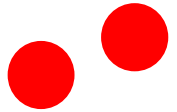


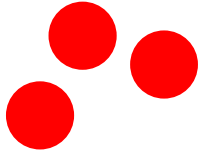


Sirkusmatematik
Magnus Dehli Vigeland



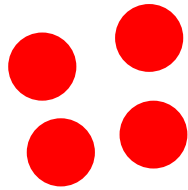
2 bolde

31
501



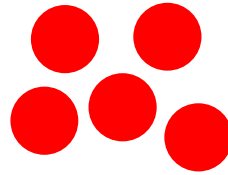
3 bolde

441
51
531
60
73131



4 bolde

53
534
633
71
7333



5 bolde

5
744

Teorem

Gennemsnit

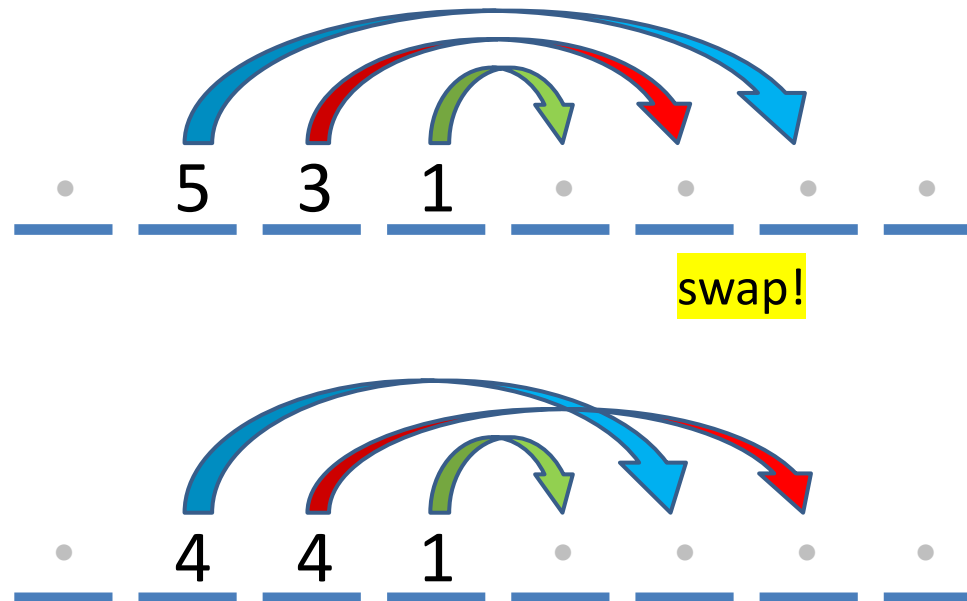


antal bolde

Teorem:

Gennemsnit = # bolde

Skitse af bevis



Gennemsnittet
er uændret!

531 → 441 → 423 → 333



DET OMVENDTE PROBLEM

➤ Tag en tallrekke: **52215**

$$\frac{5+2+2+1+5}{5} = 3 \text{ bolde}$$

➤ Kan dette jongleres??



Svar: Nei

. . . **5 2 2 1 5** . . .

➤ Men hva hvis vi **permuterer**?

Svar: Ja! **52512**

Dette er alltid mulig!

Bevist av matematikeren Hall i 1952.



Proceedings of the American Mathematical Society

1952

A COMBINATORIAL PROBLEM ON ABELIAN GROUPS

MARSHALL HALL, JR.

1. **Introduction.** Suppose we are given a finite abelian group A of order n , the group operation being addition. If

$$\begin{pmatrix} a_1, a_2, \dots, a_n \\ c_1, c_2, \dots, c_n \end{pmatrix}$$

is a permutation of the elements of A , then the differences $c_1 - a_1 = b_1, \dots, c_n - a_n = b_n$ are n elements of A , not in general distinct, such that $\sum_{i=1}^n b_i = \sum_{i=1}^n c_i - \sum_{i=1}^n a_i = 0$, since the sum of the c 's and the sum of the a 's are each the sum of all the elements of A . The problem is to show that conversely given a function $\phi(i) = b_i$,



