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Speaking of Graphics

Chapter 1

Incas and Quipu

1.1 Quipu in Inca Peru

When Francisco Pizarro and a handful of Spanish conquistadors landed in 1532 on the shores of what is now called Peru, they discovered an all-pervasive accounting and reporting system, called 'quipu', which formed the principal instrument of administration of Inca society. Originally, the term Inca referred exclusively to the ruling class, but the Spanish subsequently applied it to the whole of the population. A peculiar aspect of the quipu system is that it does not use written characters or narrative texts. As the people under strongly centralized Inca reign did not possess a written language, they had to rely on visual means for handling data about social, economic, military, historical and religious matters. It is assumed that the quipu system has been developed in pre-Inca times, long before the legendary descendant of the sun, Manco Capac, founded the Inca capital at Cuzco, in the thirteenth century.

Basically, a quipu is composed of a thick cord to which thinner ropes are attached. The positions of knots placed on these ropes indicate quantities much in the way of a decimal counting system. The higher the knot is on the rope, the higher its value. For example, nodes close to the extremities represent one, two, three, four units, etcetera. Those closer to the central cord were used for recording units of ten, hundred, thousand, and so on. Quipus were colored differently according to the subject to which they were applied. Green colored quipus may have been used for the recording of production of crops, such as maize, cocoa and potatoes. Blue ropes may have served for minerals such as silver and gold, to which the Incas attached only ceremonial value, and red ones for counting peasants, soldiers, public servants and crafts people. The exact meaning of the colors, however, has been lost and we can only speculate about the context in which they were used.

The recorded history of the Inca empire extends from the Inca Pachacuti in 1438 until the Spanish conquista in 1532 [1]. It rapidly expanded and developed into a highly organized, almost totalitarian society in which the possession of luxury goods and private wealth was forbidden to the lower classes. The Incas were superior to their neighboring tribes in organization, administration and communication. This may explain why in barely 100 years their culture and empire spread over a large part of the West coast of South America from Ecuador in the north to Chile in the south. As there was no money and probably no market economy, the exchange of goods and services was entirely regulated by the government. Every community was requested to supply labor and services to the ruling Inca class in return for food, shelter, clothing and other primary commodities. Provisions were also made to support those who were unable to contribute because of sickness or old age. The system enabled the rapid colonization of new territories by building strongholds, roads and storehouses. It also provided for complex irrigation works and communication systems. All these activities were performed on the basis of reciprocity and exchange, according to a system called 'mita'. Hence, accurate accounts had to be kept.

1.2 The quipu system

Many of the customs of the Inca period have been recorded in an illustrated chronicle by Felipe Guaman Poma de Ayala, who was born (presumably) in 1534, from a high ranking member of the Inca class [2].



Figure 1.1 Quipu used for statistical records, held by the official accountant and treasurer Curaca Condor Chava. The device in the left lower corner represents a counting board or yupana [2].

The drawing in Fig. 1.1 shows the chief accountant and treasurer (contador maior i tesorero) named Curaca Condor Chava holding the quipu in the typical way, with his right hand raised and with his left hand pointing downwards. The lower left corner shows a counting board or 'yupana' which was used for performing arithmetic operations by means of colored beans. It is likely that the results of counting on the yupana were transferred to the quipu and that the accountants mastered both techniques [3]. A typical quipu may have been read as follows. 'In a certain village during the year 1490, under the reign of Topa Inca Yupanqui, 400 laborers have been assigned to the goldmines, 400 have participated in the construction of fortifications at Machu Picchu, 400 labored the fields around Cuzco, 150 served in the palace of the Inca, 150 kept watch on the graves of the ancestors of the Inca, 120 processed feathers, 400 worked on fabrics and textiles, 40 accompanied the Inca during the hunting season, etc.' [4]. The quipu may also have served as a personal record of the life of a deceased member of the Inca class.

