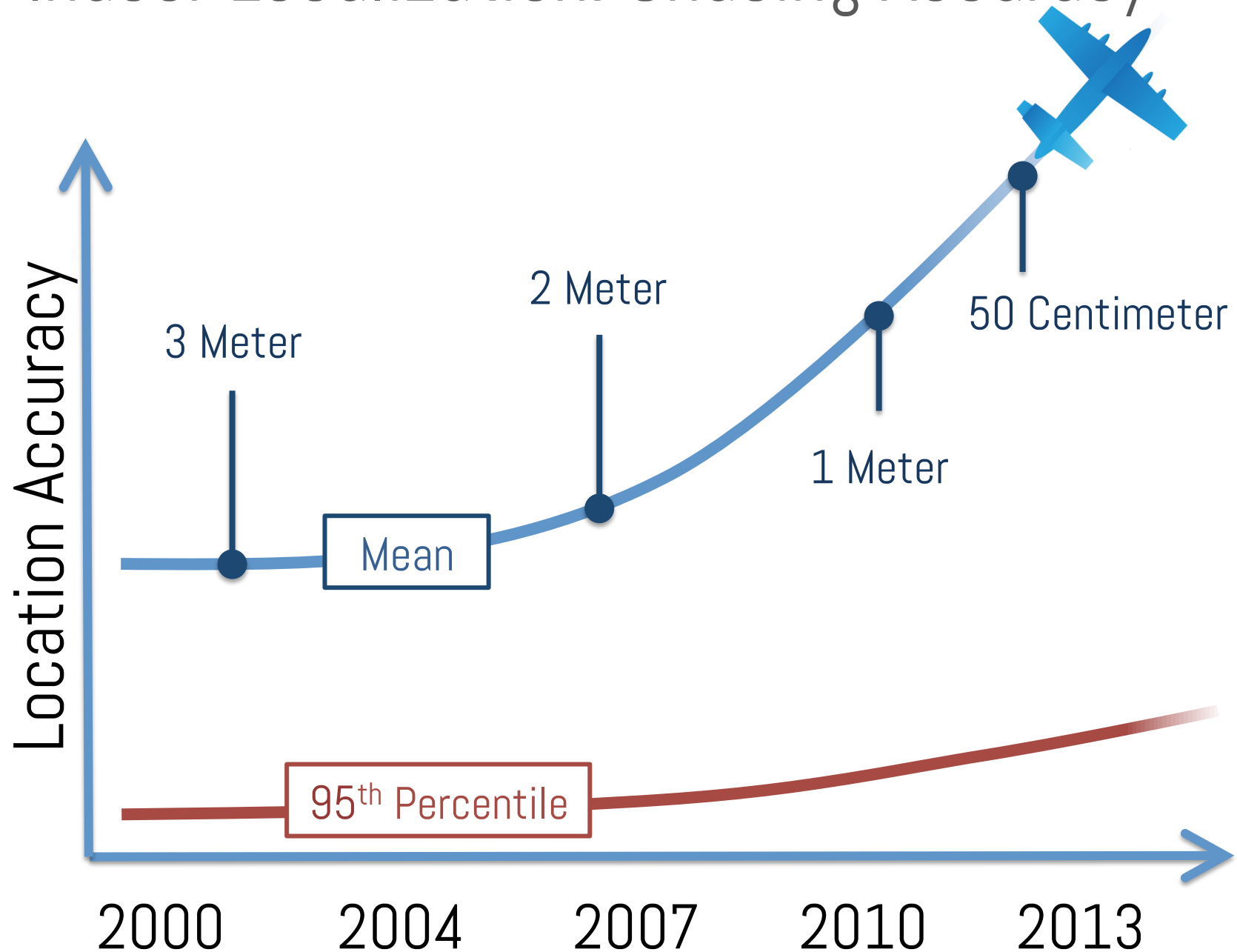


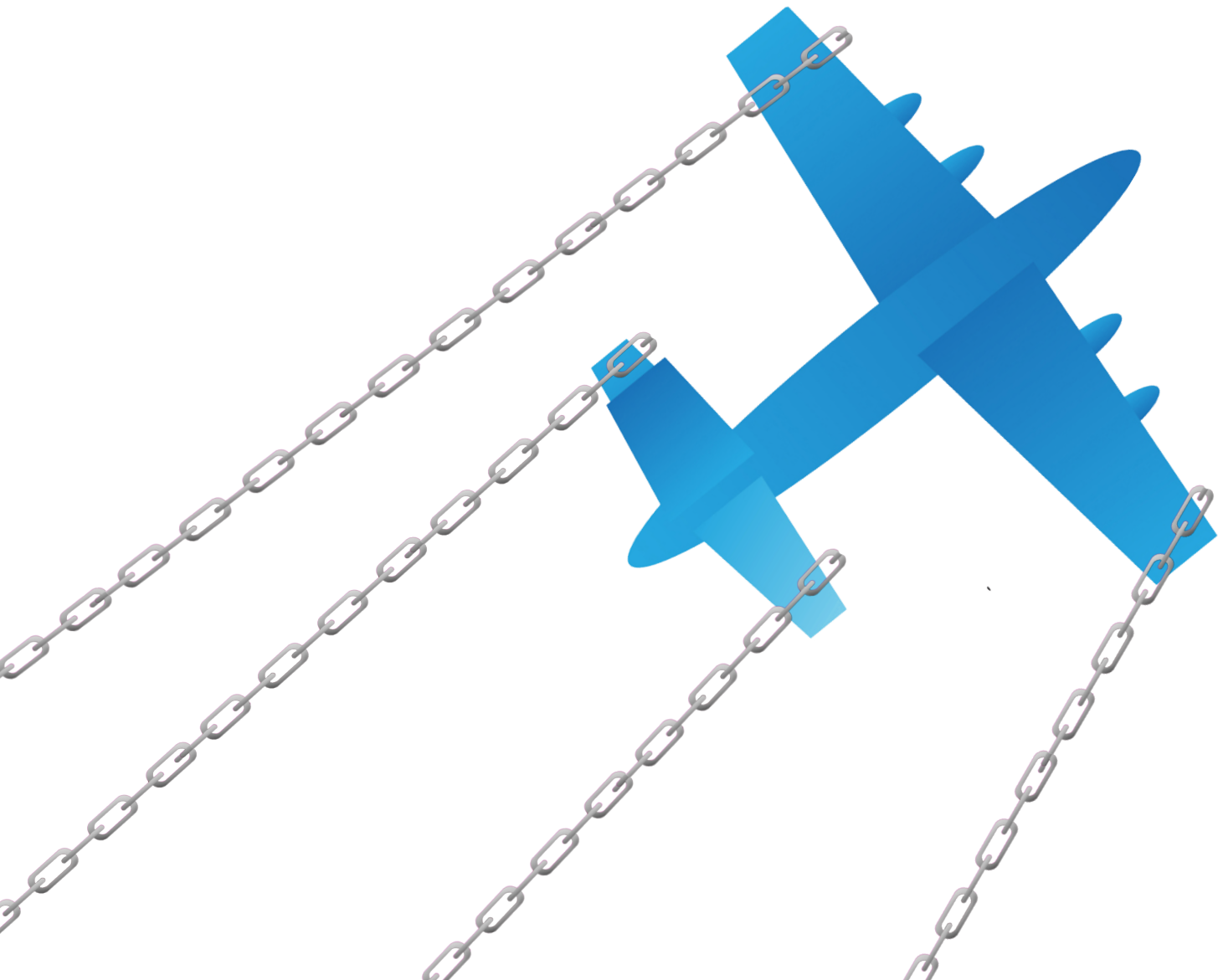
Romit Roy Choudhury

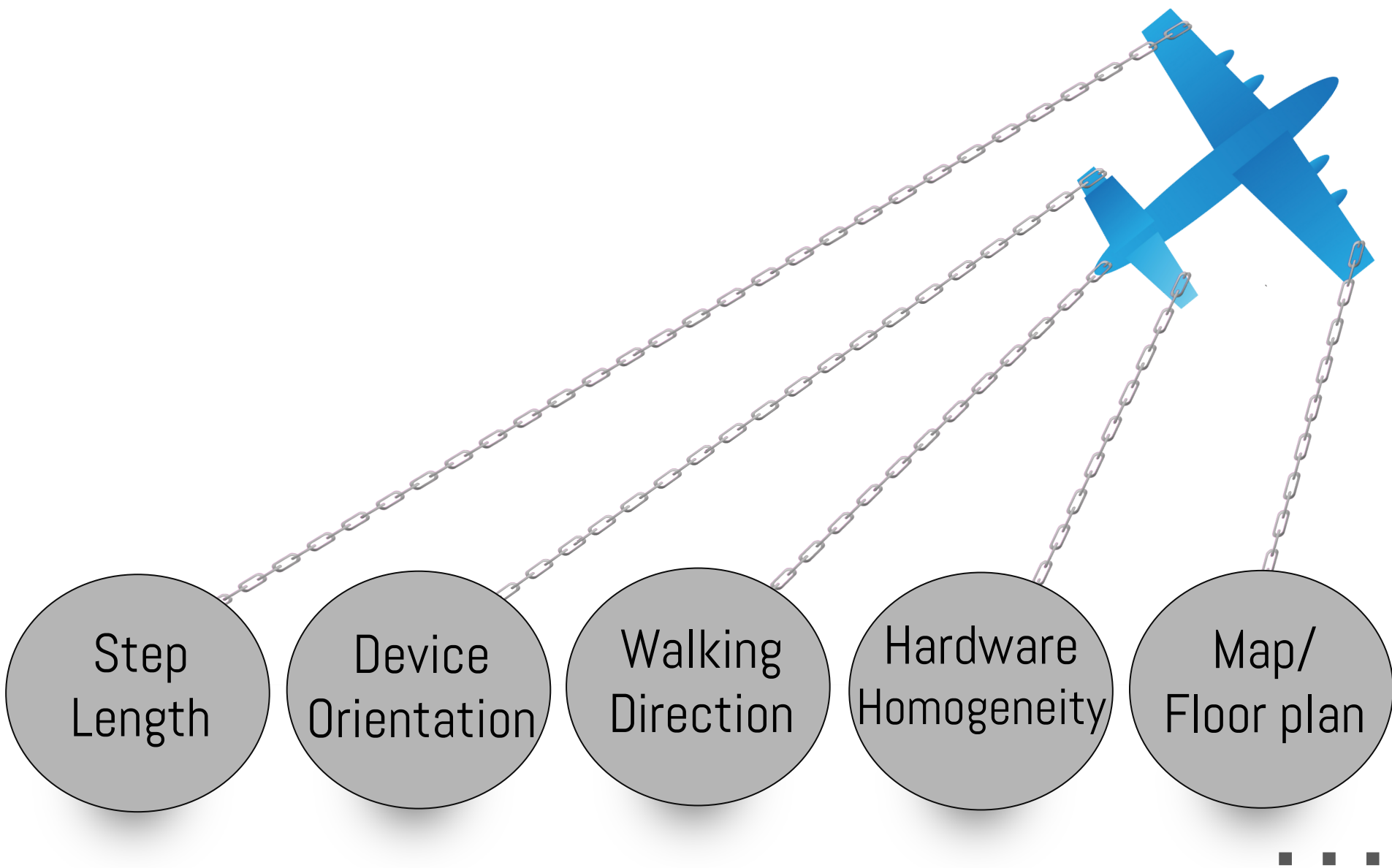
Indoor Localization: Chasing Accuracy



Indoor Localization: Chasing Accuracy



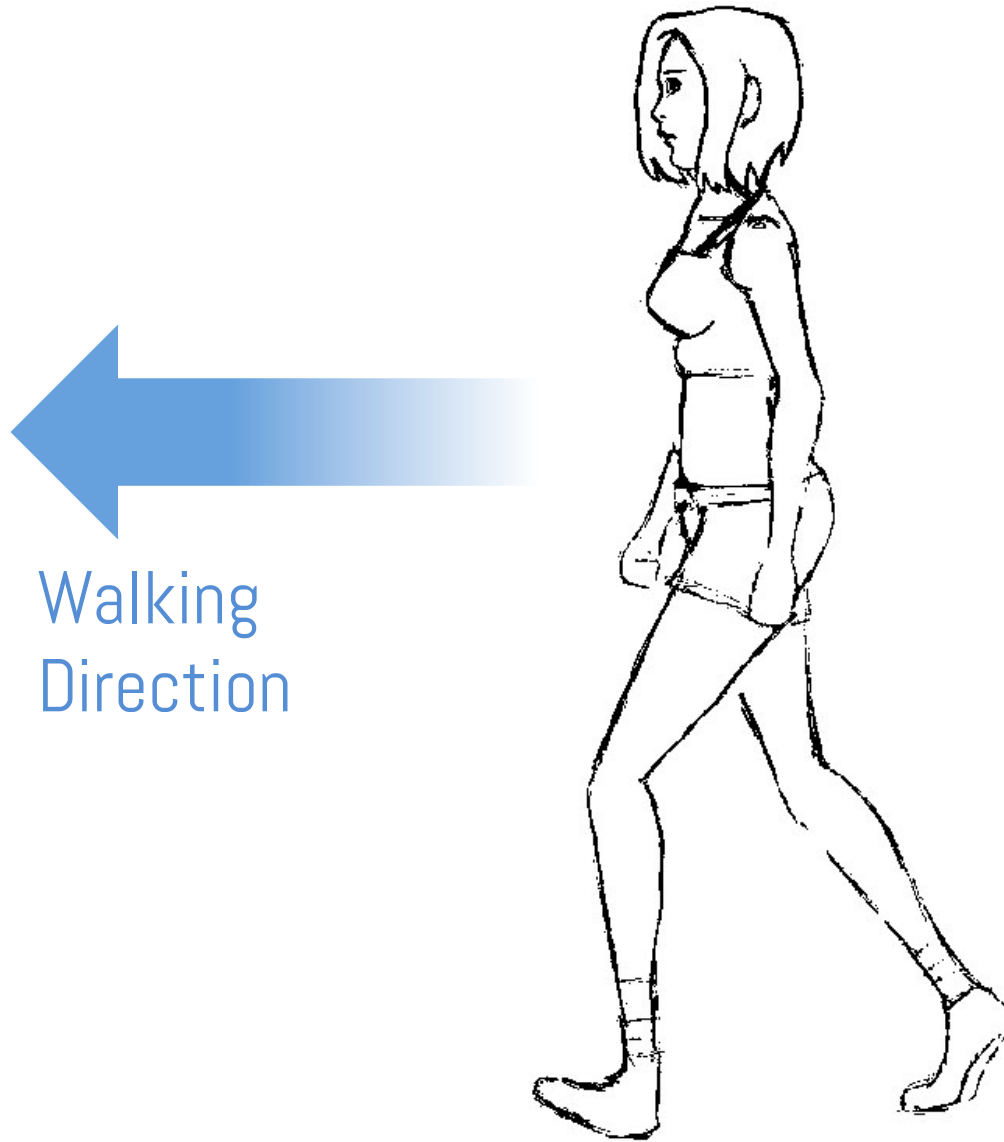




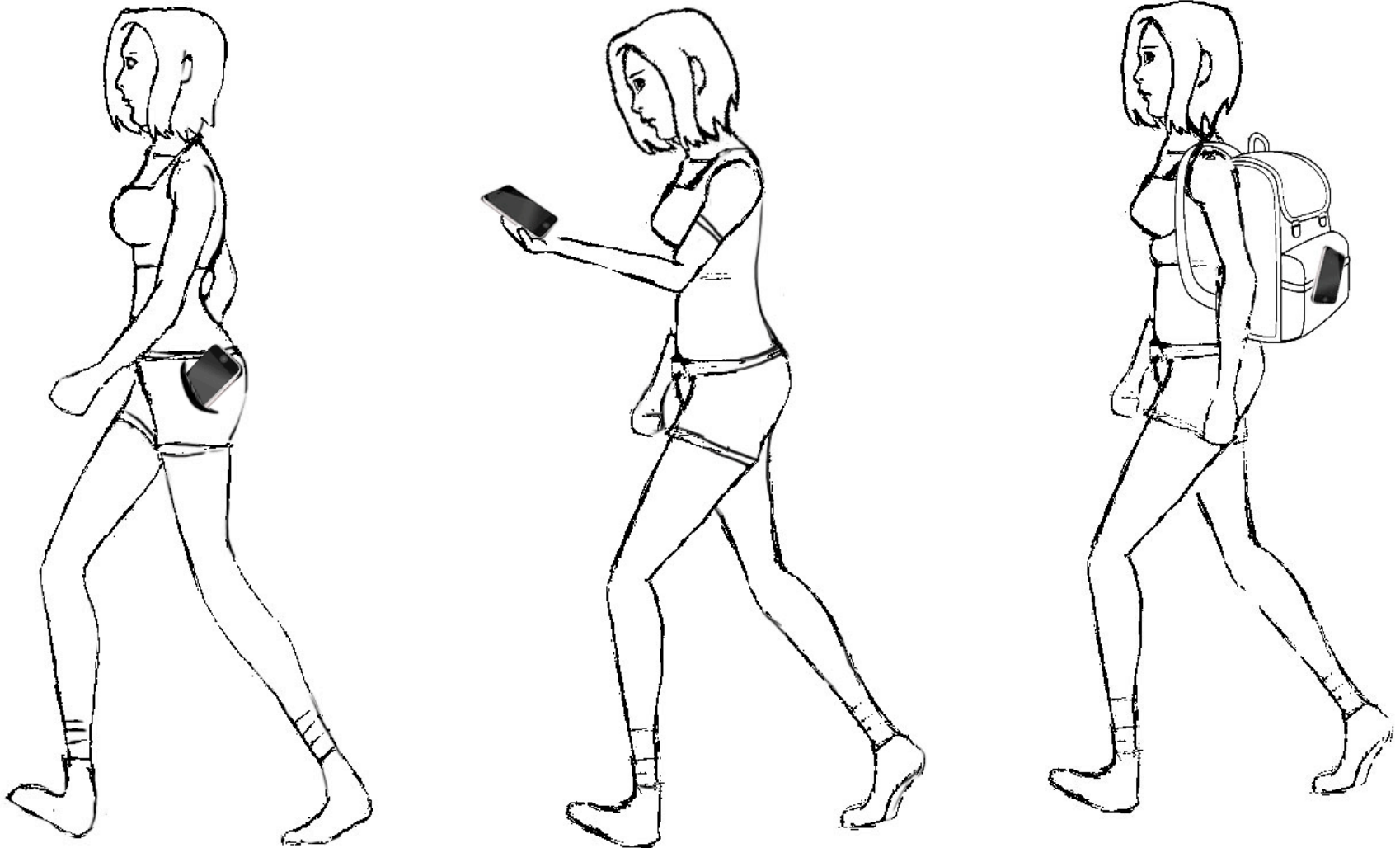


Walking
Direction

