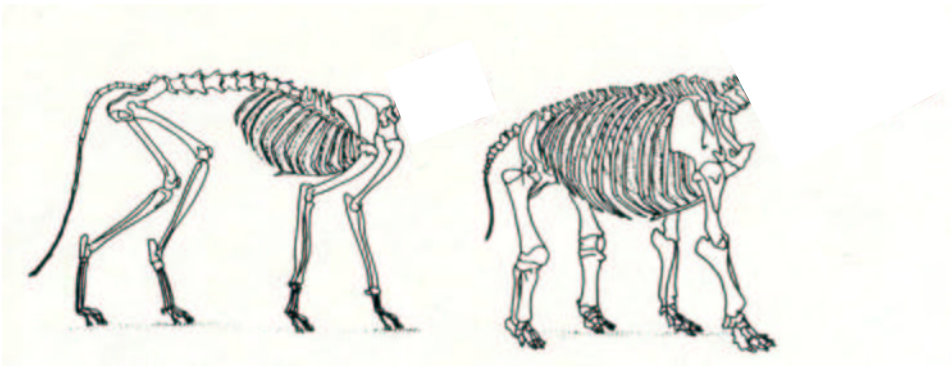
A Problem Set Containing Bones of Contention and a Feet of Great Importance



A **B**

Skeletons from two terrestrial mammals are depicted above so that they appear the same size.

1. Please state which skeleton you would predict to be larger in reality (and explain your reasoning).

2. In the 'stress similarity' model for skeleton allometry, the cross sectional area A for a leg bone is predicted to scale in direct proportion to body mass M to provide support during growth. Please state this hypothesis mathematically (*i.e.*, as a power equation involving the independent variable M, dependent variable A, the general proportionality constant a_{AM}, and a specific numerical value for the exponent b).

3. Assuming that leg bones could be modeled accurately as cylinders, please restate the power equation that you proposed in response to question 2 but replace A with leg bone diameter D (as the dependent variable).

4. Introductory Computational Biology student S. K. Ling used a more-refined model in which bone cross sectional area is calculated as π W D, wherein W represents metacarpal width (*i.e.*, diameter measured laterally, from side to side) and D represents metacarpal depth (*i.e.*, diameter measured anterior-posterior, from front to back). Please use the following approximate information, which was provided by Gertrude Roath (her friends call her 'Ger'), to estimate a mass for mammal B:

$W = 0.097\ L^{1.23}$ units (for terrestrial mammals)

$D = 0.073\ L^{1.5}$ units (for terrestrial mammals)

typical L for mammal A: 0.075 units

typical D for mammal B: 0.100 units

typical M for mammal A: 3 units

(Hint: first, use the information that was provided by Ger Roath to calculate typical W and D for species A; second, use the information that was provided by Ger Roath to calculate a typical L for species B; third, use that typical L and the information that was provided by Ger Roath to calculate a typical W for species B; fourth, use the model that was proposed by S. K. Ling to calculate typical A for the metacarpals for both species; fifth, use those typical As, the typical M for species A, and the stress similarity model that you proposed in response to question 2 to estimate a typical M for species B. Remember, answering that a bird would travel fast even when one thought that the bird – a penguin – could fly is the problem solving skill that you should be striving to develop).