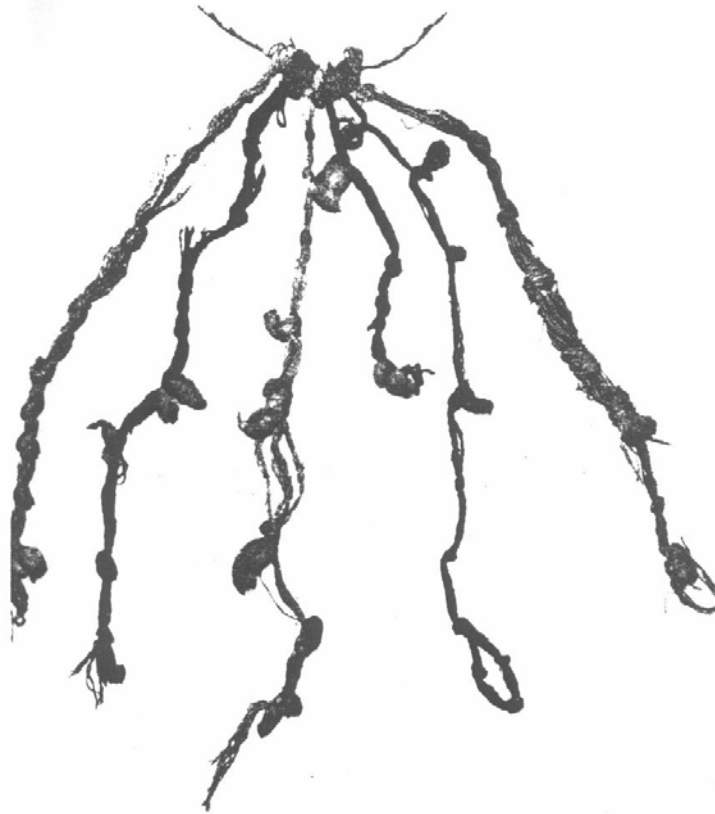


Figure 1.2 Quipu excavated from an ancient Peruvian burial site. This quipu was probably used as a biographical record of the buried [5].

Figure 1.2 shows an early quipu which has been taken from a grave in which an ancient Peruvian mummy had been buried. Such a quipu would have been read in a different way. The main cord may indicate his rank, age and region of provenance. The first branch rope defines his position in the Inca family, the number of wives and concubines, the number of legitimate and illegitimate children. The second rope tells the amount of land he administered. Yet another rope defines the size of the herds he supervised. Finally, the last branch rope may record the number of enemies he killed or the seriousness of the wounds he sustained [5]. It is clear that this type of quipu contains a vast amount of contextual information which could only be interpreted by trained quipu readers, or so-called 'quipucamayoc'. These were usually sons of provincial nobility who were educated at Cuzco in the 'house of teaching'. At the same time

they were kept as hostages in order to ensure the loyalty of the provincial heads to the central government. The training extended over four years, which were devoted to history, the Quechua language (which is still spoken today), religion and to the reading of the quipus.



Figure 1.3 Topa Inca Yupanqui requesting information from a trained quipu reader or 'quipucamayoc' about the contents of the imperial store rooms [2].

The quipu system was an essential instrument for the administration of a strongly centralized government. Figure 1.3 shows a drawing from the records of Poma de Ayala, representing Topa Inca Yupanqui (who reigned from 1471 to 1493), requesting information from his 'administrador' about the contents of his store rooms (depocitos del Ynca) [6]. The system

seems to have been highly reliable, as punishment for committing errors in recording and reproduction was extremely severe and often resulted in decapitation.