Walking Direction: The Definition



Walking Direction: The Definition

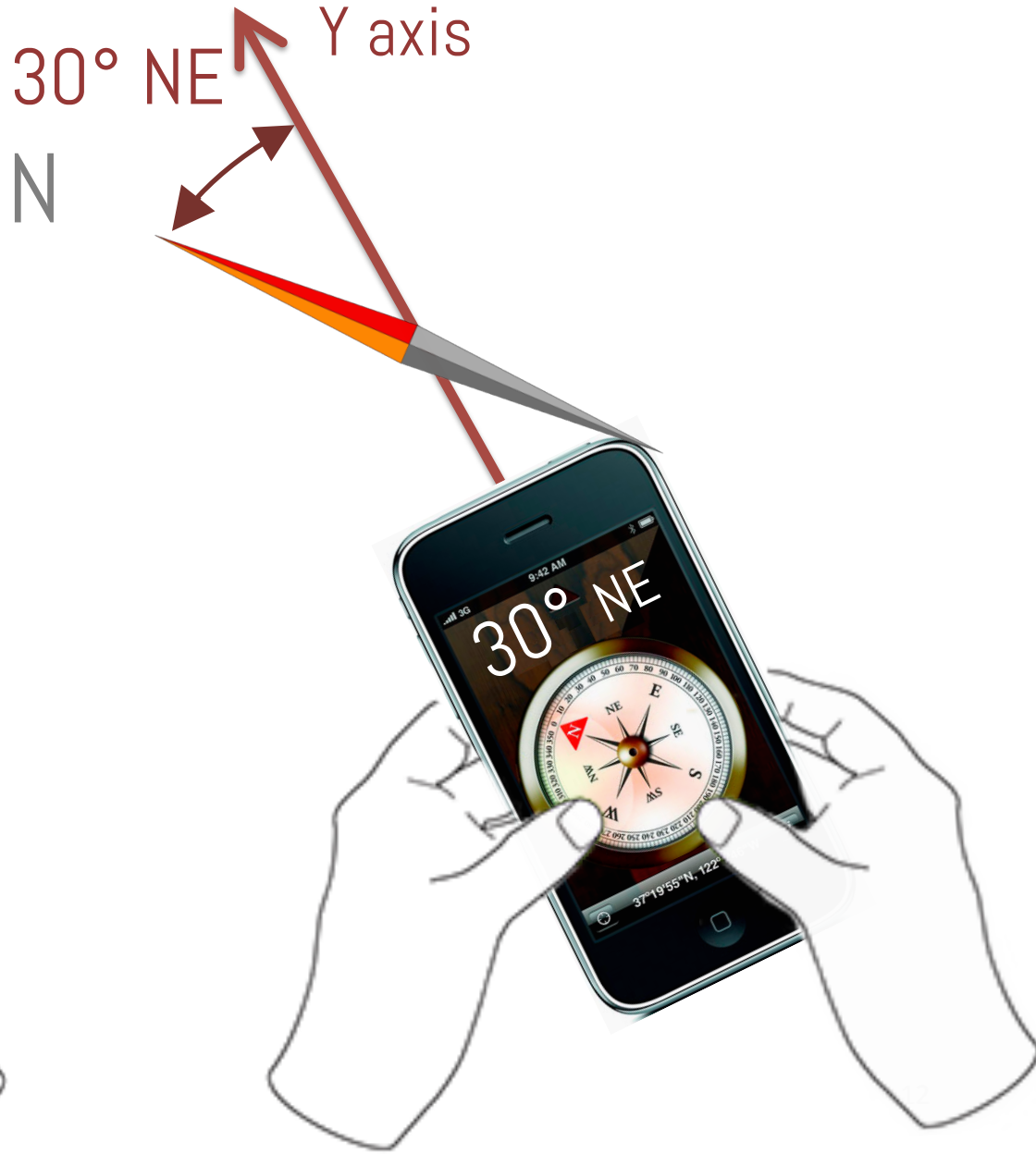


Why Not Compass ?

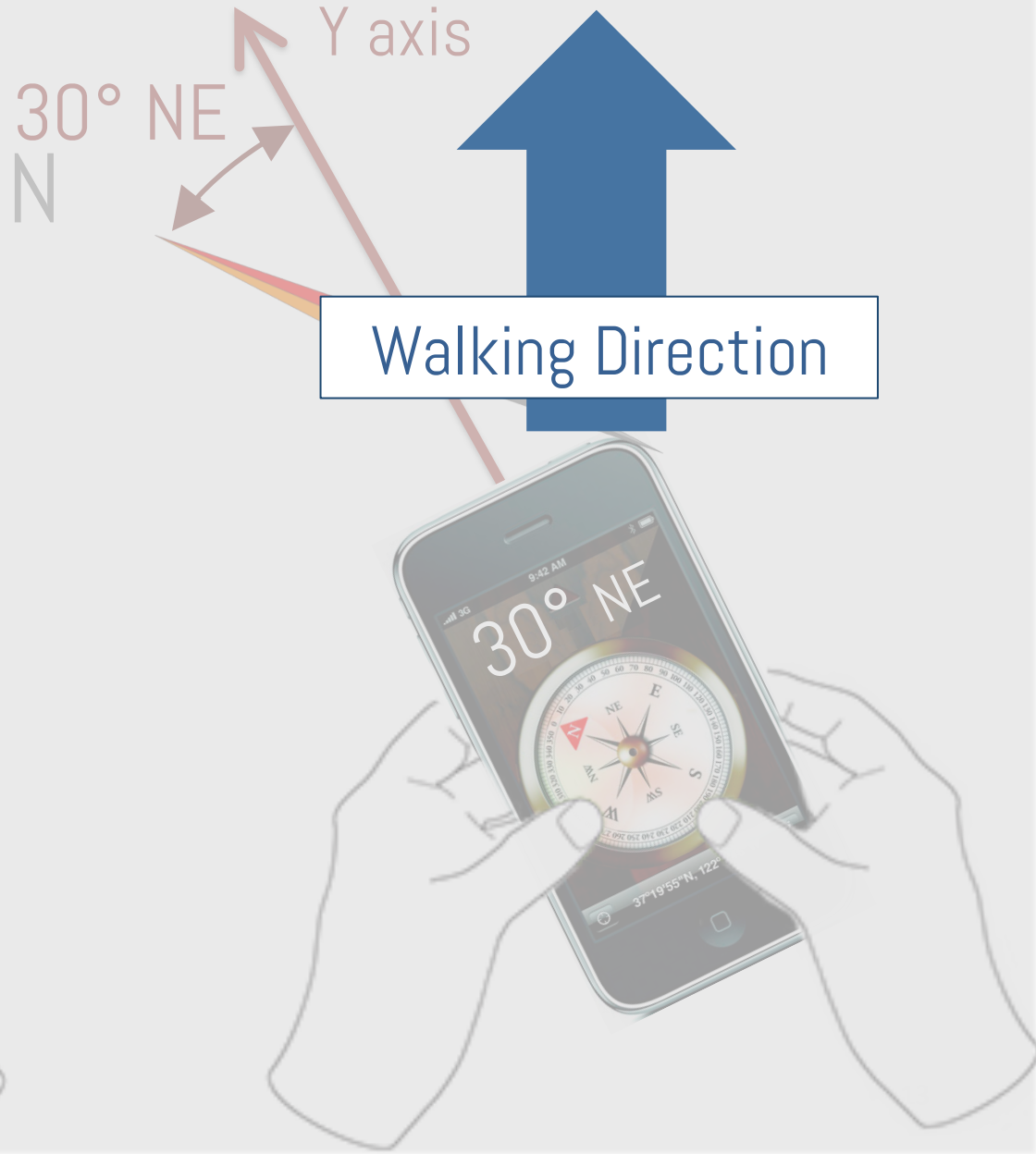
Why Not Compass?



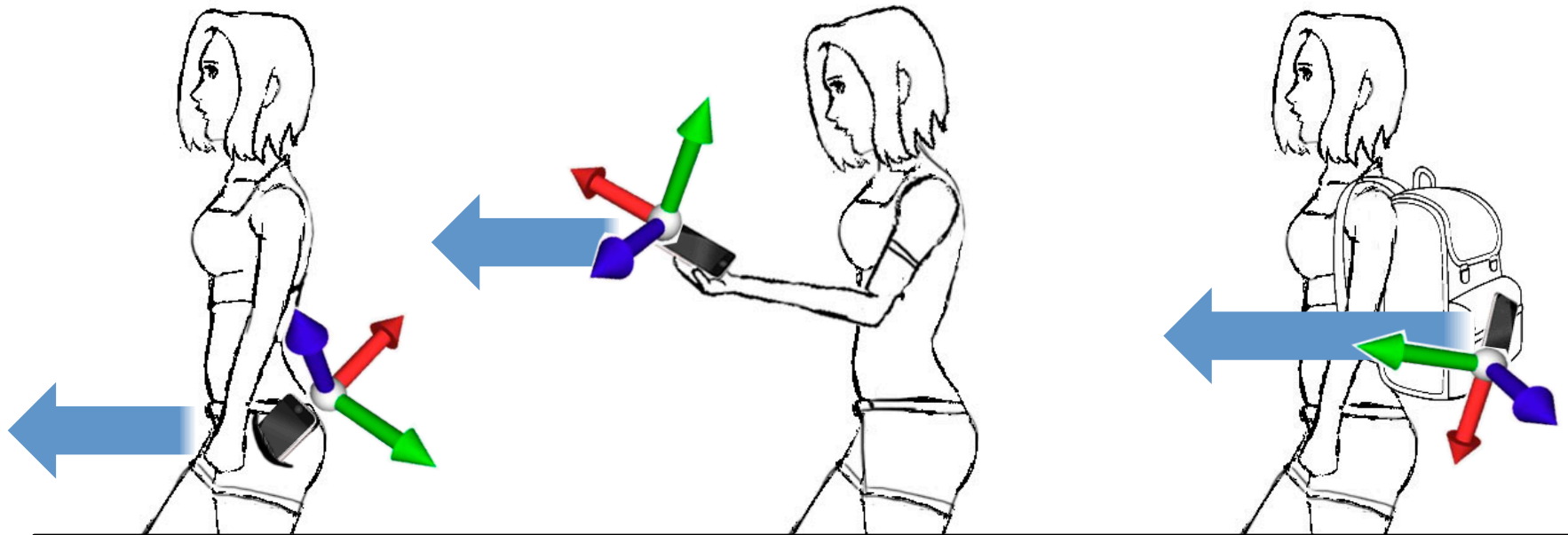
Why Not Compass?



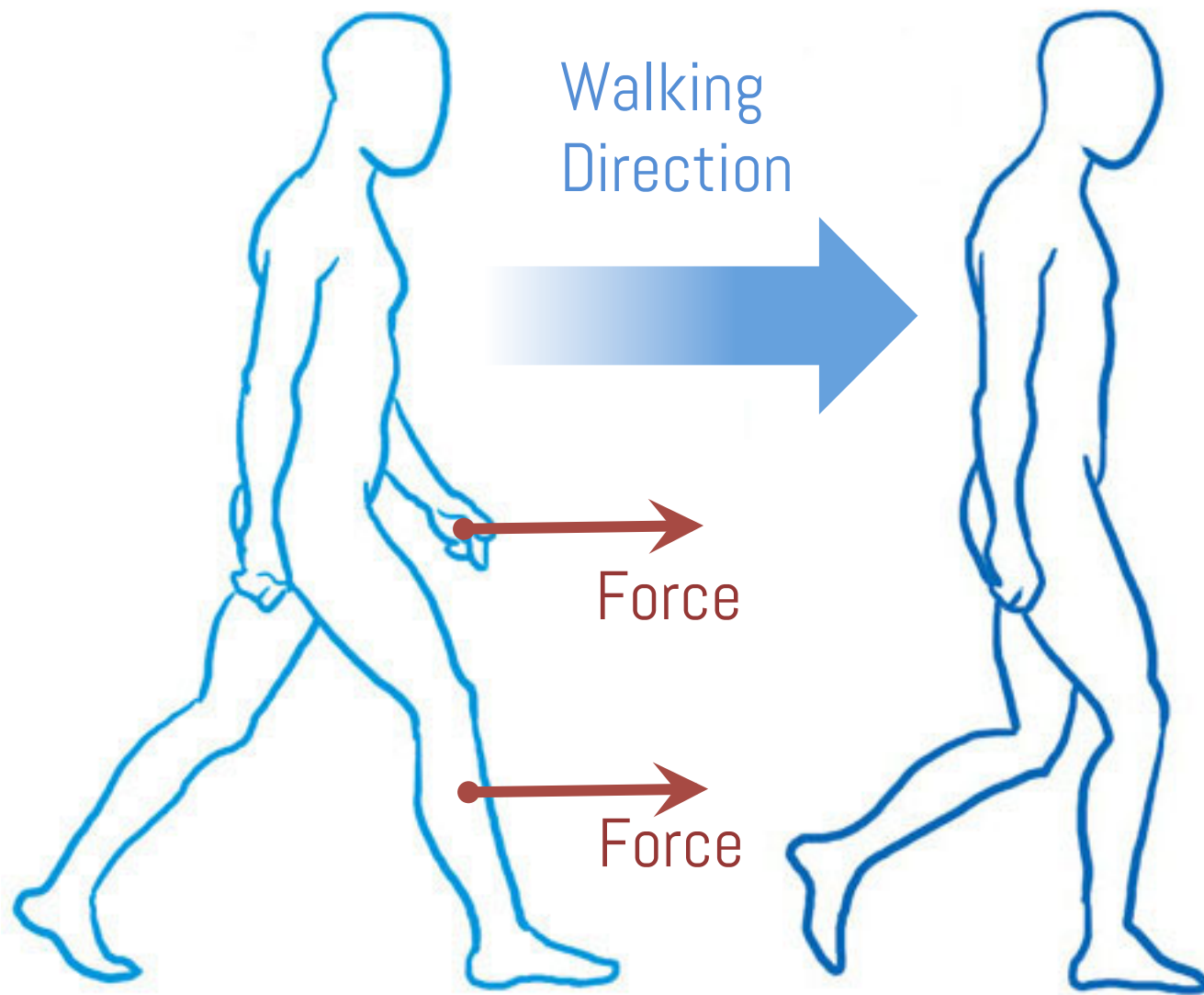
Why Not Compass?



Why Not Compass?

