# Numeral System and Cultural Mathematics

許家誠

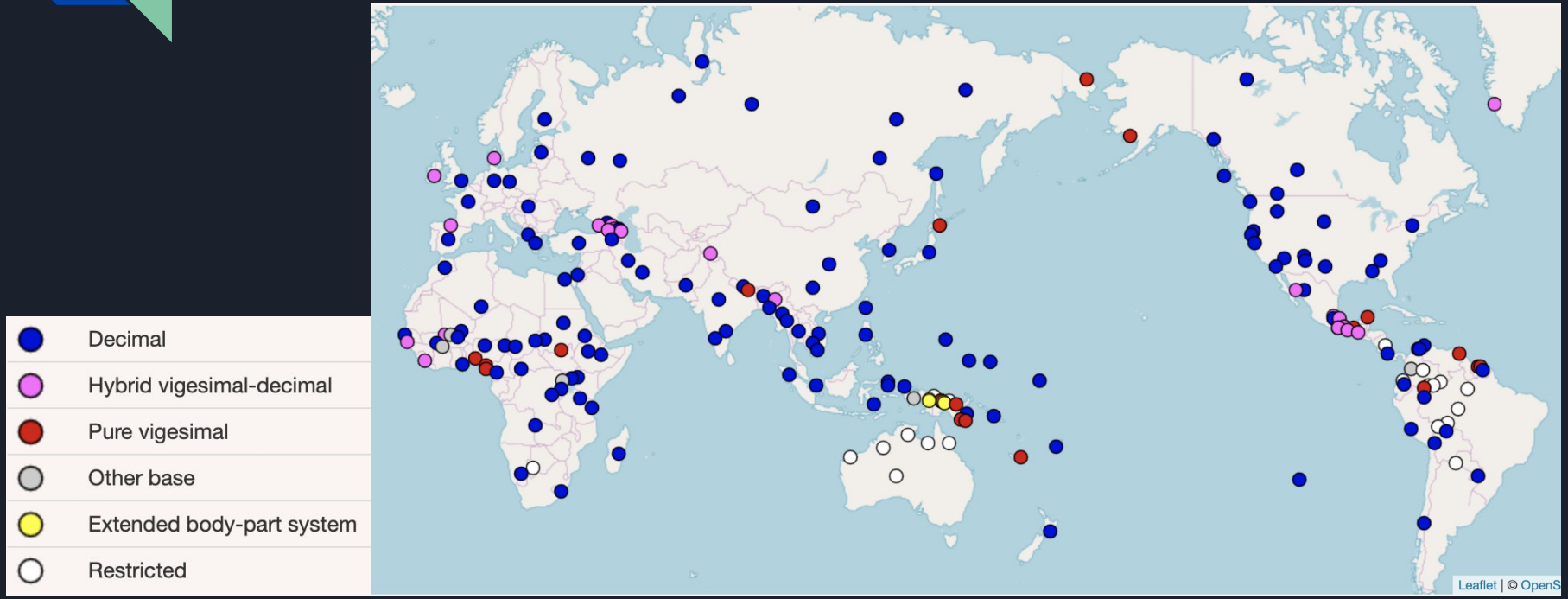
# What about numeral problems

- Frequently tested
- All or none
- How to start

# Most important concept: base

- The stucture of numeral expression
- The number of unique digits, including zero, that a positional numeral system uses to represent numbers
- General pattern:
  For base b: (n x b) + m (where m < b)
- Most commonly used: base 10

# Brief map




Bernard Comrie. 2013. Numeral Bases. In: Dryer, Matthew S. & Haspelmath, Martin (eds.) The World Atlas of Language Structures Online. Leipzig: Max Planck Institute for Evolutionary Anthropology. (Available online at http://wals.info/chapter/131, Accessed on 2019-07-14.)

# Base 5, 10, 20

- Human has 5 fingers in a hand/ 10 fingers in two hands (20 fingers and toes?)
- Commonly used for counting

# Base 6, 12, 60

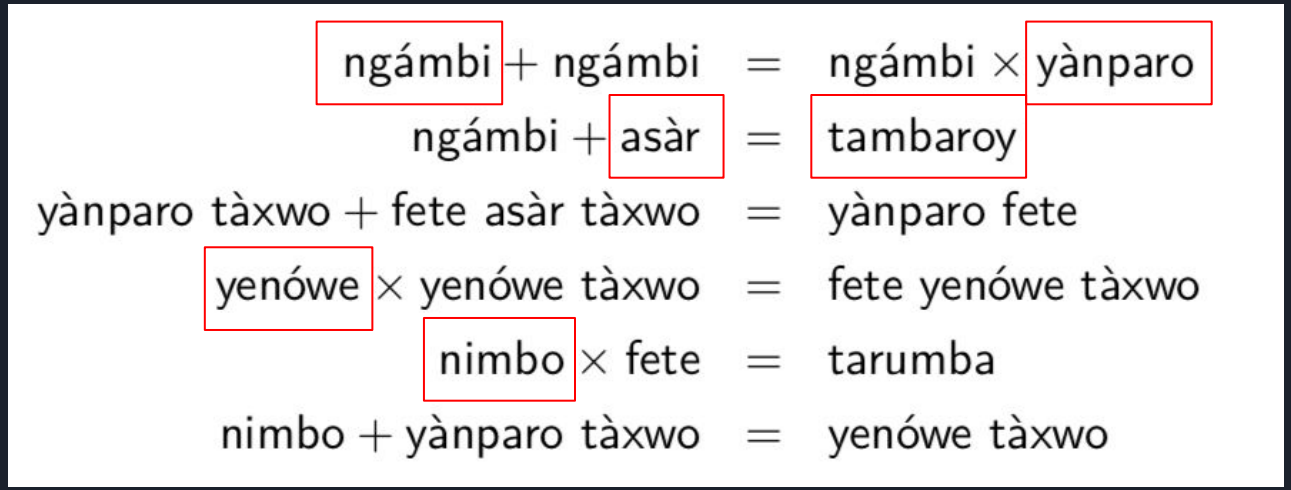
- Easily divided by 2, 3 (, 4, 5)
- A solar year is approximately equal to 12 lunar months
- A circle can easily divided into 6, 12, 24 equal parts (rather than 10 equal parts)
- Commonly used for division (e.g. time, angles)