One must distinguish between accounting quipus, which were used as instruments of centralized government and the narrative quipus, which described historical and religious events. (From the point of view of statistical graphics it is the former which concerns us most.) The quipu system served at the same time as a visual recording system for quantitative data as well as for religious, social, military and economic history. In this respect it is rather unique. More recent attempts to construct non-verbal and visual means of communication (such as Isotype by Otto Neurath [7]) have not been as successful as the quipu system. The success of quipu must be attributed to the lack of a written language, to the rich contextual structure that is offered by combining different colors, lengths of ropes, positions and types of knots, etcetera, and to the demand of a strongly hierarchical society. The quipu is a universal system of recording and reproduction of numbers which uses neither words nor numbers. It speaks a language of its own. Unfortunately, the syntax and the grammar has been lost during the troubled times that followed the Spanish conquista.



Figure 1.4 The capture of Atahualpa and the surprise attack on the Incas by the Spanish conquistadors at Cuzco in 1533 [8].

1.3 The decline of the quipu system

One may speculate briefly why the Inca Empire, which seemed to be highly efficiently organized, could not withstand 168 Spanish adventurers that disembarked on their shores together with 62 horses, a handful of muskets and two guns [8] (Fig. 1.4). Political rivalry among the leading Atahualpa (the son of a concubine of the Inca) and Huascar, the legal successor to the throne, may have contributed to the initial lack of resistance. Eventually, a heroic rebellion was led by Manco Inca, but was defeated by the Spanish in 1536 at the fortress of Sacsahuaman near Cuzco. Another reason for the rapid collapse of the Inca empire resides in

the rigid and centralistic society which prevailed and which was largely supported by quipu.

Notwithstanding its richness in context, quipu also appears as an inflexible and fragmentary instrument of government. For example, one type of quipu could provide detailed information on agricultural production in the various provinces, while another type of quipu (perhaps also requiring a different interpreter) had to be called upon for obtaining demographic data about the same provinces. The system did not allow combining the two types of information, such as to show the various degrees of productivity in the provinces. As a purely accounting system, the quipu appears essentially as a univariate carrier of information. Univariate means that one looks only at one variable at a time, such as the production of maize in the various provinces, or the number of peasants in these provinces, but not at both variables at the same time.

Univariate representations, by definition, do not show relationships between two or more variables. As we will discuss later on, information is not only contained in the individual quantities that describe how large or how small certain things are, such as crop production, labor force, fertility of the soil, etc. The most relevant information is often contained in the relationships between the quantities, for example, how crop production varies as a general rule with respect to labor force, fertility of the soil, and so on. Important information also resides in the exceptions to the general rule, for example, which provinces produce more (or less) than can be expected from the available labor force and richness of the soil. These deviations from the general pattern or trend are called contrasts. They cannot be made visible by means of univariate methods of display, and

require therefore bivariate, trivariate or multivariate approaches, which will be discussed in later chapters.

Nowadays we encounter quipus under different names and disguises, such as bar charts and pie charts. Each of these is designed to represent numbers by means of graphic elements one at a time. In the case of a bar chart, each number is translated into a line segment of corresponding length. In the case of a pie chart, each number is represented as a segment of a circle of corresponding area. These one-to-one translations do not carry information other than is expressed by the largeness or smallness of the numbers. They serve a useful purpose, however, as presentation graphics, which makes communication of factual data more efficient [9].

Notes

[1] The history and fall of the Inca Empire from 1476 to 1534 has been recorded by Garcilaso de la Vega, the son of an Inca princess and a Spanish conquistador. A modern edition of his chronicle 'Commentarios reales' appeared in Madrid in 1723.

More recent references to the Inca period in Peru are given below.

- Mason J. Alden, The ancient Civilisations of Peru. Penguin Books, Harmondsworth, Middlesex, Engl., 1957.
- G. Bankes, Peru before Pizarro. Phaidon, Oxford, 1977.
- L. Baudin, Daily Life in Peru under the last Incas. George Allen & Unwin, London, 1961.
- José Antonio del Busto Duthurburu, Perú Incaico. Libreria Studium, Lima, 1977.
- Hans Dietrich Disselhoff, Leben im alten Peru. Callway Verlag, München, 1981.
- Peter Frost, Exploring Cuzco. Lima 2000, Lima, 1979.
- Edward Hyams and George Ordish, The last of the Incas. Longmans, London, 1963.
- Sergio Purin (Ed.), Inca-Perú, 3000 Years of History. Royal Musea of Art and History, Brussels, 1990.