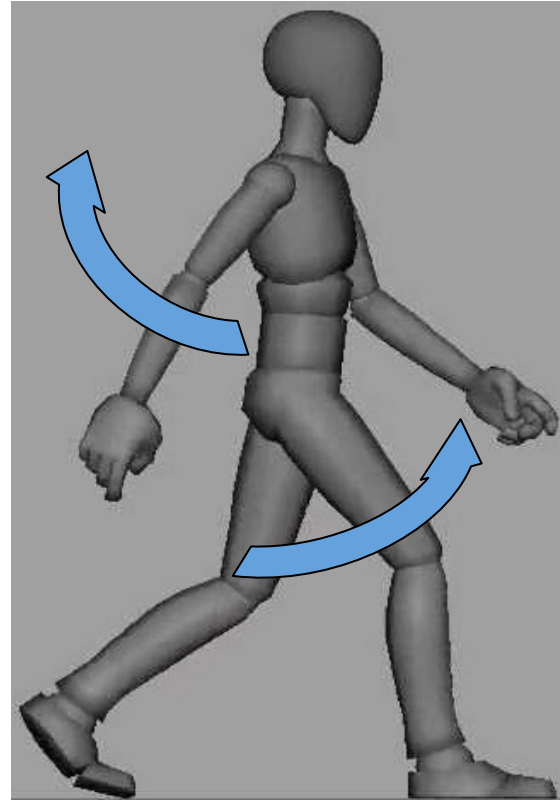
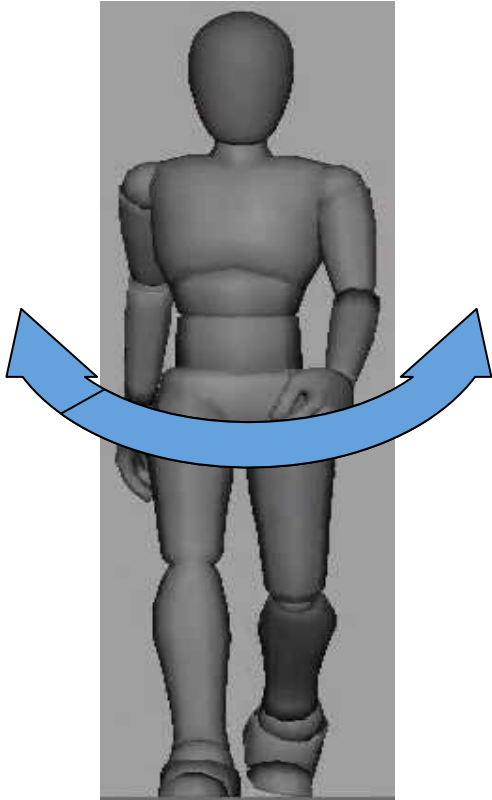


Compass Direction $\neq$ Walking Direction



Challenges

Challenge 1: Finding the Right Force



Complex combination of forces

Challenge 2: Finding Common Solution

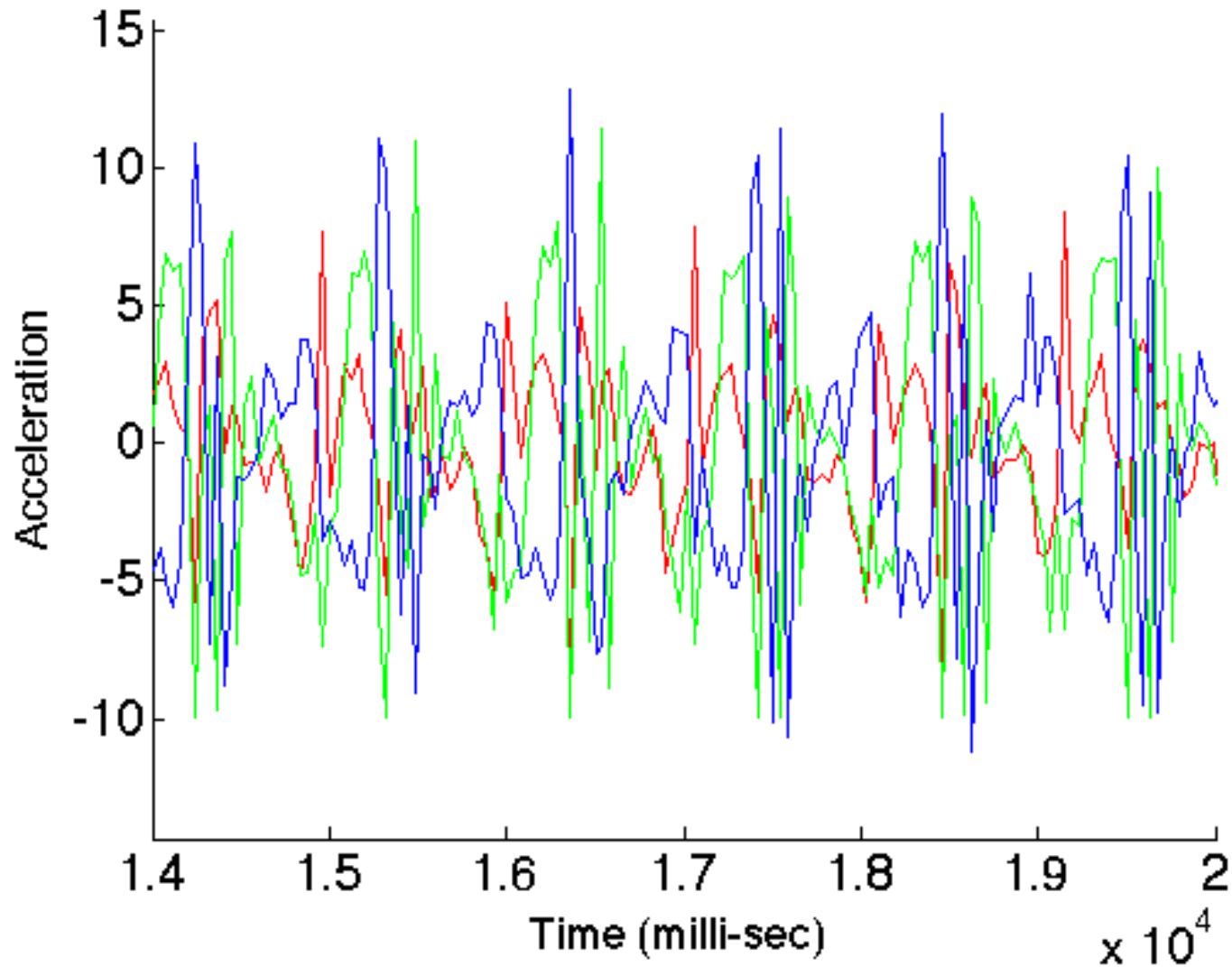


Different walking patterns



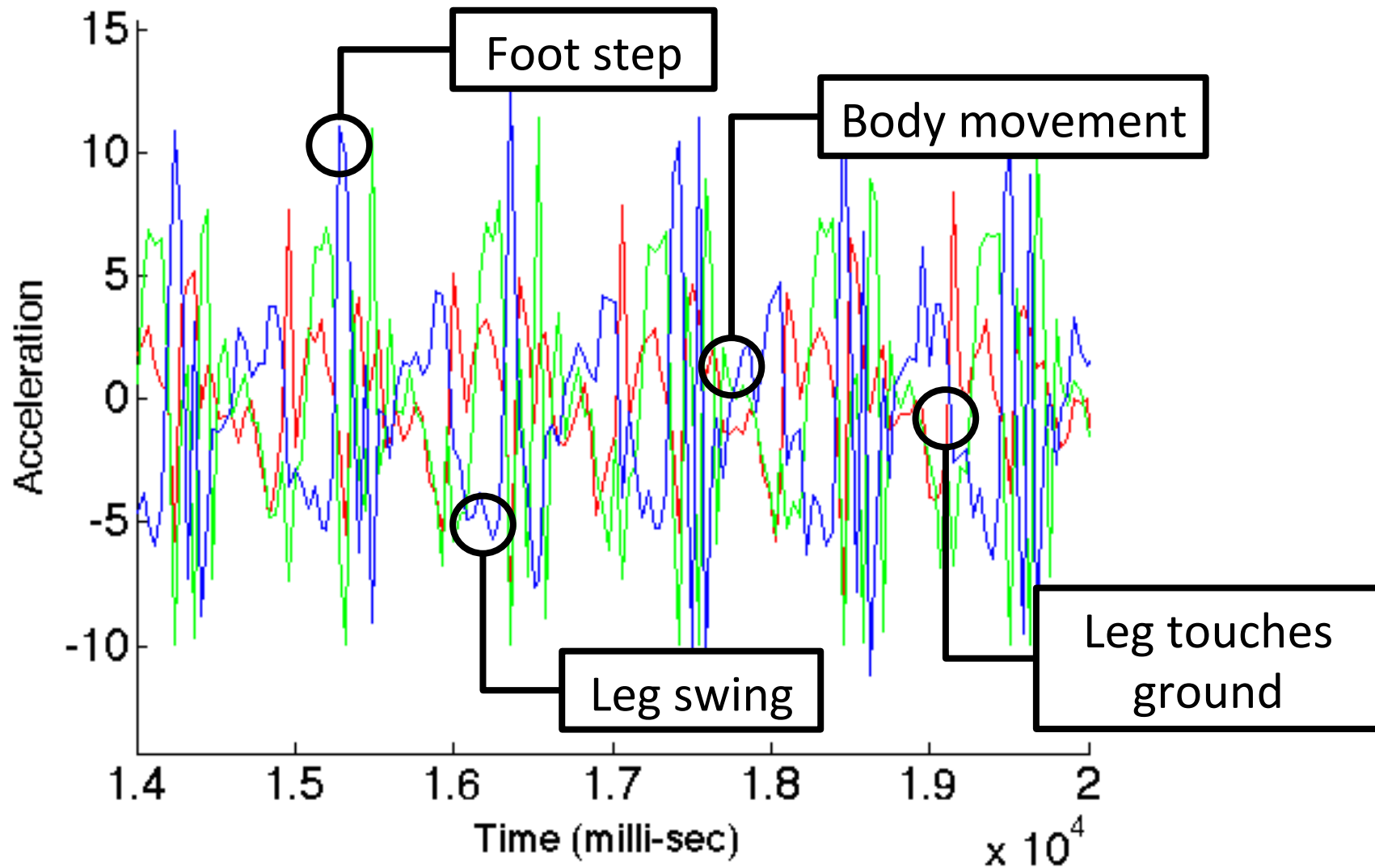
Different phone locations

Understanding a Walk Signal



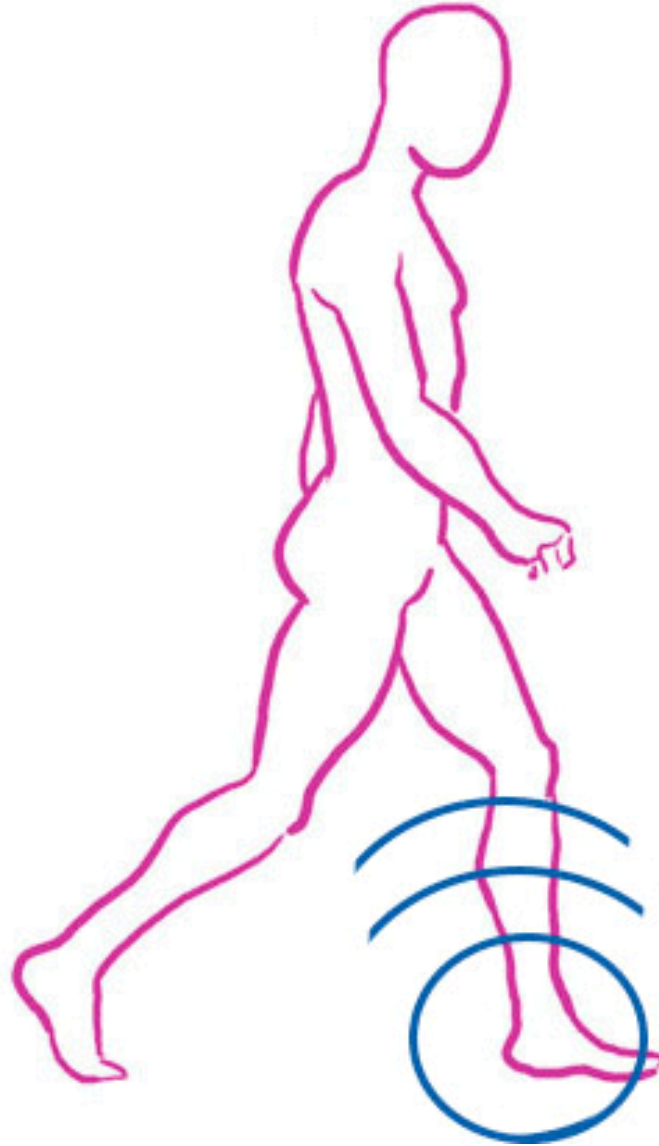
Raw accelerometer signal
Phone Location: Pants pocket

Understanding a Walk Signal



Raw accelerometer signal
Phone Location: Pants pocket

Segmentation of the Signal: Key Intuition

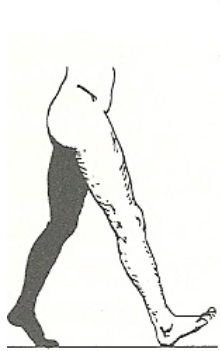


Technique Overview

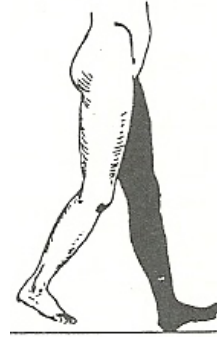
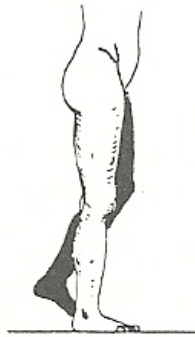
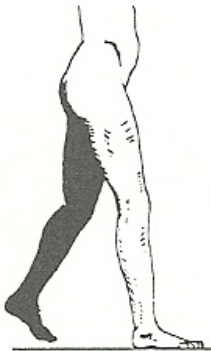
Anatomy of a Human Walk

Stance Phase (60%)

Swing Phase (40%)



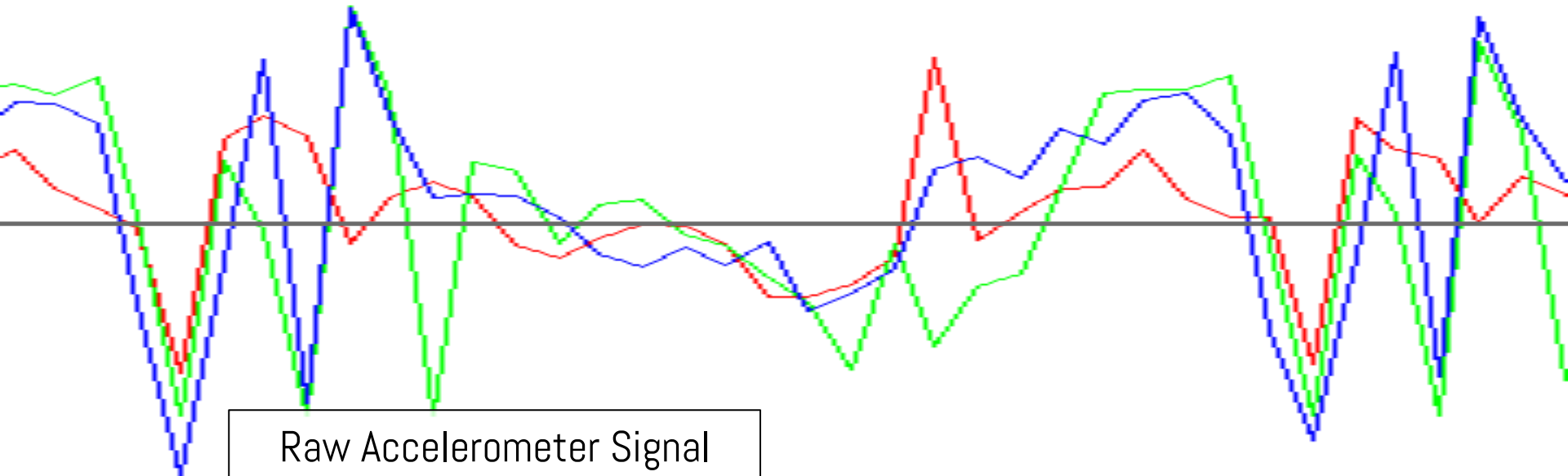
Heel-touch
(Right)



Heel-touch
(Left)



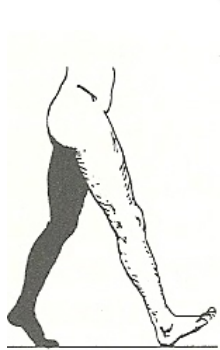
Heel-touch
(Right)



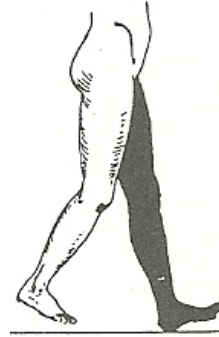
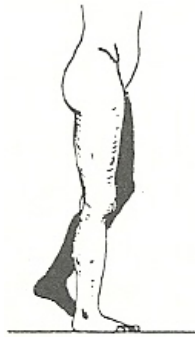
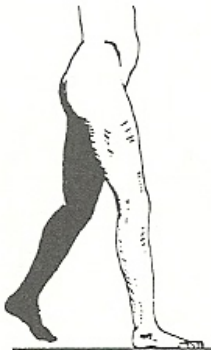
Anatomy of a Human Walk

Stance Phase (60%)

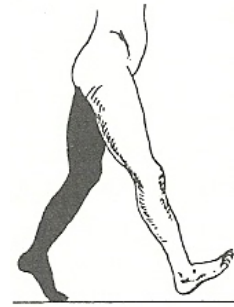
Swing Phase (40%)



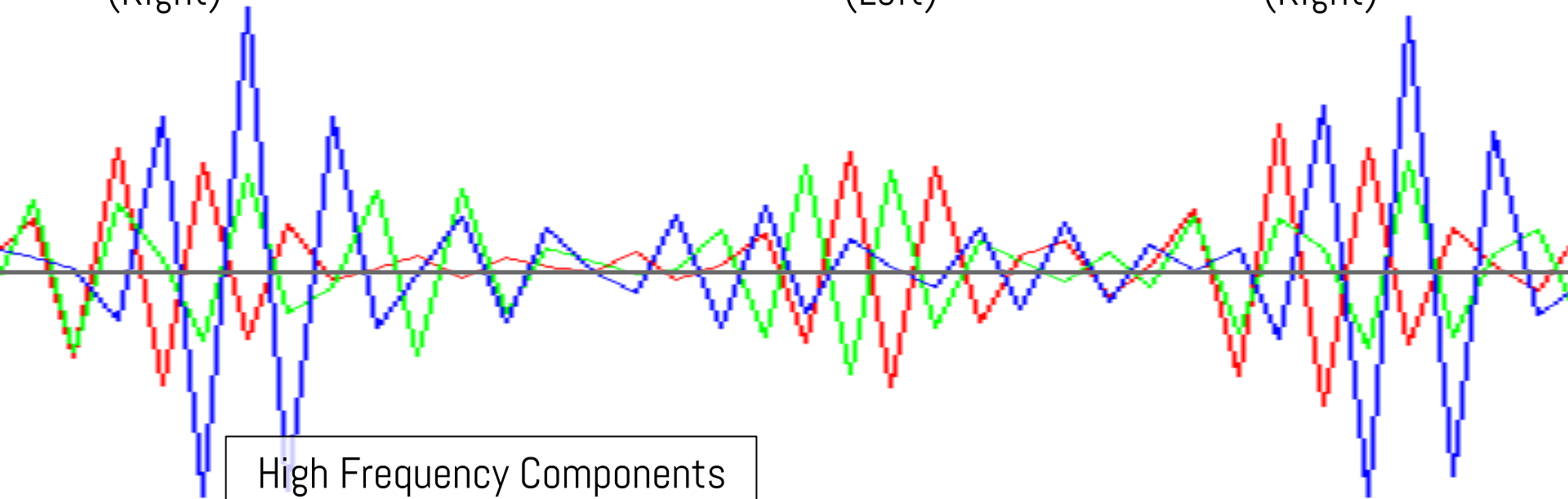
Heel-touch
(Right)