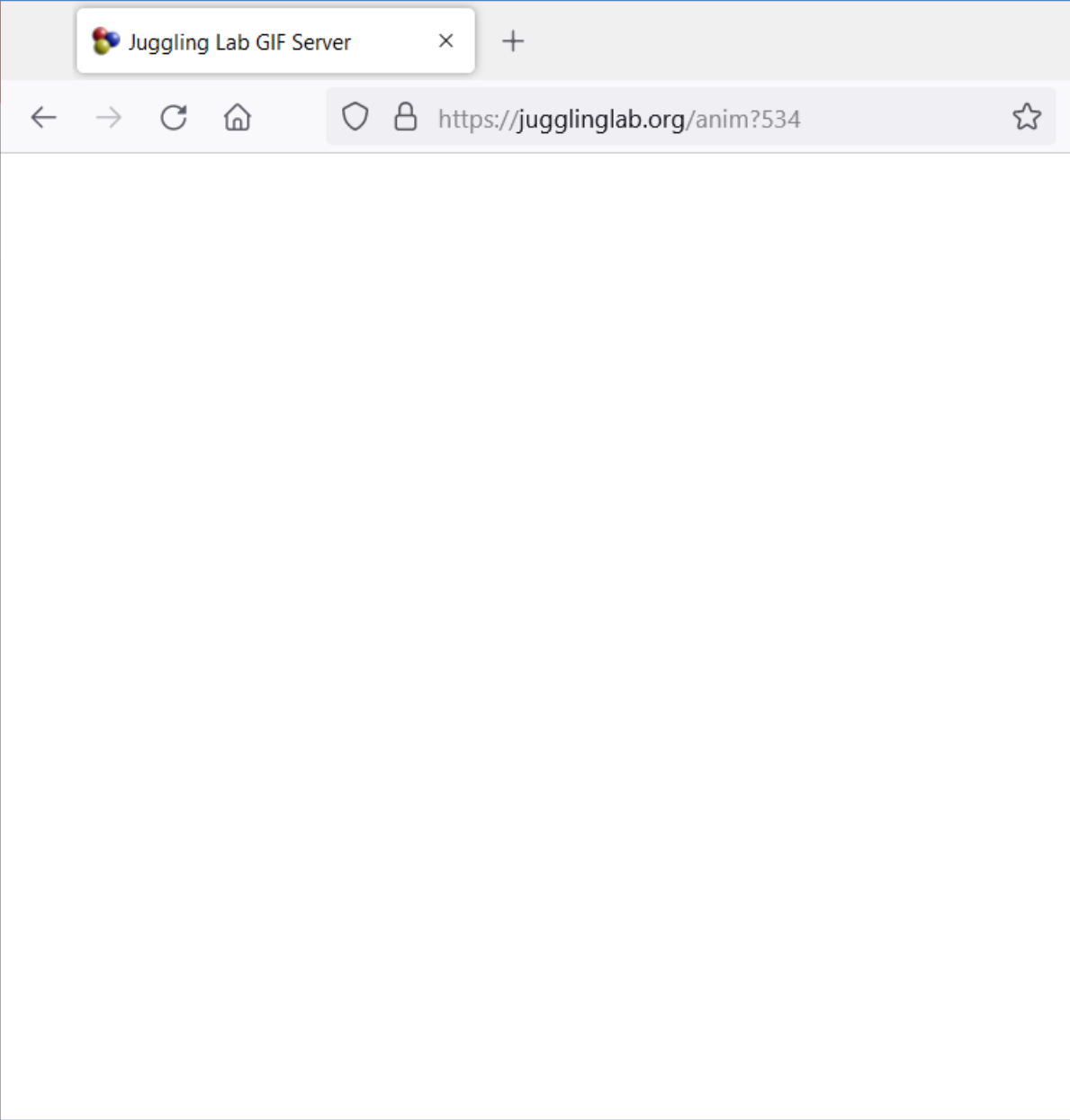
Shannon's Juggling Theorem

$$\frac{F + D}{V + D} = \frac{B}{H}$$

- F = flight time
- D = dwell time
- V = vacant time
- B = # bolde
- H = # hender