[2] Felipe Guaman Poma de Ayala, Nueva Cronica y bien Gobierno (1613). The illustrated record of Inca history and customs was intended as a letter to King Filips III of Spain. It was lost, but has been rediscovered in 1908 at the Royal Library of Copenhagen. According to the Encyclopaedia Britannica, a new edition was prepared by Arthur Posnansky in 1944.

[3] The counting and recording systems by yupana and quipu have been studied by:

William Burns Glynn, Introducción à la clave de la escritura secreta de los Incas (Introduction to the key of the secret writing of the Incas). Boletin de Lima, nr. 11-14, May-September 1981.

A discussion of quipus in the context of statistics is provided in:

J. Leroy Folks, Ideas of Statistics. J. Wiley, New York, NY, 1981.

They have also been referred to in:

'Schnüre und Stäbe zum Erinnern' (Ropes and sticks for memory). IBM Nachrichten, April 1986.

Both the yupana and the quipu may have been in use from pre-Inca times.

[4] This quipu is typical for the so-called 'mita', the socio-economic system of the Incas, which was based on reciprocity and exchange of goods and services. The interpretation of the quipu is from Sergio Purin, Inca-Perú. Opus cit.

[5] The quipu resides in the Museo di Antropologia e Etnologia in Florence. The interpretation is from E. Hyams and G. Ordich, The last of the Incas. Opus cit.

[6] Felipe Guaman Poma de Ayala, Nueva Cronica y bien Gobierno. Opus cit.
The quipu reader or quipucamayoc is Apo Poma Chava, the father of Curaca Condor Chava represented in Fig. 1.1.

[7] See the chapter on Otto Neurath and the Vienna method of picture statistics in this book.

[8] A description of the Spanish conquest of Peru, led by Francisco Pizarro, is found in: William H. Prescott, History of the conquest of Peru with a preliminary View of the Incas. Phillis, Sampson Publ., 1858. Original text at: <http://www.gutenberg.org/dirs/etext98/hcpru10a.txt>

[9] Richard N. Bialac, Analysis of the effectiveness and efficiency of business decision making using computer graphics. PhD Thesis, College of Business Administration, University of Cincinnati, 1985. University Microfilms Int., Ann Arbor, MI, 1986.

History of Peru and the Conquest

≈ 1200 AD Manco Capac, descendant of the sun, founded the Inca dynasty at Cuzco, according to legend.

1438-1471 Reign of Inca Pachacuti and installation of central government.

1471-1493 Reign of Topa Inca Yupanqui, conquest of the Chimu in Northern Peru.

1493-1527 Reign of Inca Huayna Capac, further conquests in the Andes and along the Western coast.

1524 and 1526 First and second exploratory expeditions by Francisco Pizarro and Diego de Almagro to Peru, starting from Panama.

1527 Atahualpa, bastard son of Huayna Capac, seizes power from Huascar, the legal heir. Civil war.

1532 Spanish conquest led by Francisco Pizarro and his two brothers. Capture of Atahualpa.

1533 Francisco Pizarro enters Cuzco unopposed. Atahualpa is held hostage for a huge ransom in gold. He is executed nevertheless, after payment of the ransom.

1536-1537 Heroic rebellion by Manco Inca. Siege of the fortress of Sacsahuaman, near Cuzco, and defeat of the Inca resistance.

1537-1538 Conflict between Francisco Pizarro and Diego de Almagro, ending with the execution of the latter at Sacsahuaman.

1541 Francisco Pizarro is assassinated in Lima by the son of Diego de Almagro.

1571 and 1572 Insurrections against Spanish rule.