Heel-touch
(Left)



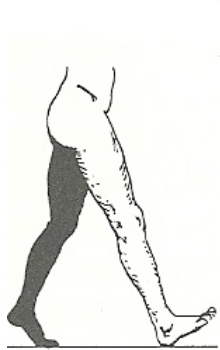
Heel-touch
(Right)



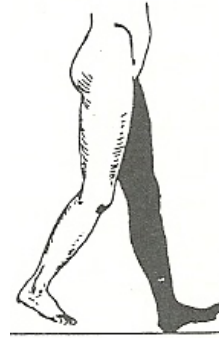
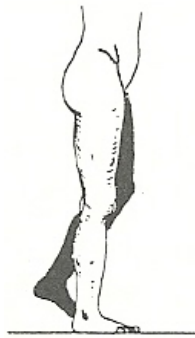
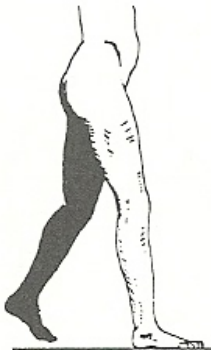
Anatomy of a Human Walk

Stance Phase (60%)

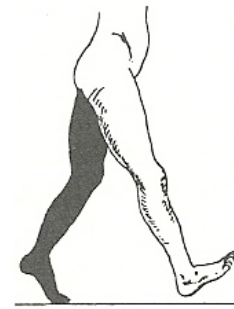
Swing Phase (40%)



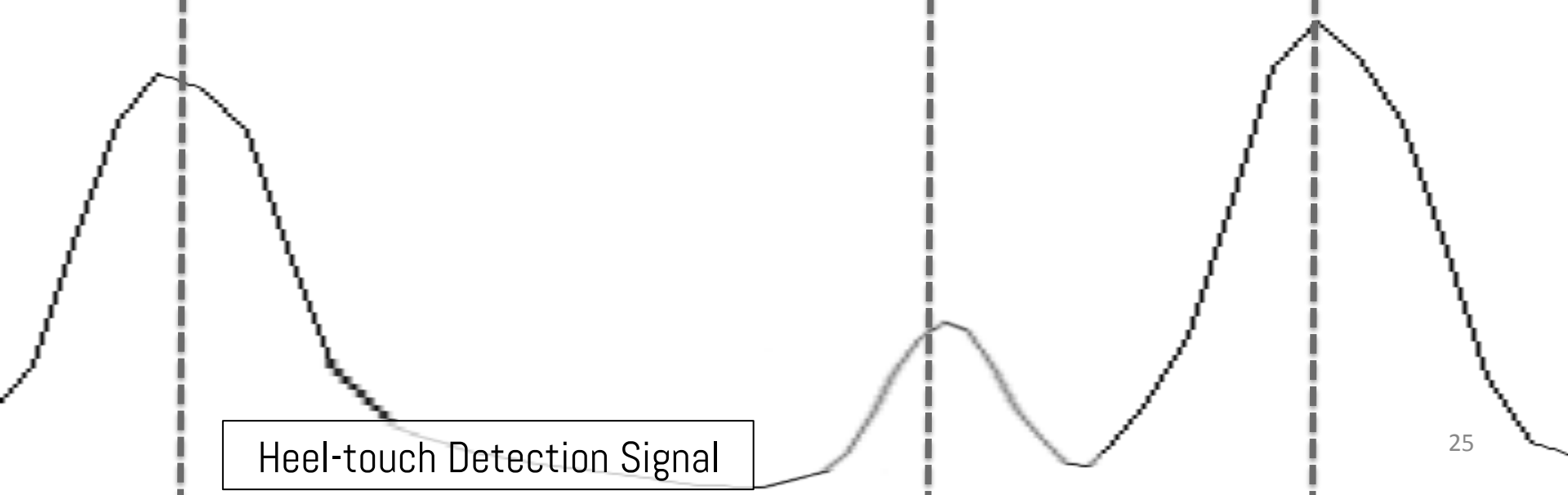
Heel-touch
(Right)



Heel-touch
(Left)



Heel-touch
(Right)

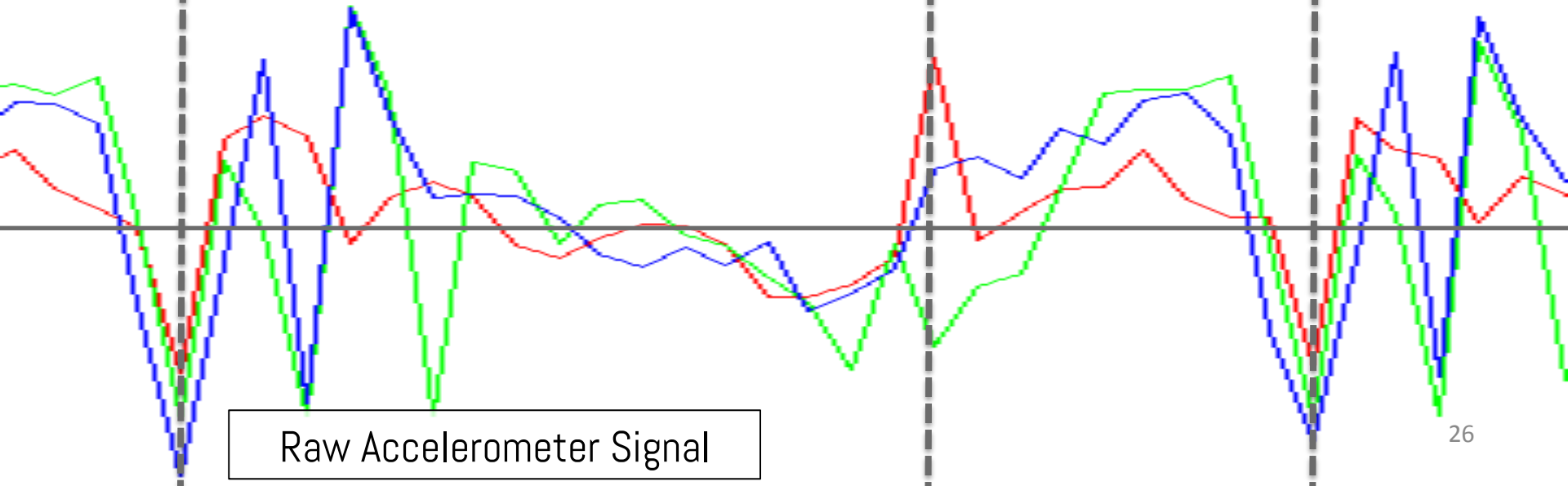
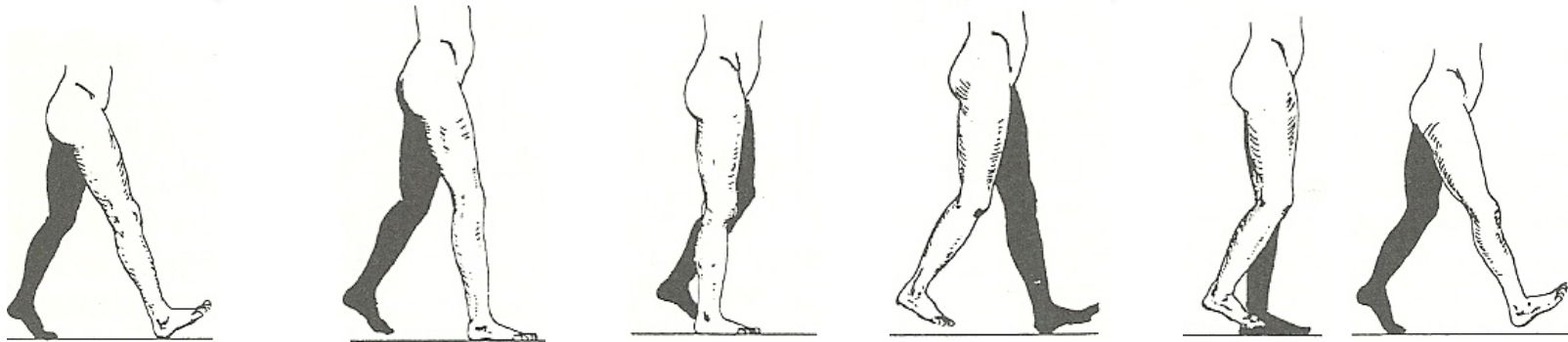


Heel-touch Detection Signal

Anatomy of a Human Walk

Stance Phase (60%)

Swing Phase (40%)

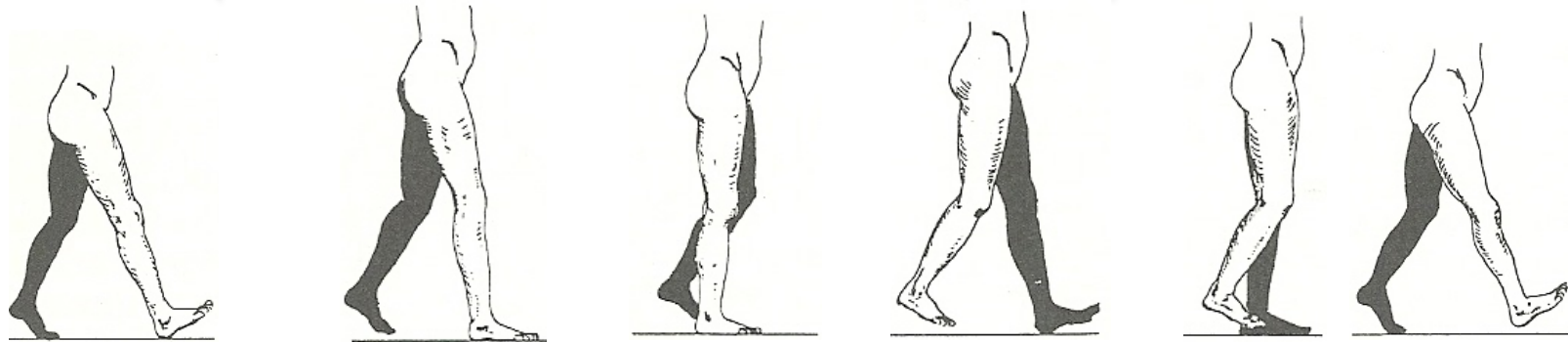


Raw Accelerometer Signal

Anatomy of a Human Walk

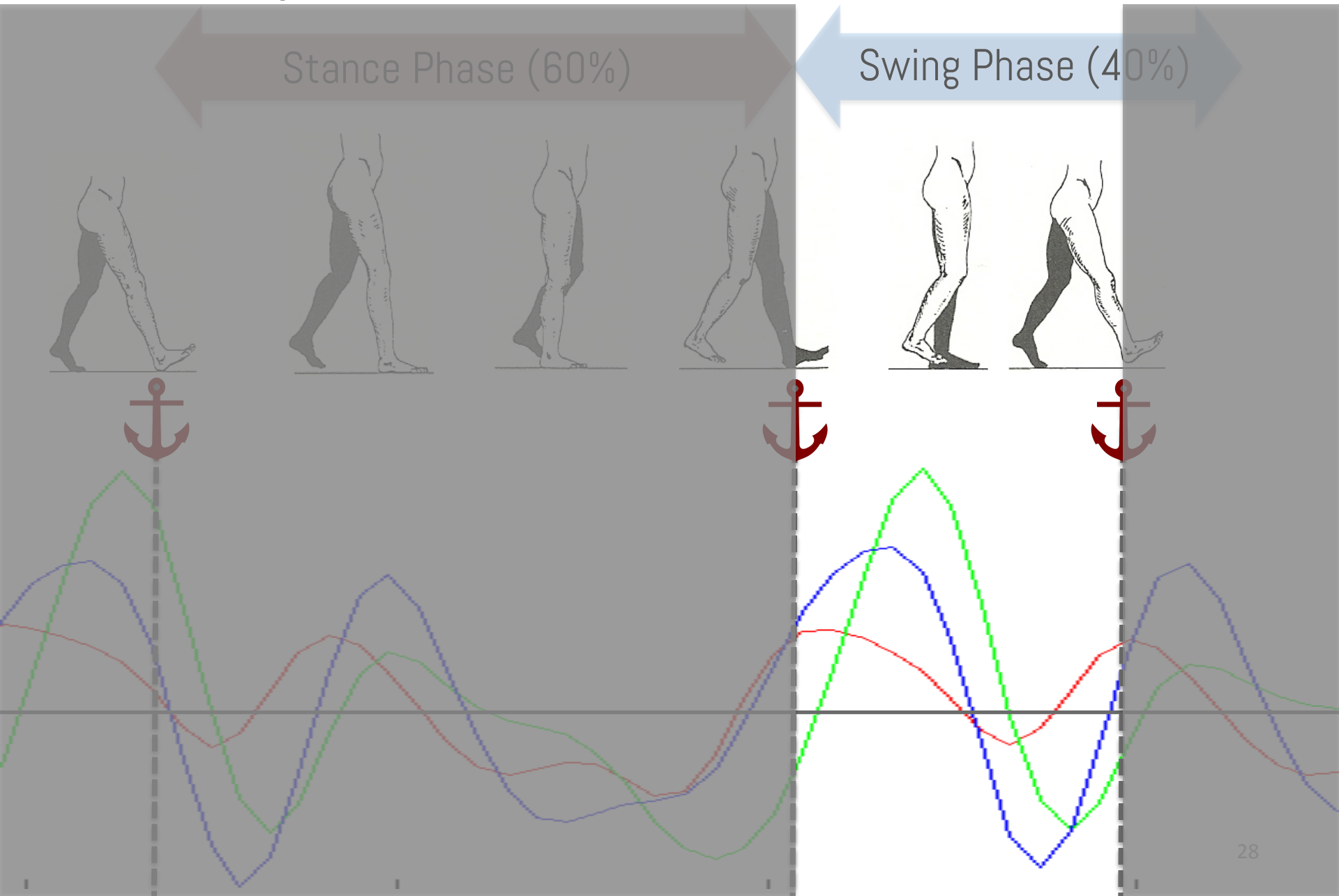
Stance Phase (60%)

Swing Phase (40%)