# How bases help

- For base b, the general form might be:
  (n x b) + m (where m < b)
- base ≥ # of distinct words/ morphemes

# How bases help

III-C-apx_11



# How math helps

- Basic idententical equality
- Factors and multiples
- Square numbers

# How math helps

III-C-apx_11

$$\begin{aligned}
\text{ngámbi} + \text{ngámbi} &= \text{ngámbi} \times \text{yànparo} \\
\text{ngámbi} + \text{asàr} &= \text{tambaroy} \\
\text{yànparo tàxwo} + \text{fete asàr tàxwo} &= \text{yànparo fete} \\
\text{yenówe} \times \text{yenówe tàxwo} &= \text{fete yenówe tàxwo} \\
\text{nimbo} \times \text{fete} &= \text{tarumba} \\
\text{nimbo} + \text{yànparo tàxwo} &= \text{yenówe tàxwo}
\end{aligned}$$

yànparo=2

# How math helps

III-C-apx_5

(a) mẽña mẽña mẽña mẽña + mẽña go mẽña = ãẽmãẽmpoke go aroke × 2

(b) aroke$^2$ + mẽña$^2$ = ãẽmãẽmpoke

(c) ãẽmãẽmpoke go aroke$^2$ = mẽña go mẽña × ãẽmãẽmpoke mẽña go mẽña

(d) mẽña × ãẽmãẽmpoke = tipãẽmpoke

(b) $1^2 + 2^2 = 5$, $1^2 + 3^2 = 10$

(c) $6^2 = 4 \times 9$, $4^2 = 2 \times 8$

(d) mẽña ≠ 1, ãẽmãẽmpoke ≤ 5

# Imagination

III-C_6, 7

- Subtraction:
  $(n \times b) - m$
- Rounding: addition and subtraction
  $(3 \times 12) - 6 = 30 = (2 \times 12) + 6$ ?
- Division:
  $\frac{1}{2} \times b$
- 2 or more bases:
  $(n_1 \times b_1) + (n_2 \times b_2) + m$

# Rounding

## III-C-apx_1

Kell on üks.

Kell on kaks.

Veerand kaks.

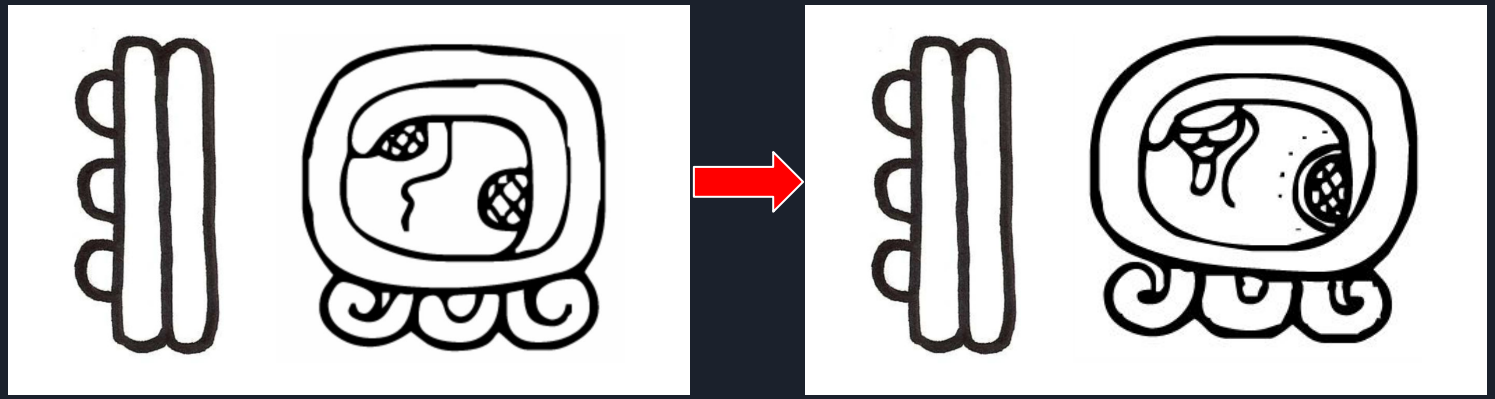
Pool neli.

Kolmveerand üksteist.

Viis minutit üks läbi.

# Calendar

III-C-apx_7, 8/29



# Calendar

- Regularity
- dot-bar parts:
  8/1 = 9/9 = 9/22, 8/2 = 8/15 = 8/28, 8/13 = 9/21, ...
  differences of days with same parts = multiples of 13
  → base = 13
- right parts: 8/18 = 9/7 = 9/27, 8/13 = 9/22, 8/15 = 9/24
  differences = multiples of 20, and base ≥ 20
  → base = 20

# Body parts

III-C-apx_3

- Some languages in Papua New Guinea
- Counting by body parts
- The count may continue down to the other side of body parts, and continue down again by reversing the order of previous count.

# Thanks