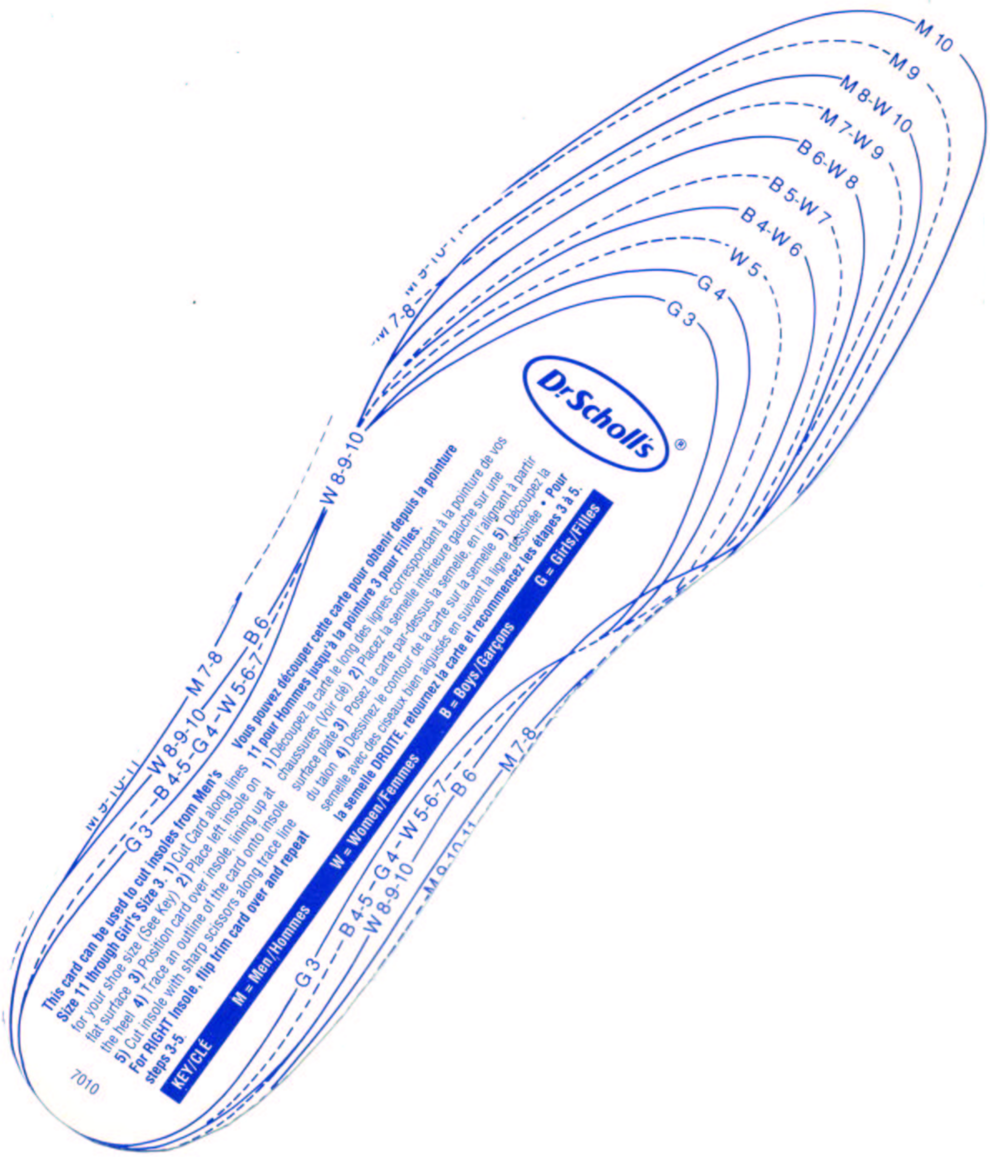
A card that is used to cut insoles for shoes is depicted on the following page (please note that the image might appear smaller than it actually is – you can calibrate all measurements using the information that is provided below, a ruler, and the assumption that the magnification factor was isometric; *i.e.*, changed all proportions equivalently).

5. Please complete the chart:

	Maximum Length [mm]	Maximum Width [mm]
G3	207	
G4		66
W5	224	
B4-W6		72
B5-W7	239	
B6-W8		78
M7-W9	258	
M8-W10		81
M9	275	
M10		89

6. Please use the data in the completed chart to describe mathematically (*i.e.*, using an equation) and etymologically (*i.e.*, using words) the manner with which human feet grow (length is measured more accurately than is width).

7. Please predict the maximum width for a Lilliputian whose foot is 1 mm long.



M 10
M 9
M 8-W 10
M 7-W 9
B 6-W 8
B 5-W 7
B 4-W 6
W 5
G 4
G 3
Dr. Scholl's®
W 8-9-10
M 7-8
B 6
W 8-9-10
B 4-5-G 4-W 5-6-7
G 3
This card can be used to cut insoles from Men's Size 11 through Girl's Size 3. 1) Cut Card along lines for your shoe size (See Key) 2) Place left insole on flat surface 3) Position card over insole, lining up at the heel 4) Trace an outline of the card onto insole 5) Cut insole with sharp scissors along trace line For RIGHT Insole, flip trim card over and repeat steps 3-5.
Vous pouvez découper cette carte pour obtenir depuis la pointure 11 pour Hommes jusqu'à la pointure 3 pour Filles. 1) Découpez la carte le long des lignes correspondant à la pointure de vos chaussures (Voir clé) 2) Placez la semelle intérieure gauche sur une surface plate 3) Posez la carte par-dessus la semelle, en l'alignant à partir du talon 4) Dessinez le contour de la carte sur la semelle 5) Découpez la semelle avec des ciseaux bien aiguisés en suivant la ligne dessinée • Pour la semelle DROITE, retournez la carte et recommencez les étapes 3 à 5.
KEY/CLÉ
M = Men/Hommes
W = Women/Femmes
B = Boys/Garçons
G = Girls/Filles
7010