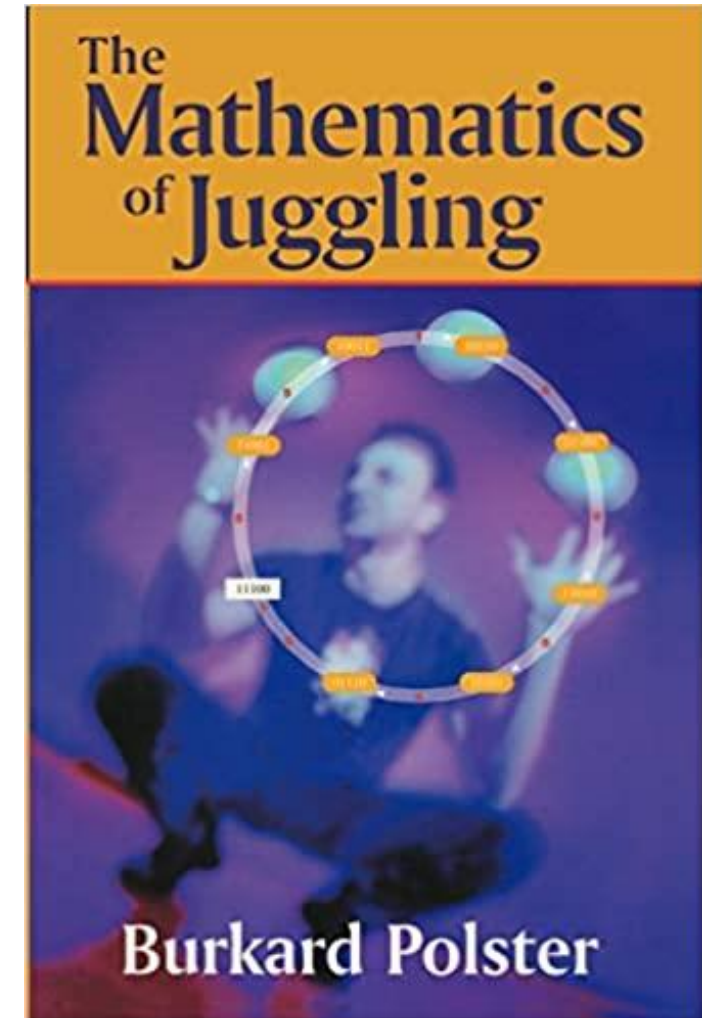
Bevis: Tiden av 1 omløp er

$$\underbrace{(F + D)H}_{\text{fra perspektivet til en ball}} = \underbrace{(V + D)B}_{\text{fra perspektivet til en hånd}}$$





- Pedagogisk hjelpemiddel
- Inspirerer **ny matematik**
- Oppdag **nye tricks** - uendelig mange!