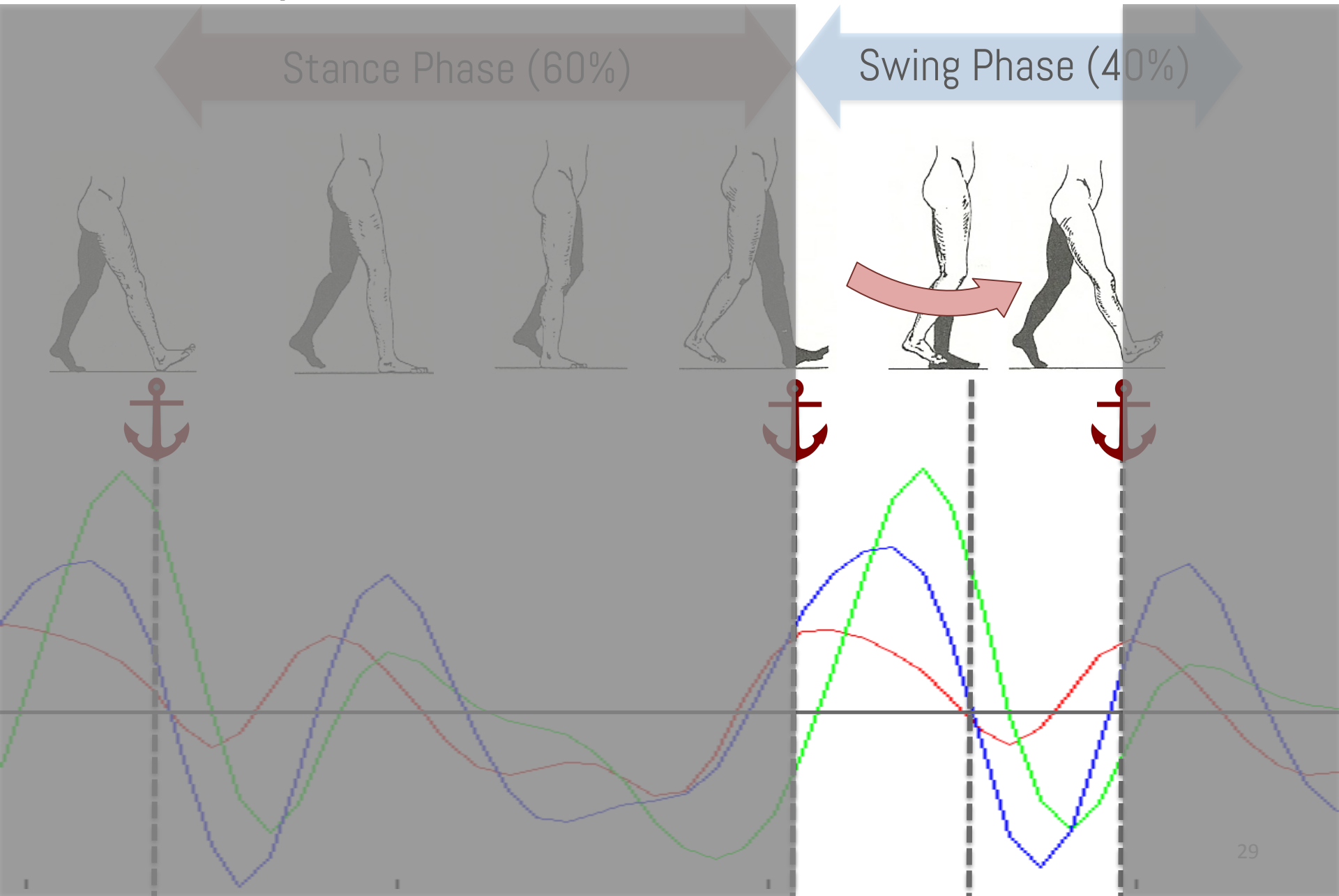


Low Frequency Components

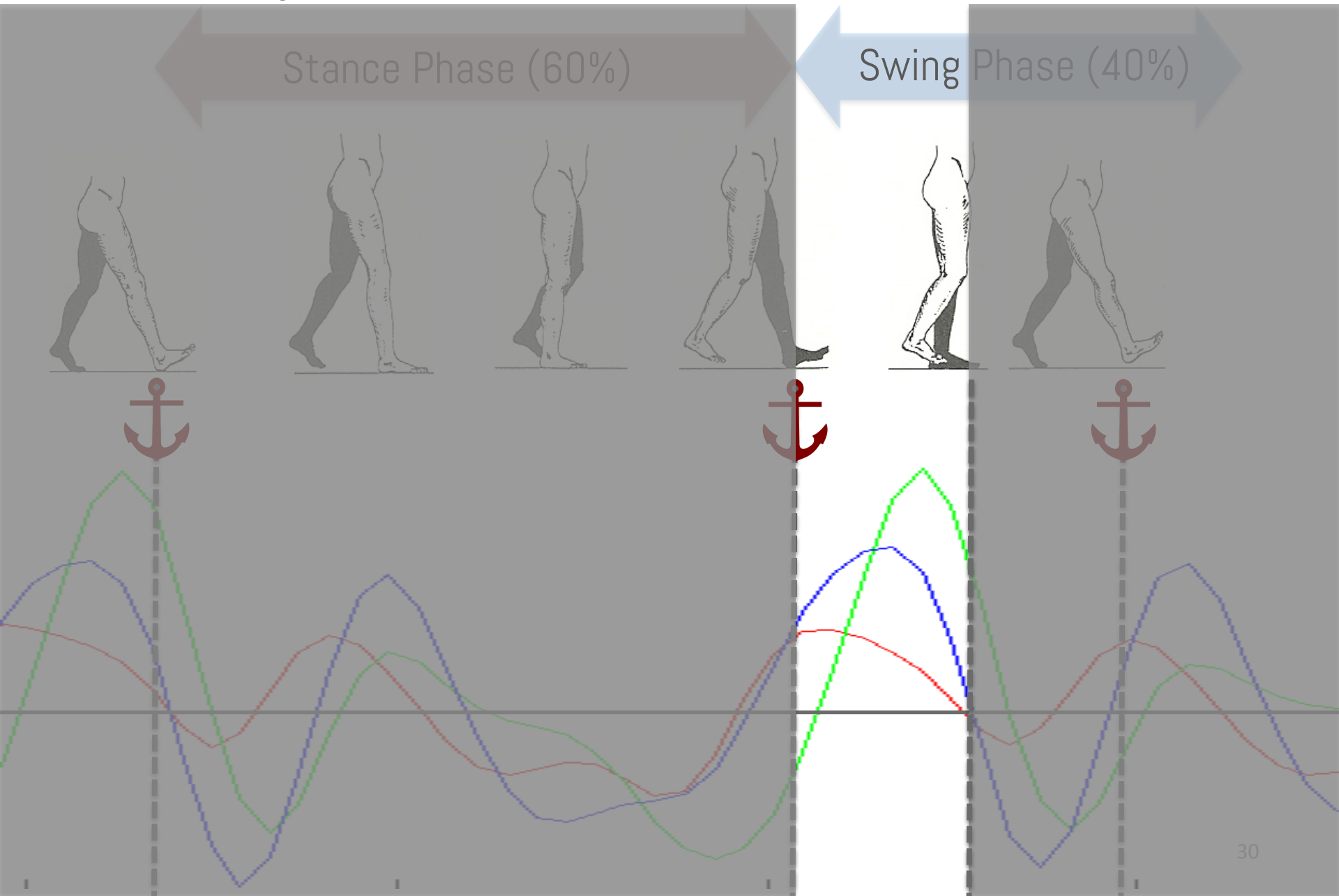
Anatomy of a Human Walk



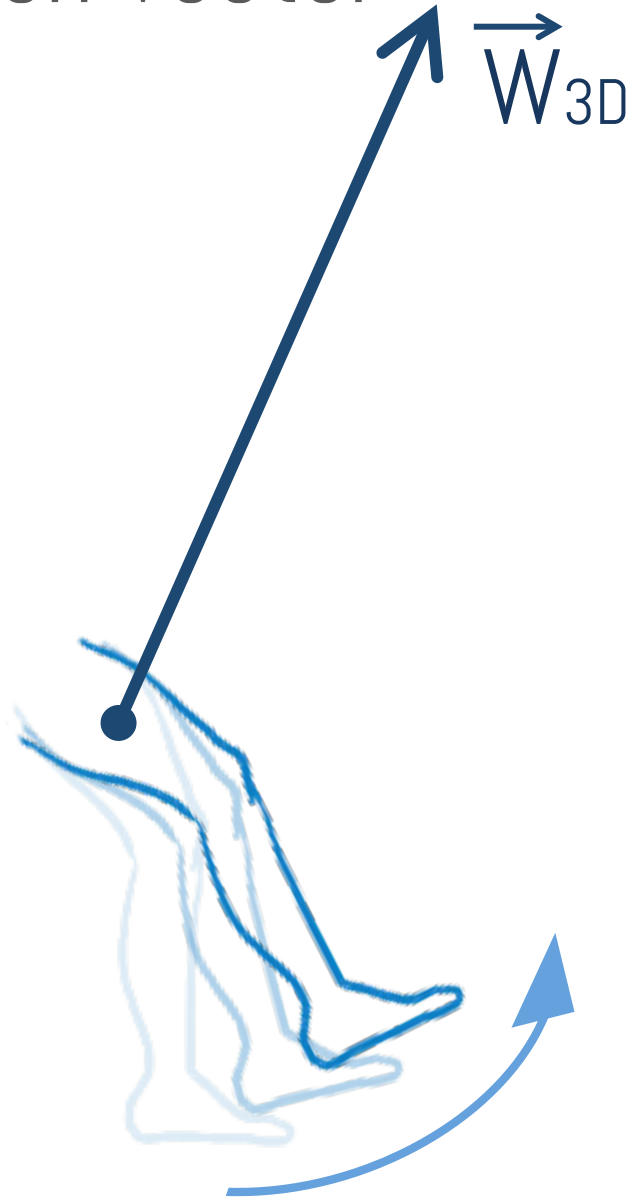
Anatomy of a Human Walk



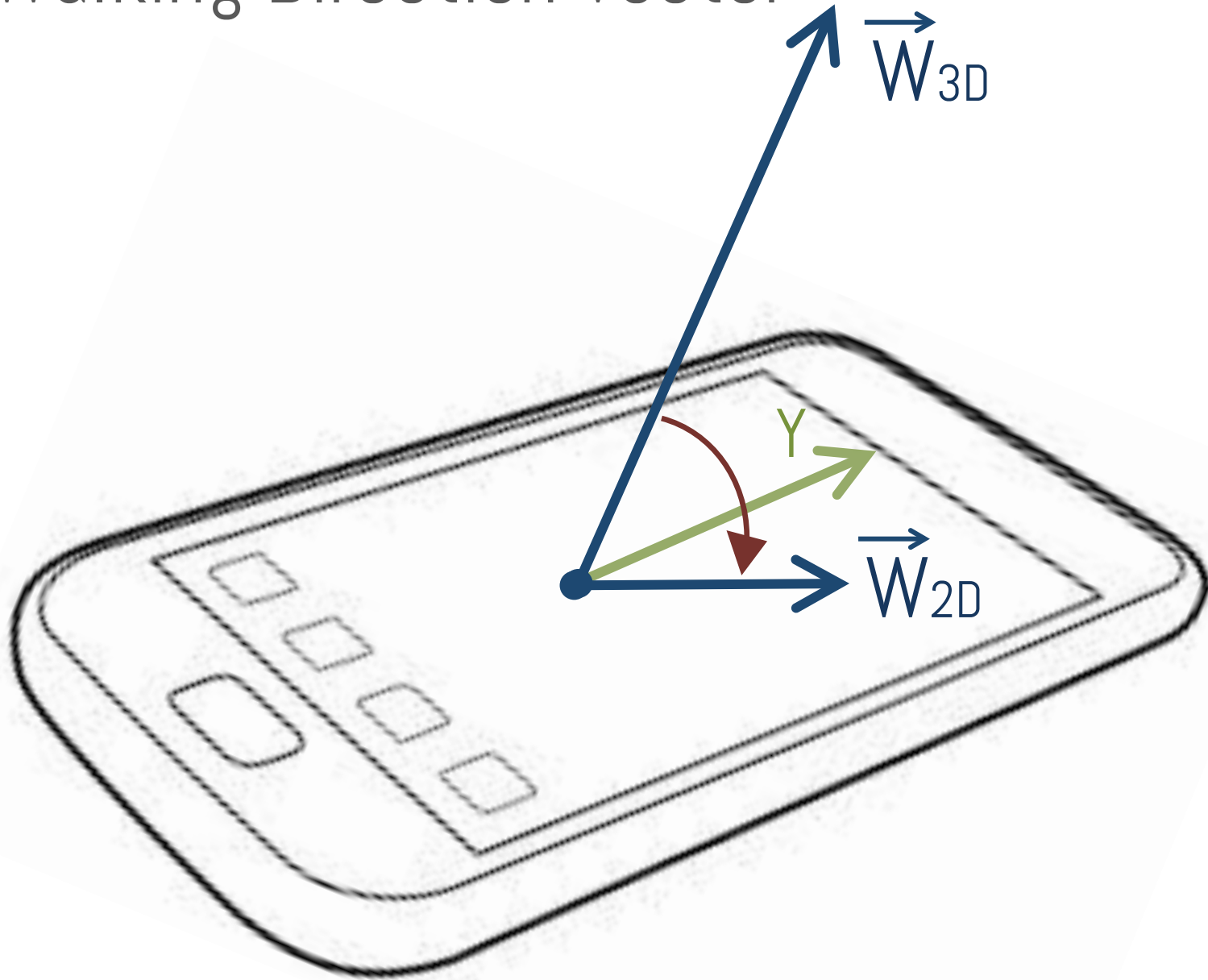
Anatomy of a Human Walk



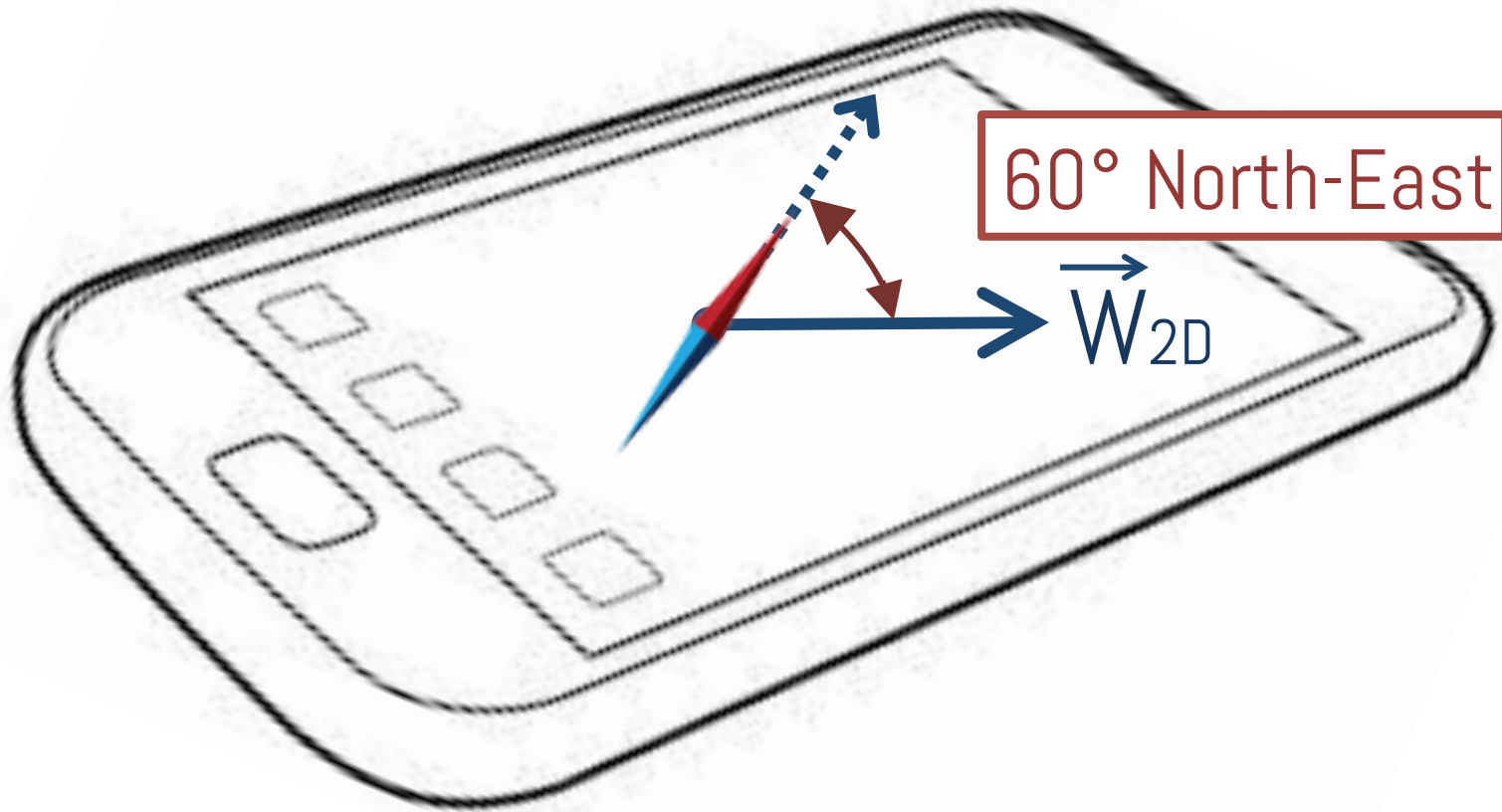
