OpenEyes - Coding Visual Acuity

Editors: G W Aylward
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Target Audience

General Interest	
Heathcare managers	
Ophthalmologists	✔
Developers	✔

Amendment Record

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Table of Contents

Introduction

Visual acuity is an essential data item for ophthalmology, but its recording and storage are complicated by a multiplicity of methods used to measure and record it. This document sets out a flexible approach to storing and manipulating visual acuity data, which is designed to be flexible enough to encompass all current and future visual acuity measurement systems.

Visual Acuity Systems

The traditional method of measuring visual acuity makes use of Snellen charts, introduced by Hermann Snellen in 1862. This is probably the most widely used system within optometry and ophthalmology. Acuity is usually expressed as a vulgar fraction with the viewing distance as the numerator. This is 6 metres in England and 20 feet in the USA. In Europe the fraction is expressed as a decimal number, e.g. 0.1.

Researchers at the National Eye Institute modified the Bailey-Lovie chart for the Early Treatment of Diabetic Retinopathy Study (ETDRS), to give a more accurate measurement of acuity.

LogMAR is an acronym for Log10 of the Minimum Angle of Resolution (MAR).The MAR is taken as the stroke width of the letters, which is one fifth of their vertical angular subtense.

Data Structure

The data structure for the acuities table is shown in the following table. Acuity will most often be recorded as part of an opthalmic examination record (See the manual OpenEyes - Viewing Events). A notable feature is that there is a field to contain the foreign key from the patients table. At first sight this violates the principle of database normalisation, since the patient_id can always be found via the event and examination key. However, since acuity is such an important measure, it is likely that it will be recorded in a variety of different situations, and the presence of a foreign key here will make analysis significantly simpler. Each entry contains values for right and left eyes, since acuities are almost always measured in both eyes. Fields giving details of the circumstances of the measurement (distnace, correction etc) are also provided.

Field	Type	Comments
acuity_id	INT UNSIGNED NOT NULL AUTO_INCREMENT	Primary Key, 4 billion
patient_id	INT UNSIGNED NOT NULL	Foreign key referencing patients
examination_id	INT UNSIGNED NOT NULL	Foreign key referencing examinations
rva_ua	TINYINT UNSIGNED	Unaided acuity. Range is 0 to 118

Field	Type	Comments
lva_ua	TINYINT UNSIGNED	Unaided acuity. Range is 0 to 118
rva_cr	TINYINT UNSIGNED	Corrected acuity. Range is 0 to 118
lva_cr	TINYINT UNSIGNED	Corrected acuity. Range is 0 to 118
rva_ph	TINYINT UNSIGNED	Pinhole acuity. Range is 0 to 118
lva_ph	TINYINT UNSIGNED	Pinhole acuity. Range is 0 to 118
aid	ENUM('Unaided', 'Glasses', 'Contact Lens', 'Pinhole', 'Refraction') DEFAULT 'Unaided'	Refractive aids used for the measurement
format	ENUM('ETDRS','Snellen Foot', 'Snellen Metre', 'Decimal', 'LogMar')	Visual acuity format
distance	FLOAT(4,2) UNSIGNED	Distance in metres from the patient to the chart
type	ENUM('Near', 'Distance') DEFAULT 'Distance'	Mode of visual acuity being measured

Acuity values are stored as positive integers with the range 0 to 118, which makes for efficient storage. Values are converted ‘on the fly’ into more meaningful values according to the context. Low level values of acuity (eg hand movements) are common to all coding systems, so are directly represented as set out in the following table.

Value	Meaning
0	Not recorded
1	No perception of light
2	Perception of light
3	Hand movements
4	Counting fingers
5 - 118	ETDRS letters 1 - 114

Values of 5 or greater are then converted into other acuity systems using formulae described in the next section.

Conversion between systems

Stored value to ETDRS

Since the number of ETDRS letters is also a positive integer, the conversion from the acuity value to ETDRS is a simple offset, ie:

$$e = v - 4$$

where e is the number of ETDRS letters, and v is the stored value.

ETDRS to Decimal

Decimal acuity may be derived from the number of ETDRS letters using the following formula;

$$d = \frac{1}{10^{1.7-0.02e}}$$

where d is the decimal acuity, and e is the number of ETDRS letters

Decimal to Snellen

Deriving the equivalent Snellen acuity is simply done by converting the decimal acuity into a vulgar fraction as follows;

$$s = \frac{6}{d}$$

Where d is the decimal acuity, and the numerator is 6 or 20 for metres or feet respectively. This value is normally rounded to an integer value, and expressed as the denominator of the fraction.

The Acuity Converter Object

OpenEyes includes a PHP class (OEVisualAcuityConverterClass) which handles conversion from stored acuity values to strings suitable for display. Class methods are provided to convert both ways for display, and editing of acuity values. Currently conversion to ETDRS letters, Snellen (metres), Snellen (feet), and Decimal are provided. The class also provides convenience methods to write HTML select elements allowing user selection of acuity values.

References