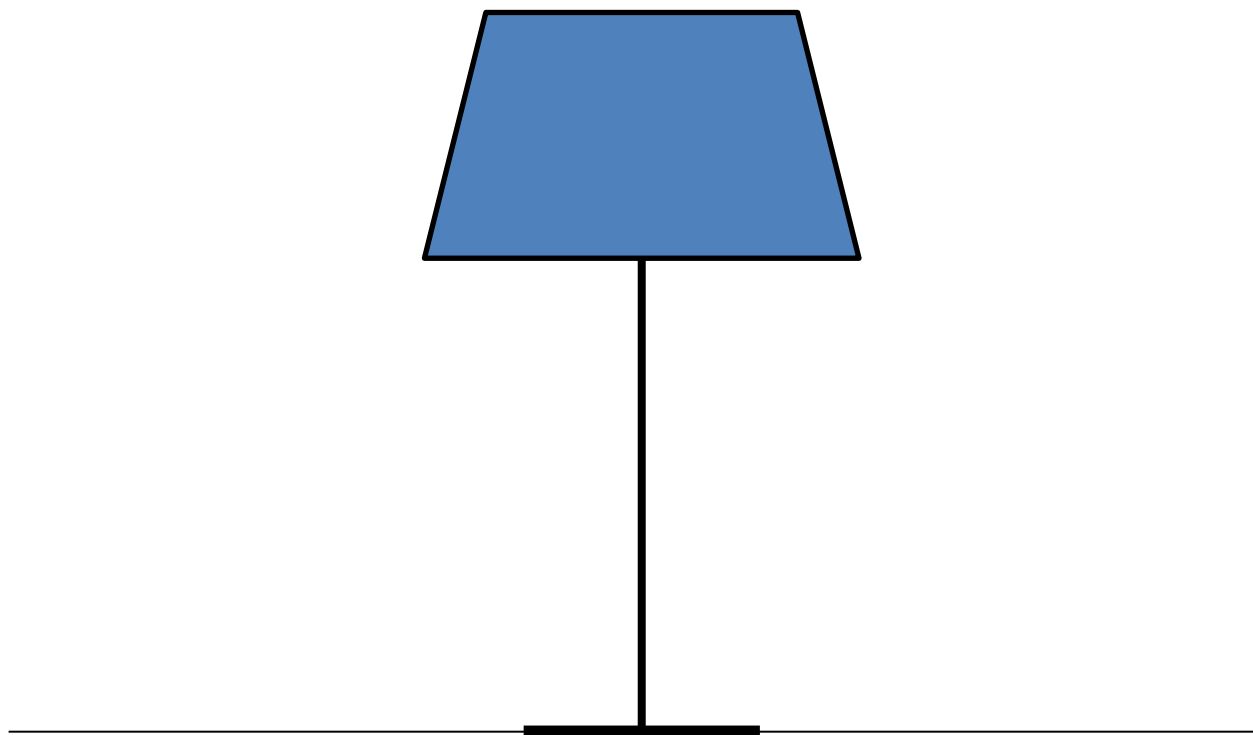


2	31	312	3302	40123	3	51	423	4413	51234	4	53	534	5524	53444	5	64	645	7166	66661	6	75	756	7746	75666	7	86	867	8677
	40	330	4013			60	441	5124	51414		71	552	5551	55514		73	663	7346	72466		84	744	7773	75756		95	885	8857
		411	4112				531	5304	52413		80	531	6055	61355		91	723	7445	73456		93	837	8277	77475			948	8884
		501	5130				504	5340	52440			633	6235	62345			744	7463	73636			855	8457	77772			966	9388
			5111				612	5511	52512			642	6415	62525			753	7526	74635			864	8556	81777				9568
			6011				711	6051	53034			660	6451	62561			771	7535	74734			882	8574	84567				9667
							801	6231	53403			714	6631	63353			825	7562	75364			918	8637	84747				9685
								6312	55014			723	7045	63524			834	7571	75616			936	8646	85575				9748
								6330	61251			741	7063	63551			861	7733	75625			945	8673	85746				9757
								6411	61305			831	7126	63623			915	8156	75661			963	8682	85845				9784
								7041	61314			912	7135	64055			933	8174	75751			972	8817	86277				9793
								7131	61350				7333	64145			942	8246	77416			990	8844	86475				9928
								7401	63051				7405	64163				8273	77425				8853	86727				9955
								8013	63141				7441	64253				8417	77461				8880	86781				9964
								8040	63303				8134	64505				8516	77731				9168	86817				9991
								8130	63501				8170	64613				8633	81277				9267	86862				
								9111	64005				8233	66125				8642	81466				9285	88446				
									64014				8413	66161				8813	81475				9348	88527				
									64050				9124	66305				9128	81727				9357	91677				
									64140				9151	66314				9155	81772				9384	92577				
									64500				9241	66350				9164	81817				9528	92928				
									66300				9304	70166				9254	81772				9555	94188				
									70161				9313	70256				9281	81817				9564	94584				
									70251				9601	70355				9344	83446				9591	94692				
									70305					70364				9353	83833				9627	94944				
									70314					70616				9515	84517				9645	95645				
									70350					70625				9524	84733				9663	96456				
									70701					70661				9551	84742				9681	96474				
									71111					70706				9641	85516				9708	96627				
									72111					72335				9713	85561				9717	96672				
														72461					85741				9744	96681				
														73136					86416				9753	96852				
														73406					86425				9780	97581				
														73451					86461				9915	99192				
														73631					86731				9924	99444				
														74135					88441				9951	99552				
														74162					90808				9960					
																			91456									
																			91474									
																			91627									