Walking Direction Vector



Walking Direction Vector

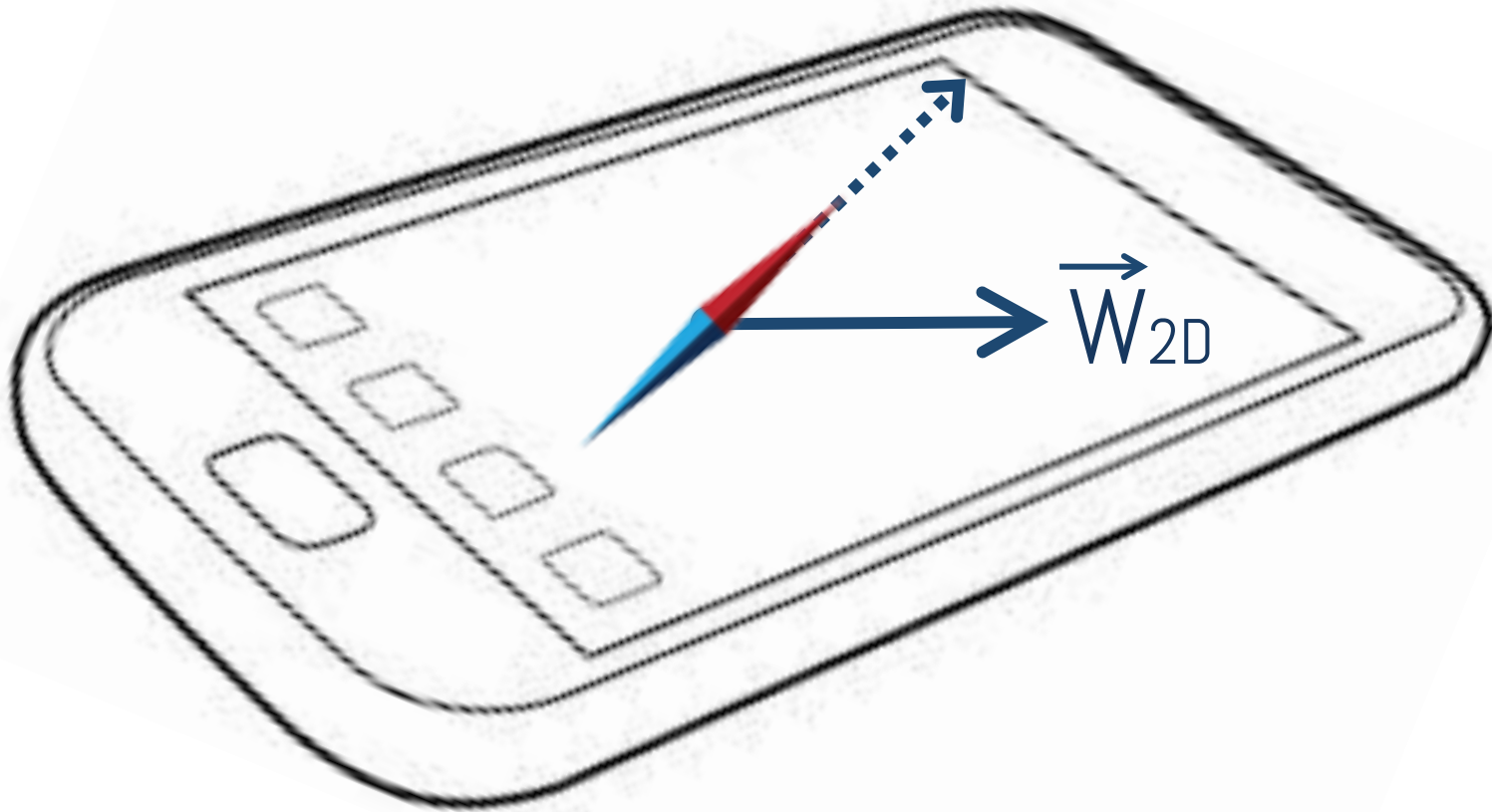


Global Walking Direction

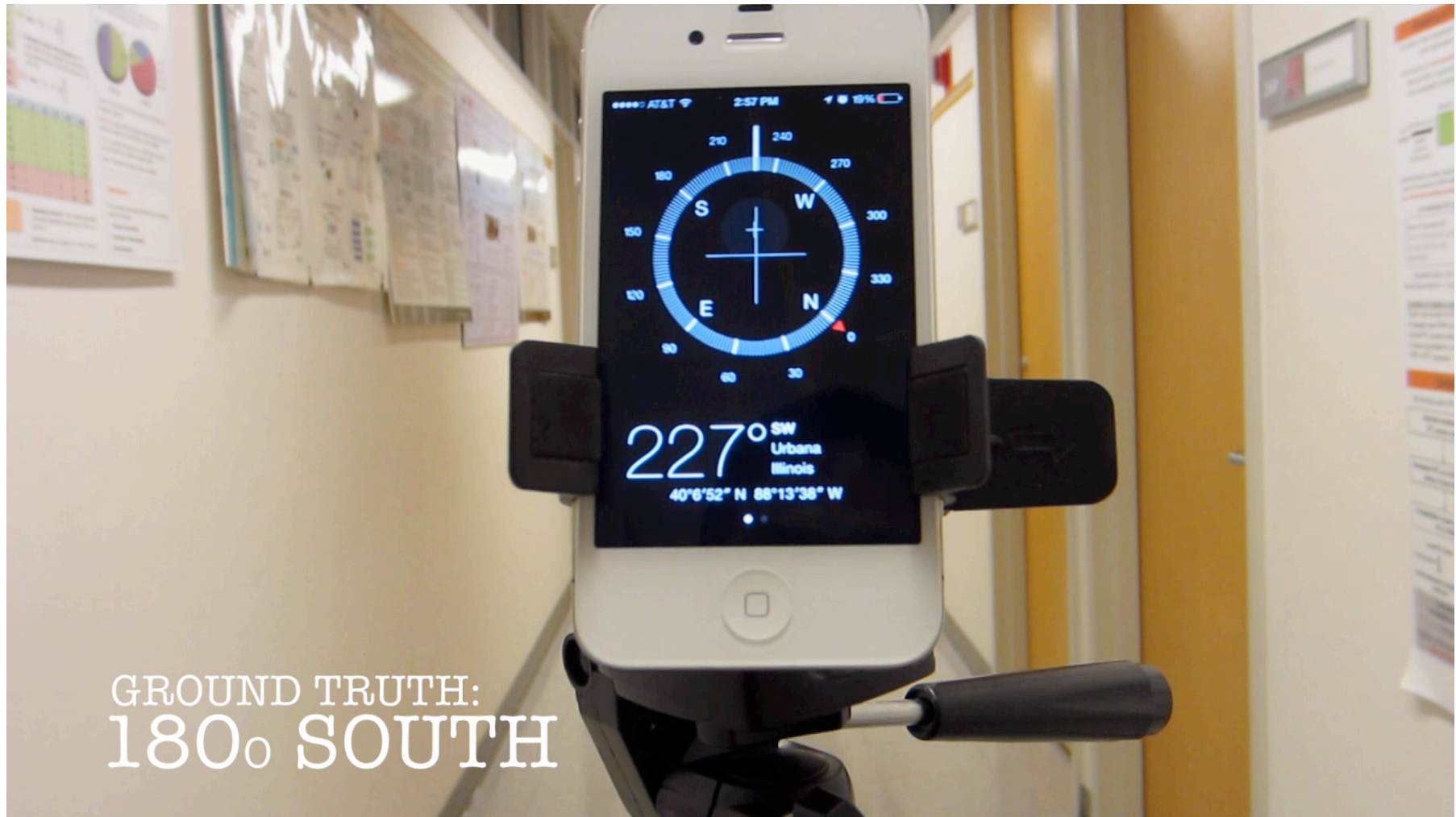


But...

Global Walking Direction

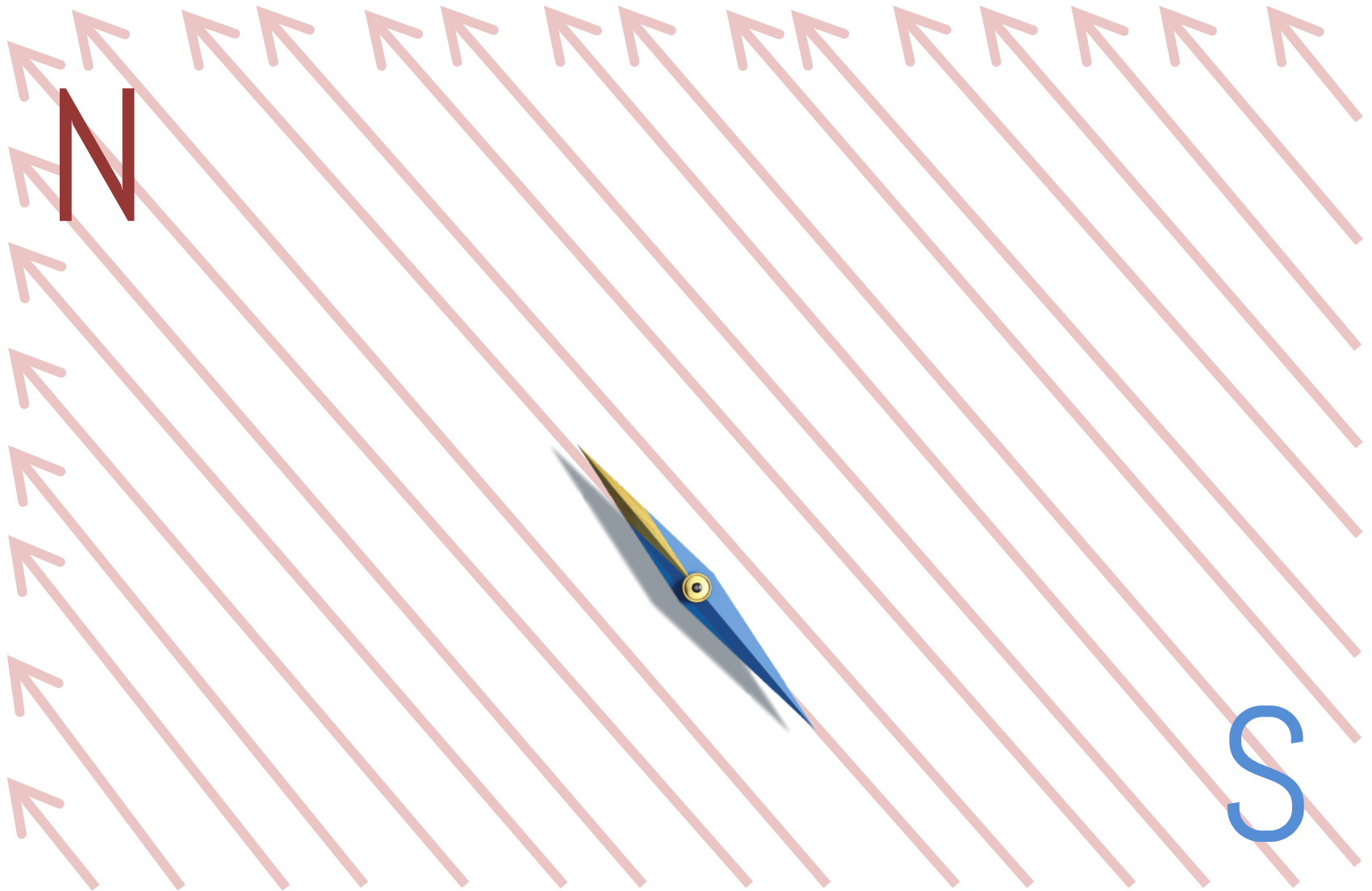


Compass: How Reliable is this?

