

Get the message across: Be Vague, Flex the Maths, and Make Size Matter!

Sandra Williams and Richard Power

Be vague, be clear



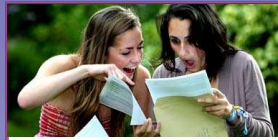
The HARPS search for southern extra-solar planets
XI. An habitable super-Earth ($5M_{\oplus}$) in a 3-planet system
 S. Udry, A. Bourrier, X. Barthelemy, T. Forveille, M. Mayor, C. Perrin, F. Brogi, C. Lovis, F. Pepe, D. Queloz, and J.-L. Beuzen

Abstract. ... One of the planets has a mass of $5M_{\oplus}$ and resides in the habitable zone of the star. It is thus the known exoplanet which most resembles our own Earth. [...]
Introduction
 M dwarfs are of primary interest for planet search programmes. ... The minimum mass of the 2nd new planet is 5.59 terrestrial mass (the lowest for any exoplanet to date) and [...]

(Astronomy & Astrophysics, 25 April 2007)

Approximation:
 Good writers approximate early in a text.
Precision:
 Later in a document, they are more precise.

Flex the Maths



A-level results show record number of A grades
Record numbers of teenagers have received top A-levels grades.
 By Graham Pridgen

More than a quarter of papers were marked A as results in the so-called gold standard examination reach a new high. [...]

According to figures released today by the Joint Council for Qualifications, **25.9 per cent** of A-level papers were awarded an A grade this summer, compared to 25.3 per cent 12 months earlier - and just 12 per cent in 1990.

(Telegraph, 14 August 2008)

Simple form: Good writers use a simple mathematical form early in a text.
Complex form: Later in a document, they use a more complex one.

Make size matter



Fears over sharp decline in number of puffins
 By ALAN MACDERMID

SCIENTISTS expressed concern yesterday over an apparent sharp decline in the number of puffins on a Scottish island used as a population benchmark. [...]

steadily from a handful of pairs 50 years ago to around 69,300 pairs in 2003. This year's survey estimates the population to be 41,000 pairs - **dramatically lower** than the 100,000 pairs expected if the previous rate of increase had continued.

(The Herald, 4 June 2008)

Emphasis:
 Good writers accentuate largeness or smallness by using hedges, e.g., 'more than', 'less than'.

Precision and Form

Precision and Form Study

Observation	Freq.	Propn.	Sig.
Equal Precision	26	0.30	
Unequal Precision	62	0.70	< 0.001
Increasing Precision	56	0.90	
Decreasing Precision	6	0.10	< 0.001
Equal Maths Level	57	0.65	
Unequal Maths Level	31	0.35	< 0.01
Increasing Maths Level	25	0.81	
Decreasing Maths Level	6	0.19	< 0.001

Study performed on 88 texts.
 See Williams and Power (2010)

What follows

A natural language generation system should vary precision and mathematical form in documents; use less precise and simpler forms early on; and more precise and complex forms later.

Cognitive Model

Uses a scale system for fractions: halves:[0,1,2], thirds:[0,1,2,3] and quarters:[0,1,2,3,4], and another for percentages: tenths:[0,10,20,...,100], twentieths:[0,5,10,15,...,100], hundredths:[0,1,2,3,4,...,100], thousandths:[0.0,0.1,0.2,..., 100.0], and so on.

The model simultaneously selects:
 ■ a **Relation** between given and actual values
 ■ a **Scale System**
 ■ a **Scale** from the system
 ■ a **Point** on the scale
Input: a proportion between 0 and 1
Output: a list of approximations on different scales at points above and below actual value
Example: Input: actual value = **0.259**

Outputs:

System	Point/Scale	Relation	Example English
Percentage	259/1000	=	exactly 25.9 percent
Percentage	26/100	<	about 26 percent
Percentage	26/100	<	less than 26 percent
Fraction	1/4	>	about a quarter
Fraction	1/4	>	more than a quarter
Percentage	5/20	=	about 25 percent
Percentage	5/20	>	more than 25 percent
Percentage	3/10	>	about 30 percent
Percentage	3.10	<	less than 30 percent
Fraction	1/3	>	about a third
Fraction	1/3	<	less than a third
Fraction	1/2	<	about a half
Fraction	1/2	<	less than a half

Evaluation results

Most given values produced by 50 participants in a survey were predicted by our model, with an overall coverage of about 90%;
 Quality of output was also high (i.e., most generated solutions were employed at least once by participants).
 See Power and Williams (under review).

Numerical Hedges

Perception study

Phrase	Round	N	Approx.	Precise	χ^2	Sig. 2-sided
5.03	N	63	9	54		
5	Y	42	23	19		< .0001
250,000	Y	63	50	13		< .0001
275,912	N	42	10	32		< .0001
E40,921,250	N	63	2	61		
E40,000,000	Y	42	7	35		< .0156
2.3 per cent	N	63	7	56		
5 per cent	Y	42	20	22		< .0001
30 per cent	Y	63	49	14		
31 per cent	N	42	9	27		< .0001
67%	N	63	25	38		
70%	Y	42	29	13		< .0032
nine-fourteenths	N	63	19	44		
half	Y	42	39	6		< .0001
three-fourteenths	N	63	34	29		
a third	Y	42	36	6		< .0008
three-quarters	Y	63	59	4		
nine-fourteenths	N	42	11	31		< .0001

105 participants judged numerical phrases seen in sentences as being 'approximate' or 'precise'.
 See Williams and Power (under review)

Hedging vs. Rounding

	Hedged	Non-Hedged	Total
Round	229	484	713
Non-Round	104	412	516
	333	896	1229

A greater proportion of hedged numbers are round than non-hedged numbers and a greater proportion of round numbers are hedged than non-round numbers.
 Result is significant in a χ^2 test of independence ($\chi^2 = 21.67, p < 0.0001$).
 See Williams and Power (under review).

Our findings

Readers perceive round numbers as approximate and non-round ones as precise. In spite of this, writers add hedges to round numbers! Also, the majority of hedges are directional (greater/less than). We think that this is because writers emphasise largeness or smallness whilst presenting numbers as simply as possible.

What follows

An NLG system should round numbers where possible and add directional hedges to call attention to largeness or smallness as appropriate.