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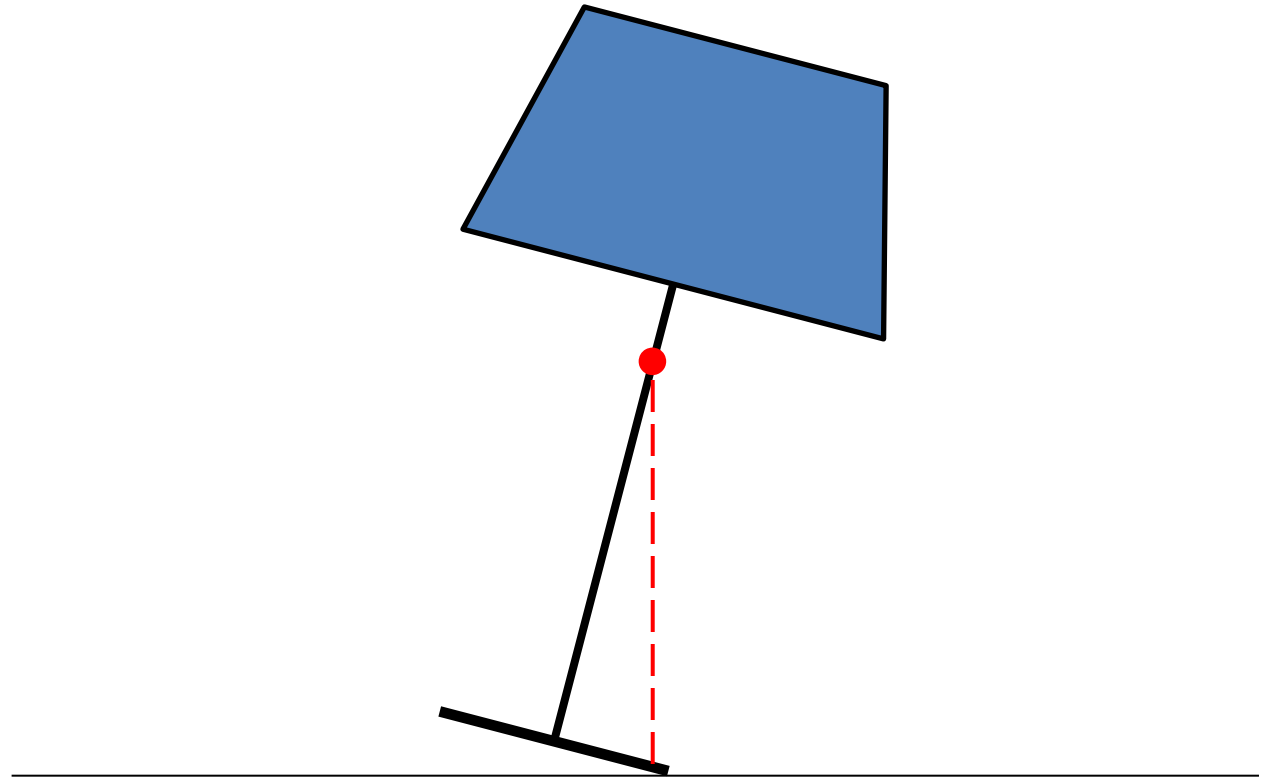