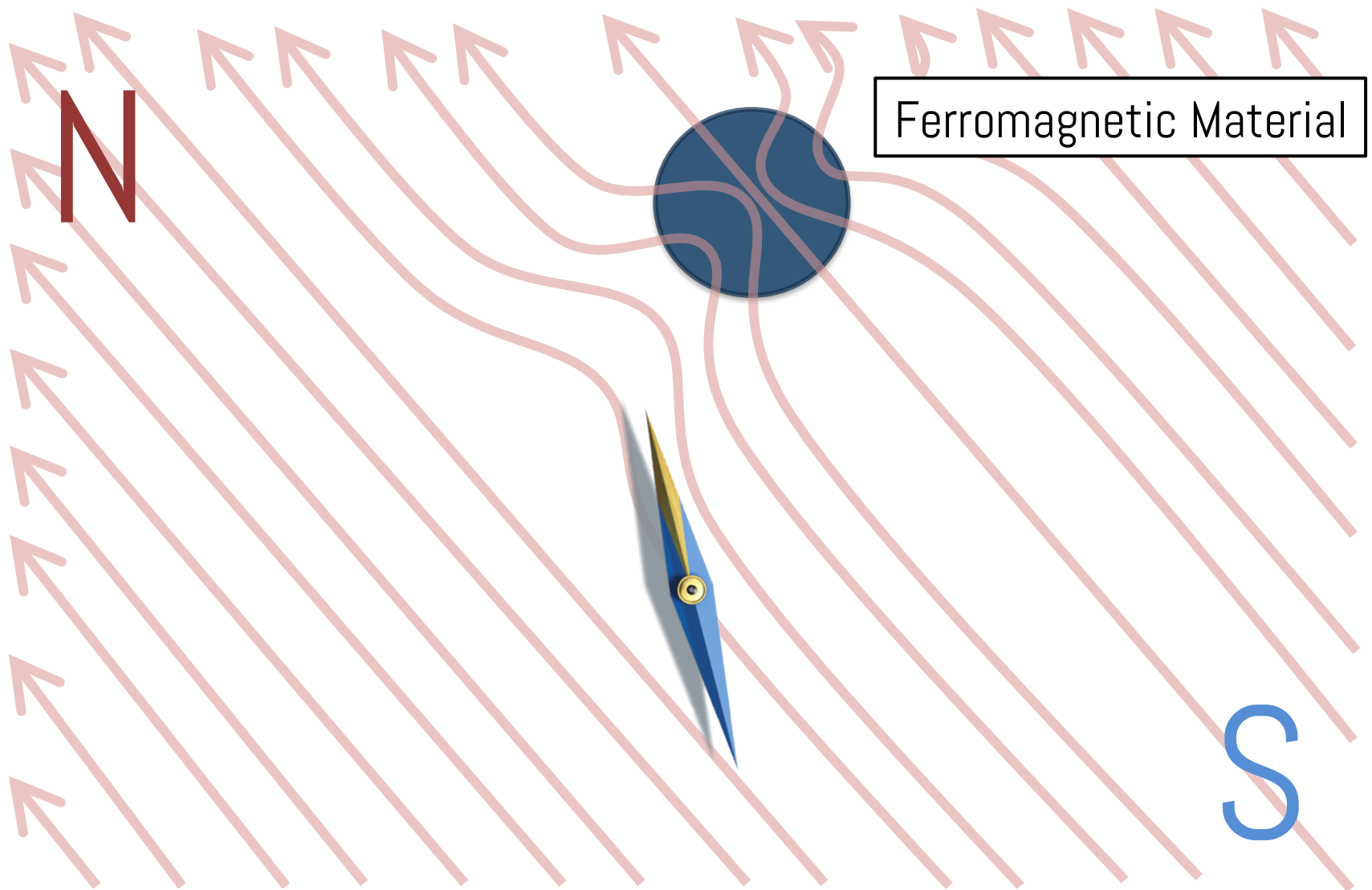


Compass Correction

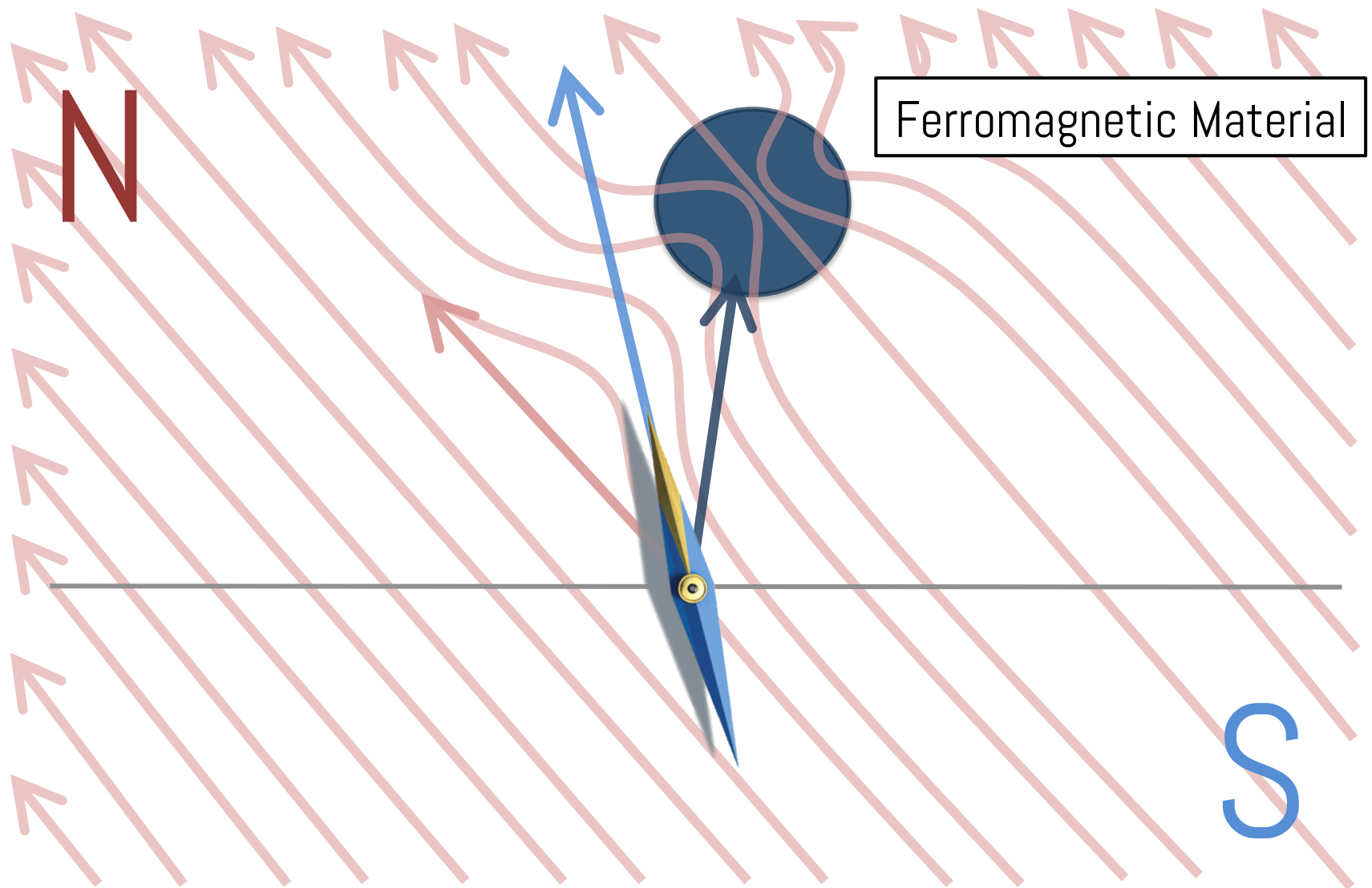
Compass: How It Works



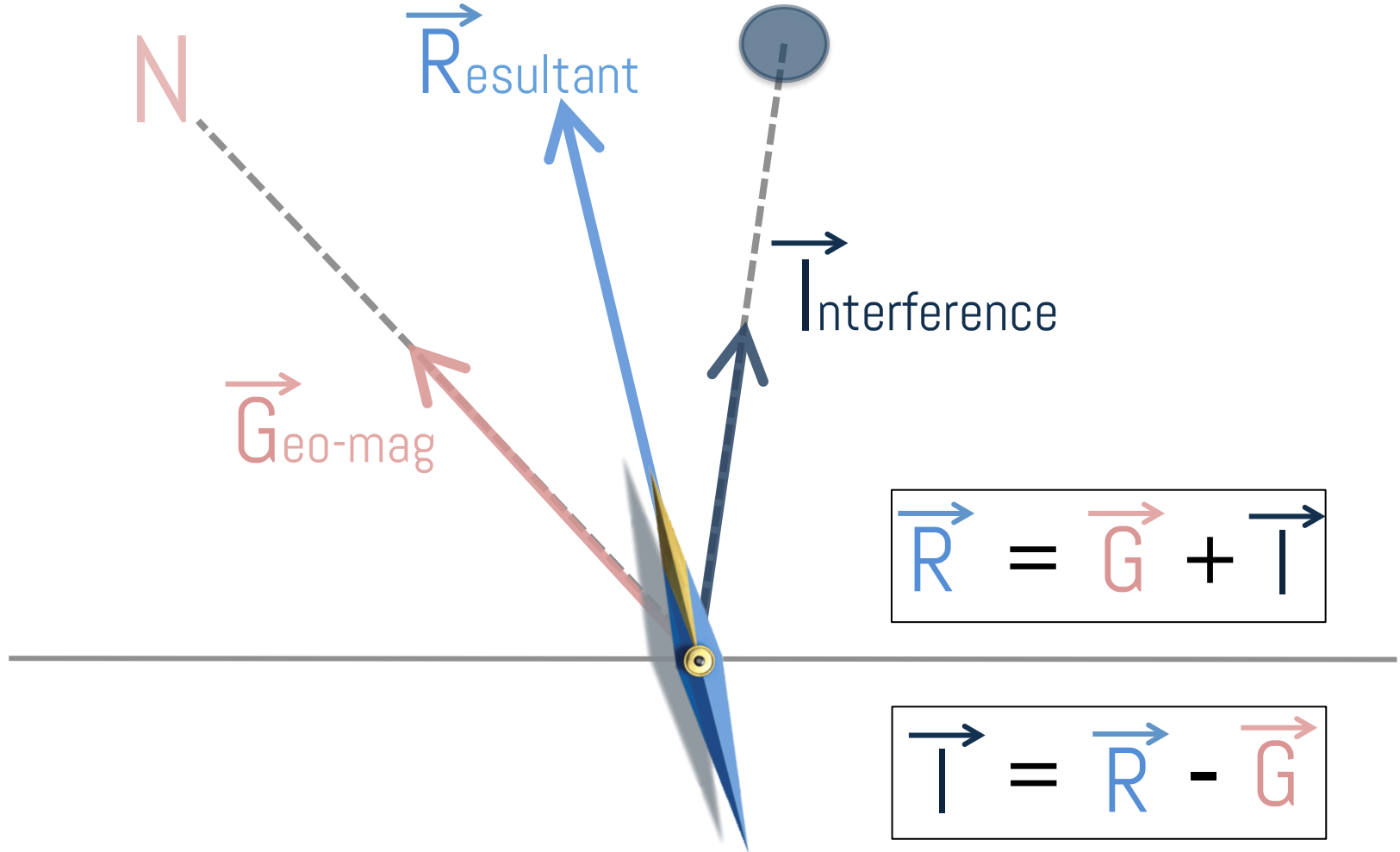
Compass: Effect of Interference



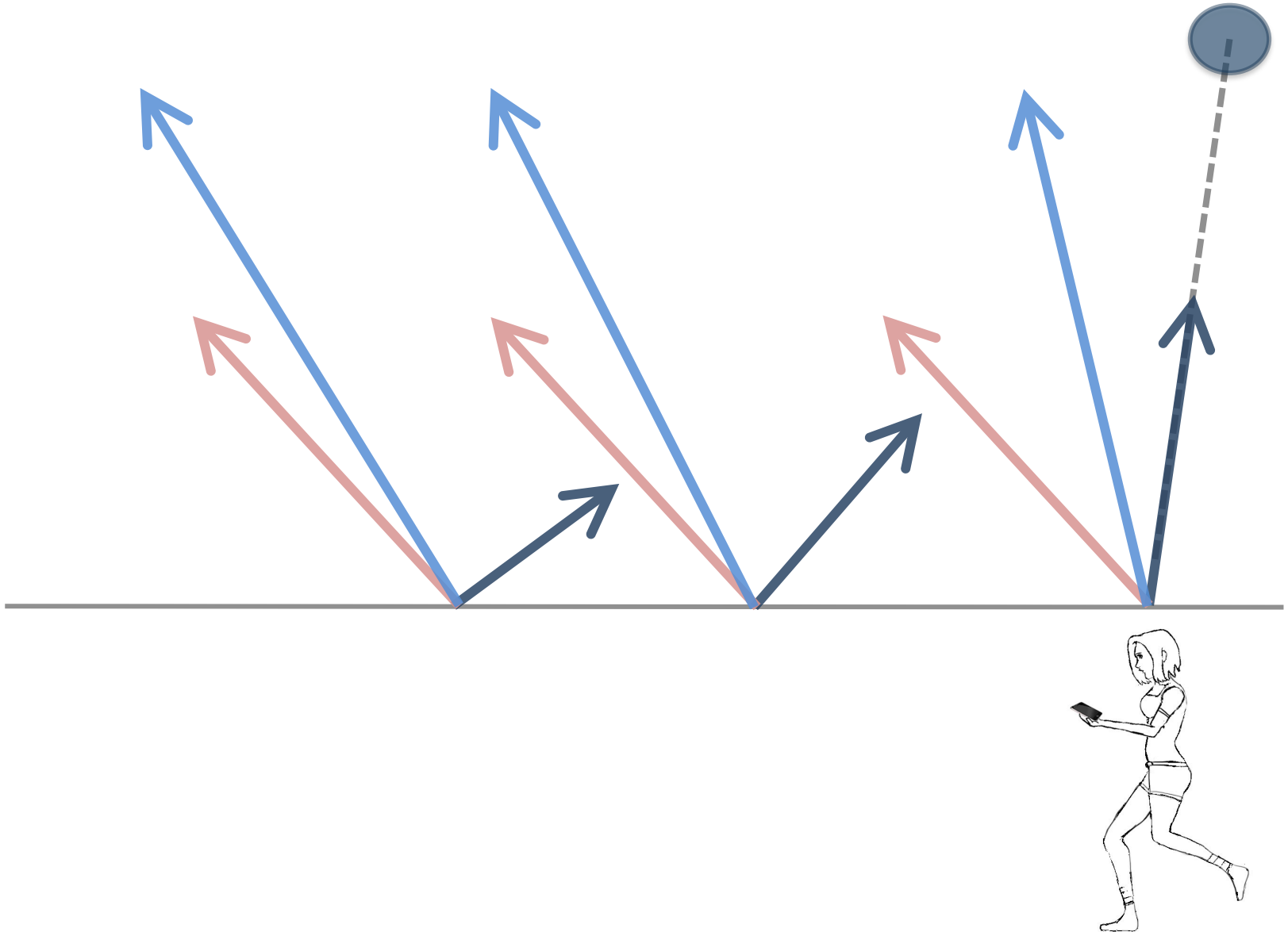
Compass: Effect of Interference



Compass: Effect of Interference

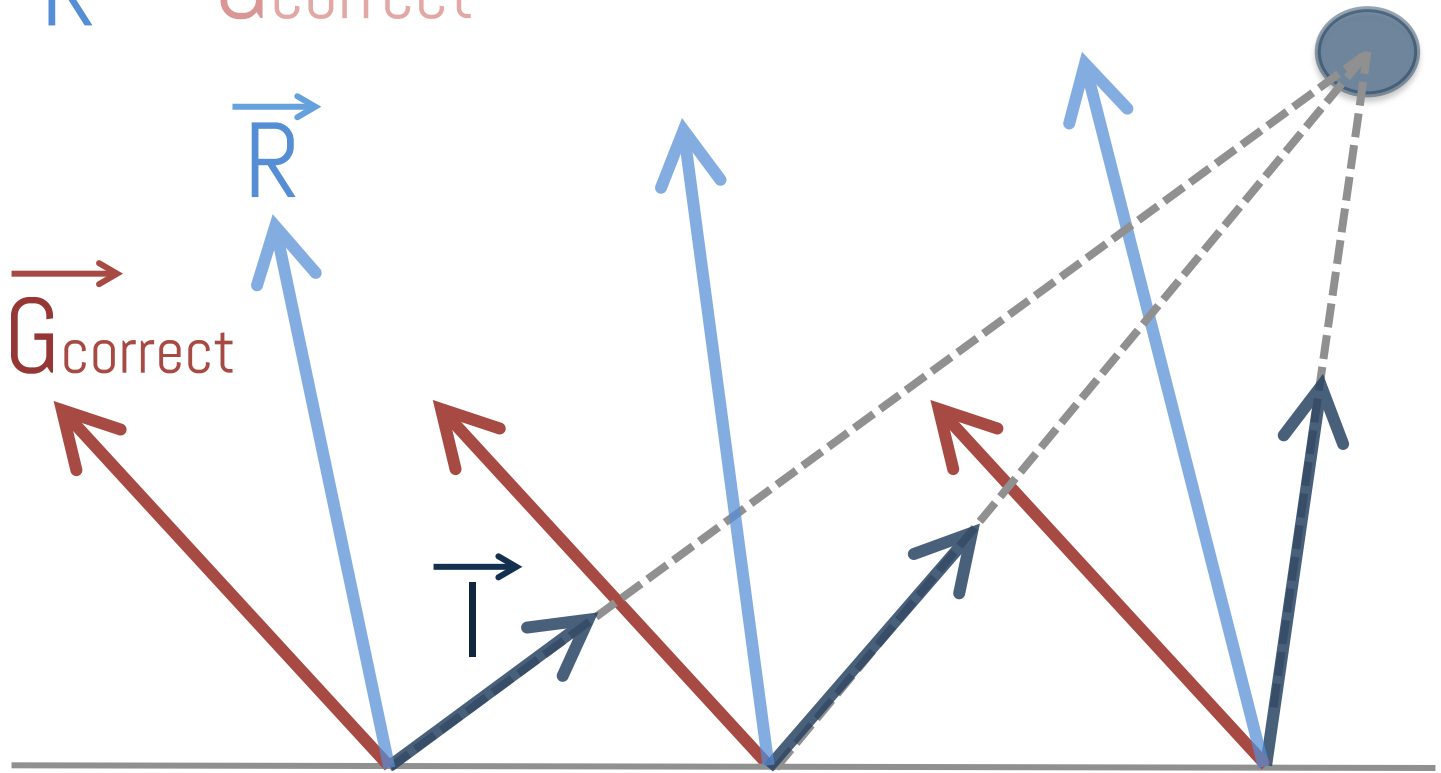


Iterative Magnetic Triangulation (IMT)



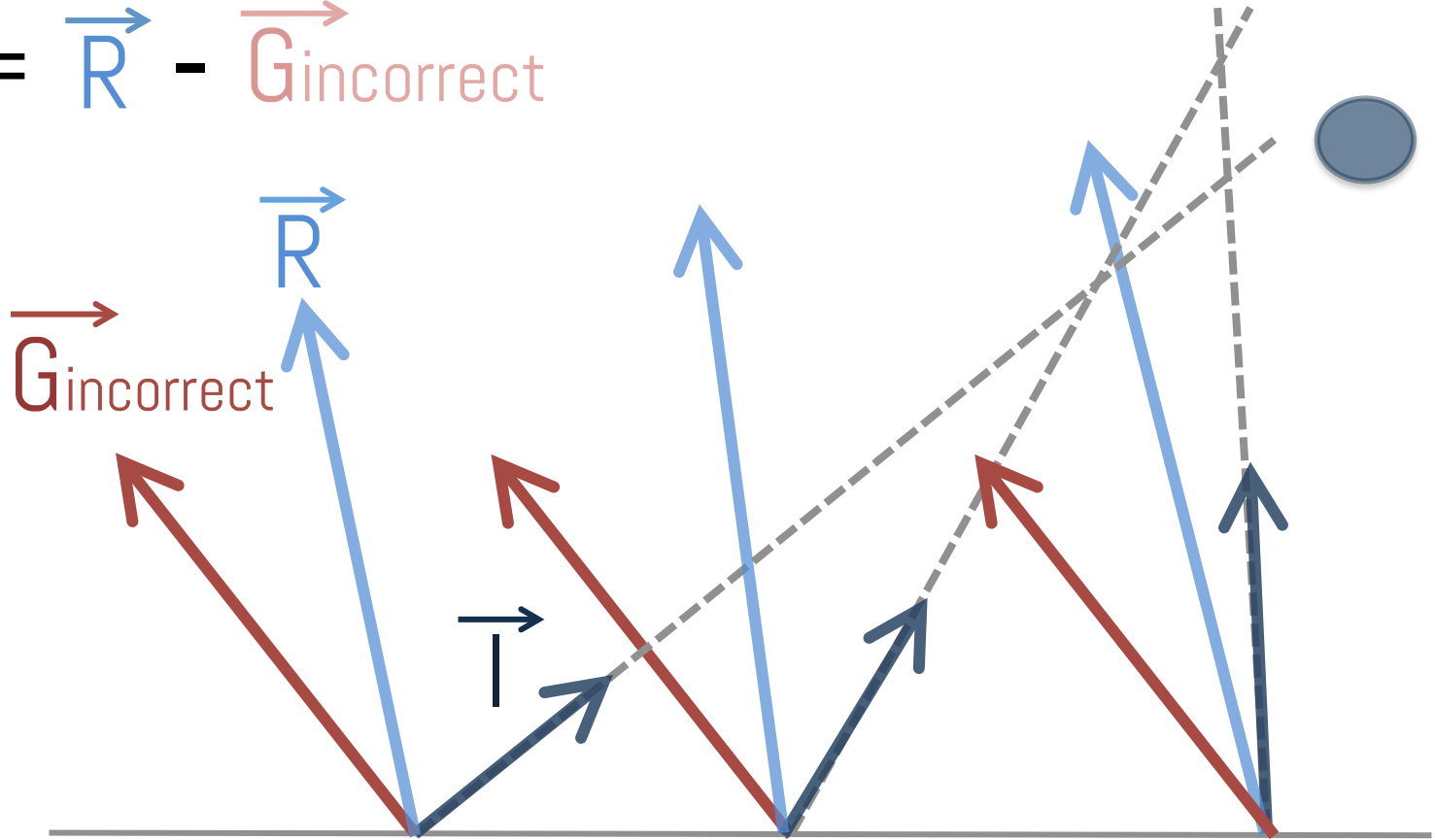
Iterative Magnetic Triangulation (IMT)

$$\vec{T} = \vec{R} - \vec{G}_{\text{correct}}$$



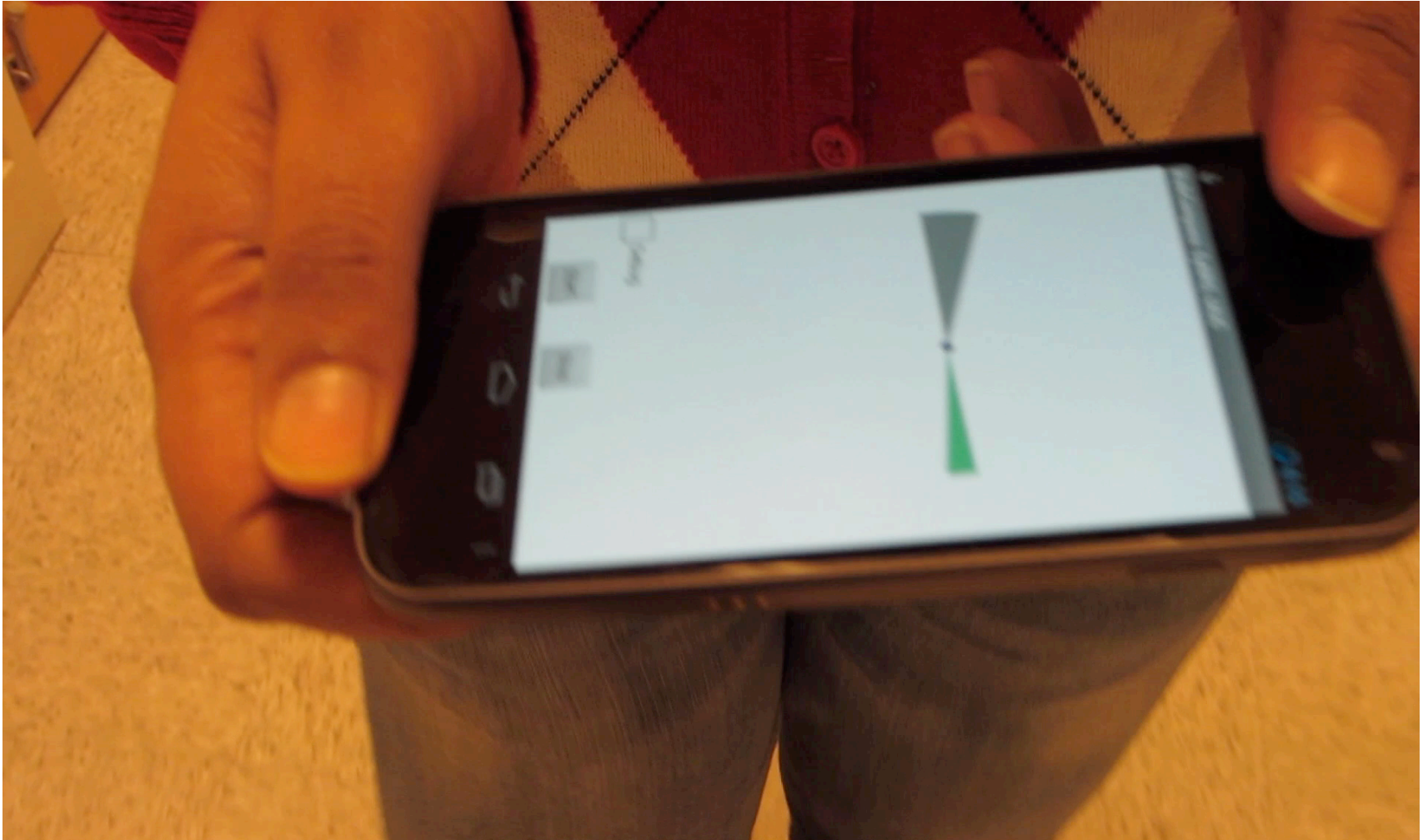
Iterative Magnetic Triangulation (IMT)