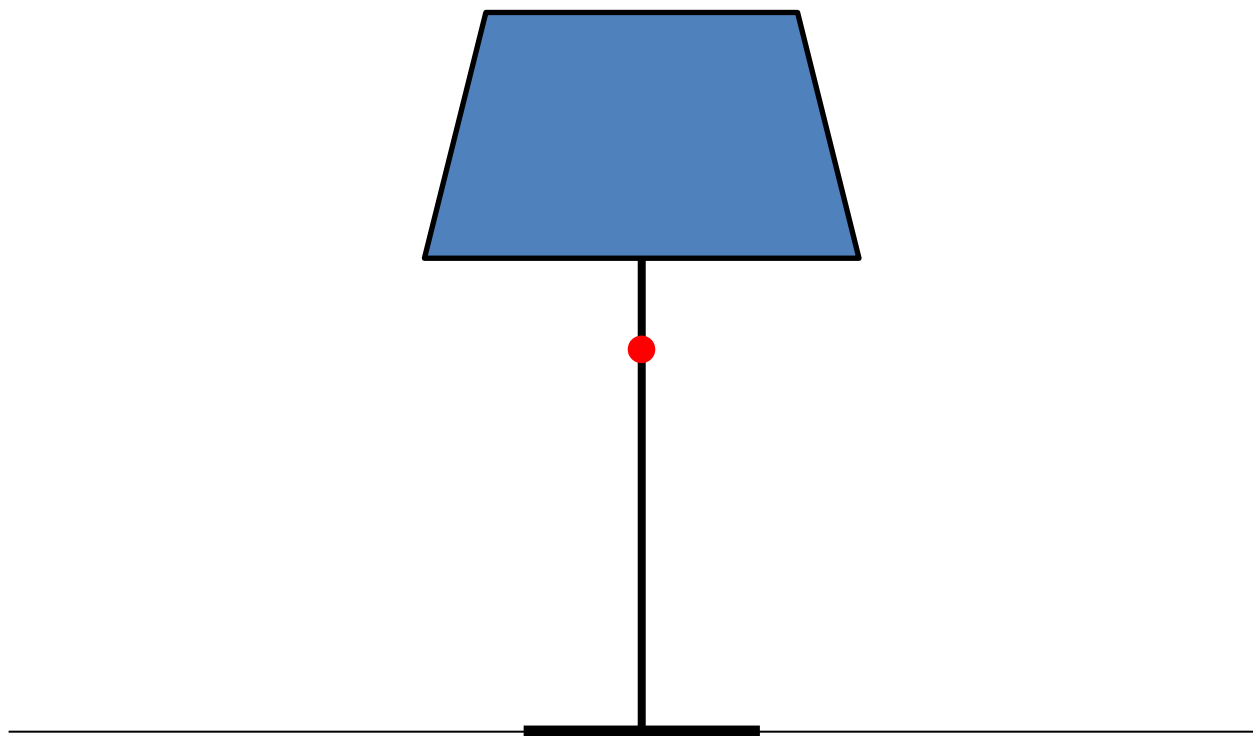
● ● ●
Del 2: BALANCE
● ● ●



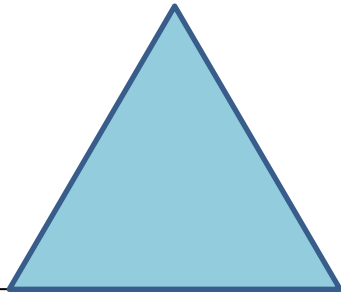


Falder den?

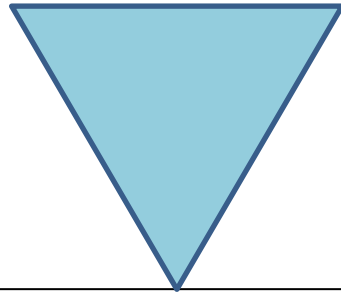




Stabil balance



Labil balance



Tips til å balancere



- Kig på tyngdepunktet - ikke toppen
- Lange ting bedre enn korte
- Nesen/panden bedre enn hånden
- Luftmodstand er godt (men ikke vind!)

EL
MAGNUS



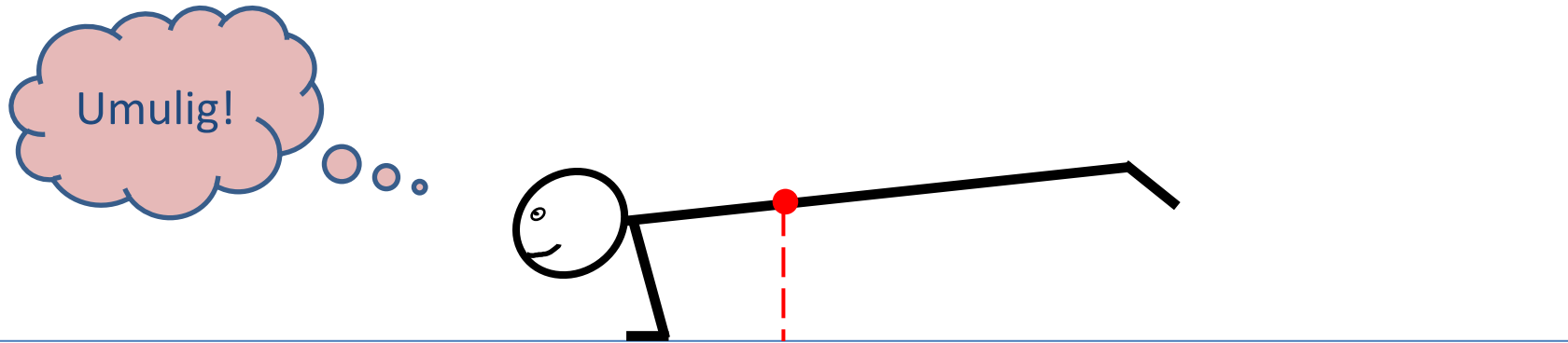
Fysik-tips til å lære håndstand

- Hold tyngdepunktet stille!
 - Ikke gelé
 - Ikke banan
- Lettere å gå enn å stå
 - (Men ikke lige så imponerende)
- Bruk for både **styrke** og **balance**





Anatoly Zalievsky



Idé: Sett noe tungt på hodet!