$$\vec{T} = \vec{R} - \vec{G}_{\text{incorrect}}$$

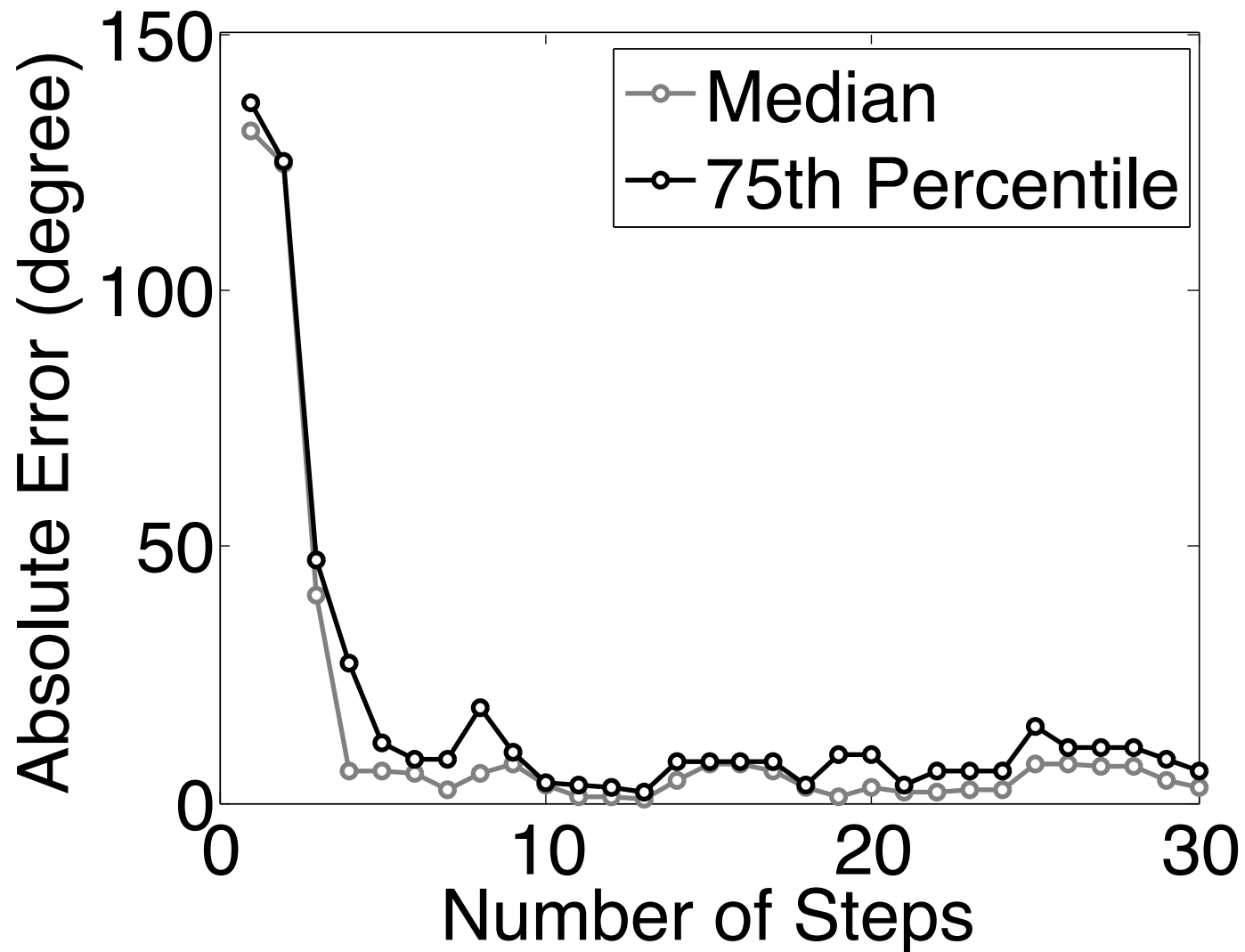


Evaluation

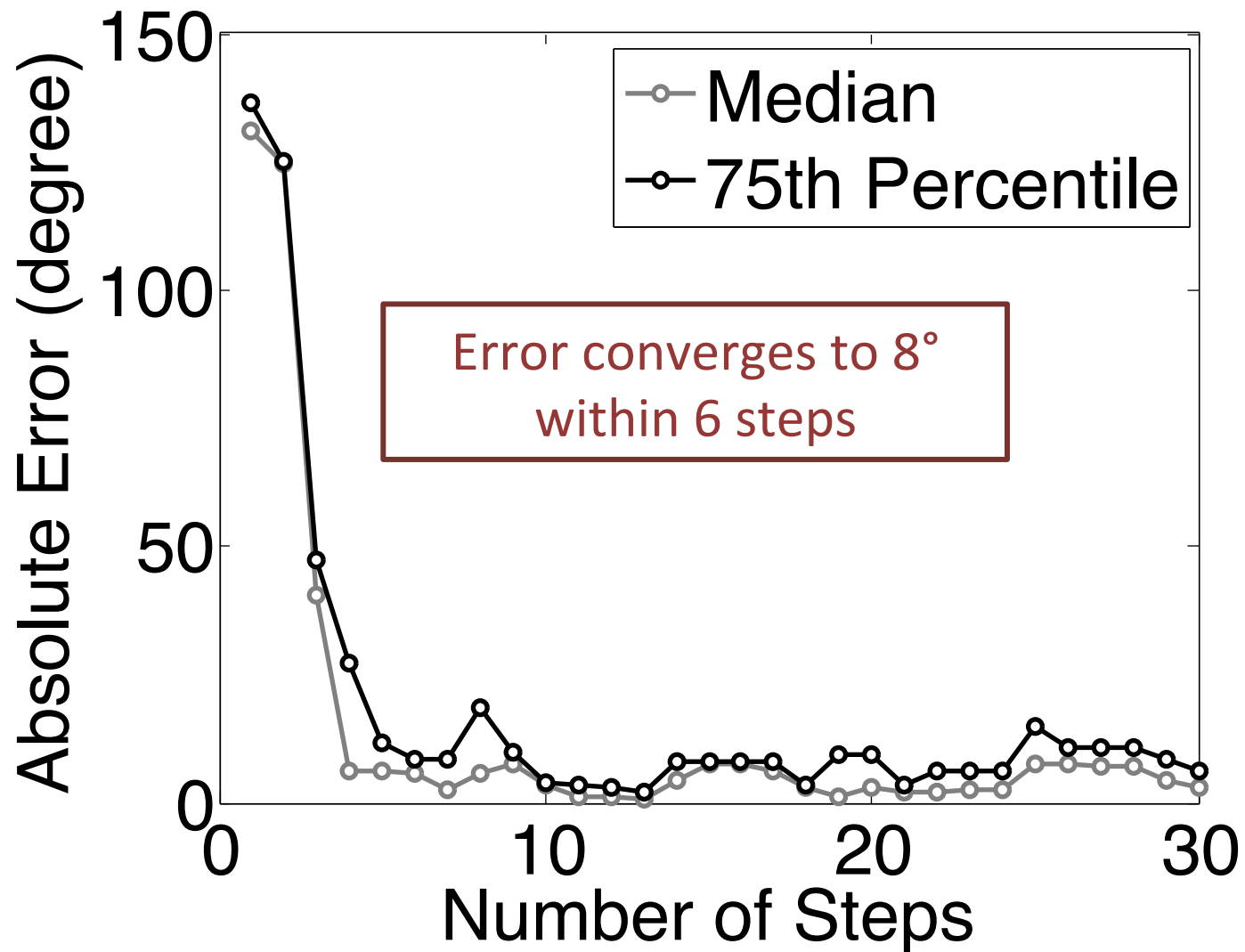
Methodology



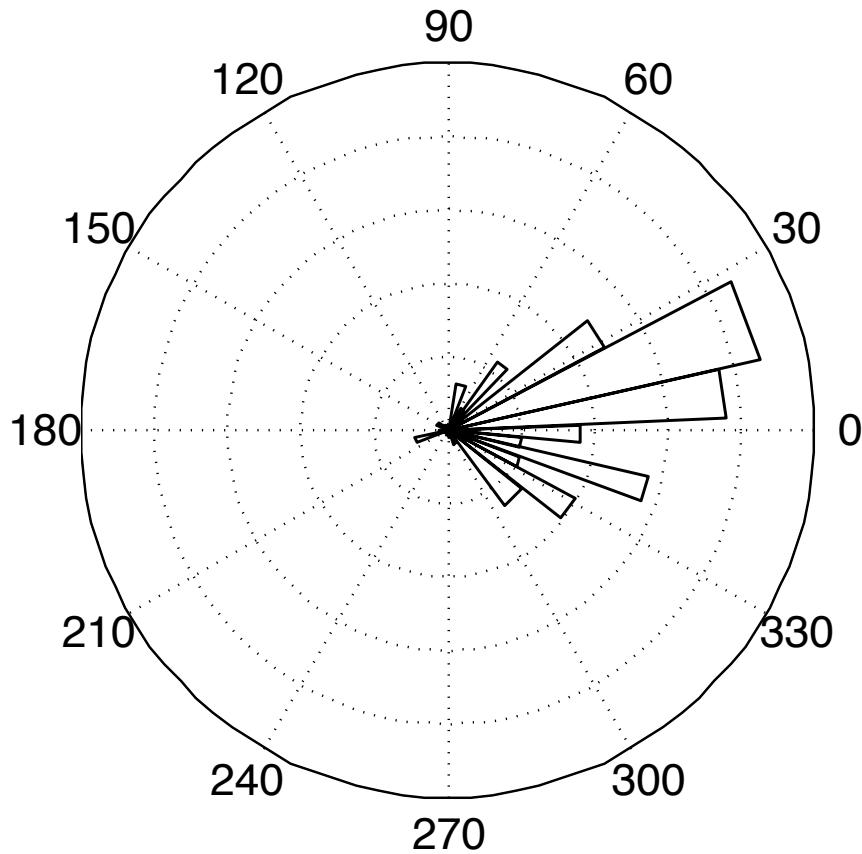
Error in Walking Direction



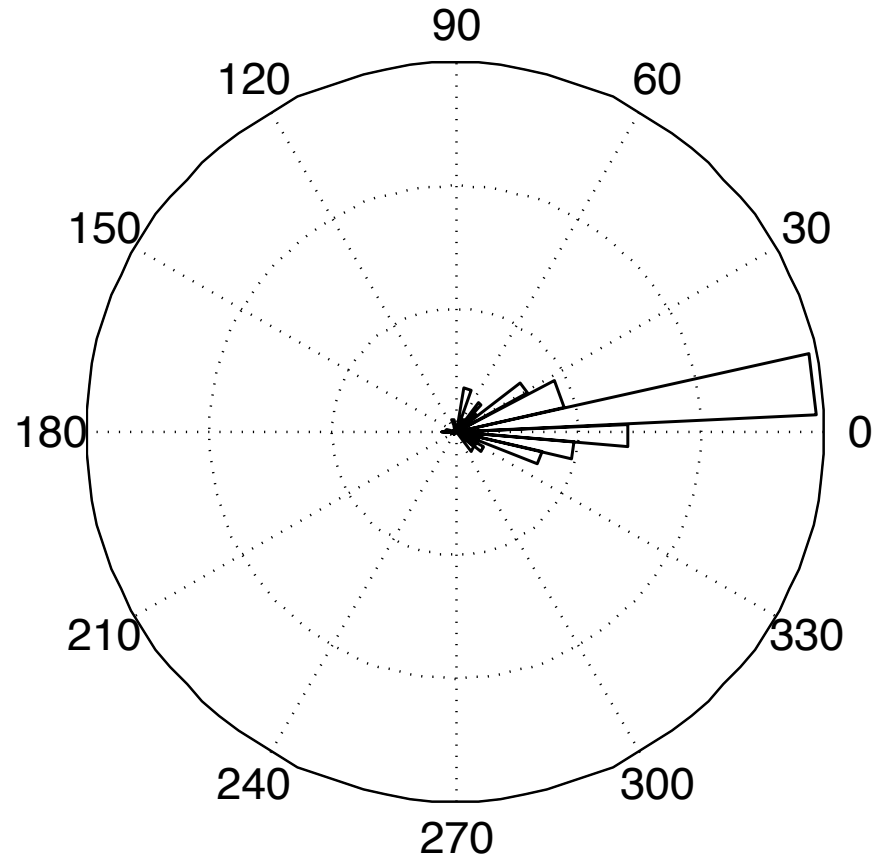
Error in Walking Direction



Better Compass

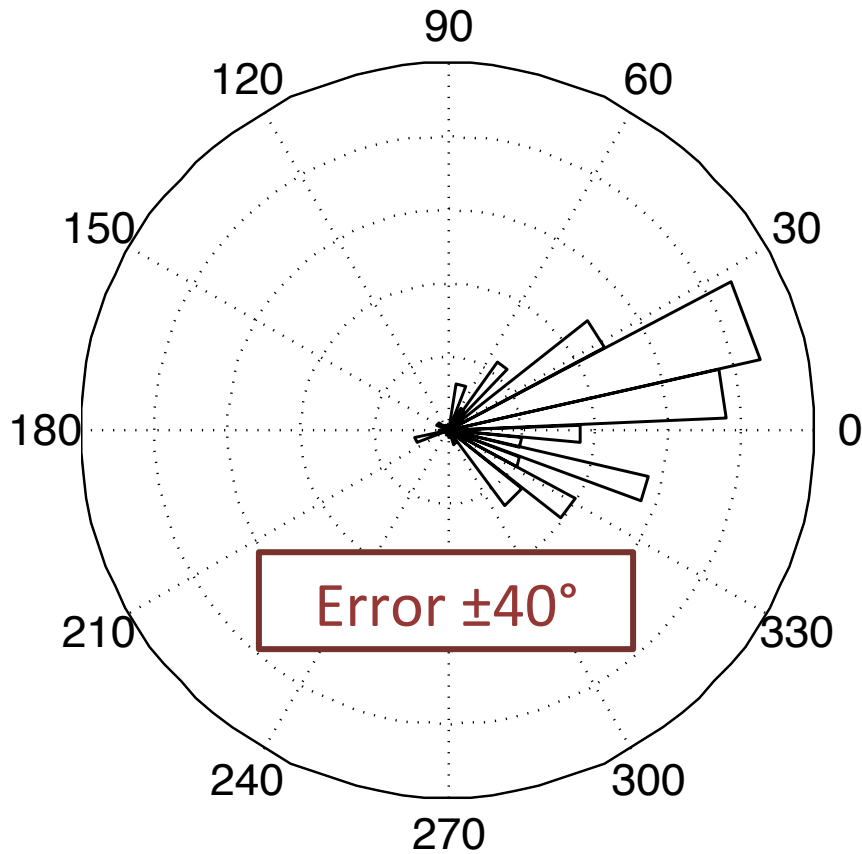


Today's
Compass

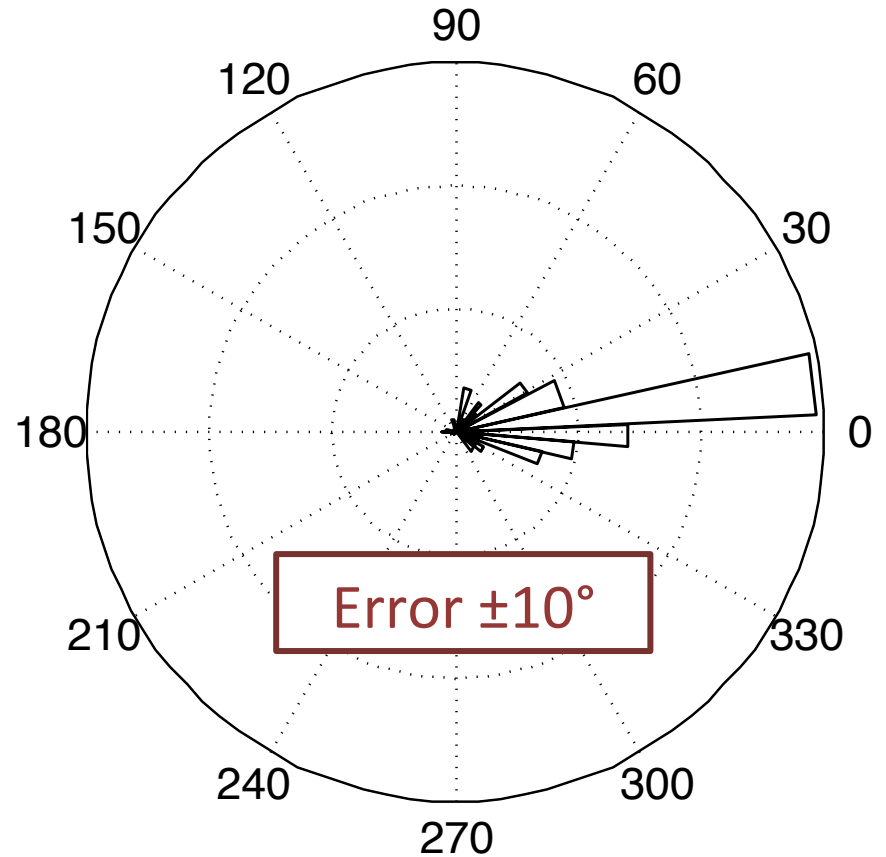


Corrected Compass
(IMT Algorithm)

Better Compass



Today's
Compass



Corrected Compass
(IMT Algorithm)

Discussion and Future Work

- Convergence time of the system
- Performance when the phone is in a bag

Conclusion



Thank You.

SyNRG @ UIUC

<http://synrg.csl.illinois.edu>

[http://synrg.csl.illinois.edu/projects/localization/
walkcompass](http://synrg.csl.illinois.edu/projects/localization/walkcompass)