

Readout of CDMAM 3.4 images by human observers

In this document an example is given of a readout of CDMAM 3.4 images by experienced observers, from the National Expert and Training Centre for Breast Cancer Screening at Nijmegen. This example can be used as reference results of measurement 2.4.1 Threshold contrast visibility of the “Addendum on digital mammography to chapter 3 of the European Guidelines, version 1.0”.

The observation

In the example 8 (unprocessed) images are made of the CDMAM-phantom type 3.4. Four experienced observers have scored each 2 different images from the set of 8. The images have been scored on a high-resolution diagnostic monitor. The window width and level and zoom facilities have been adjusted to maximise the visibility of the details on the displayed images.

The observed position of the eccentric disks (only the squares just above and below the line of the threshold of visibility) have been written down on a “Score form CDMAM-phantom” from the “Manual of the CDMAM-phantom type 3.4”. After that, the indicated positions of the eccentric disks have been compared to the true disk positions in the phantom. For that the “Evaluation form CDMAM-phantom”, also from the manual of the phantom, has been used. The files “ScoreFormImage*.jpg” show the results. The small blue crosses are the indicated positions of the eccentric disks. A big red cross shows when the eccentric disk was indicated at a false position. To evaluate the observations a so-called “nearest neighbours correction” has been applied. In the next section this is described briefly, see the manual of the phantom for details of the correction.

The evaluation

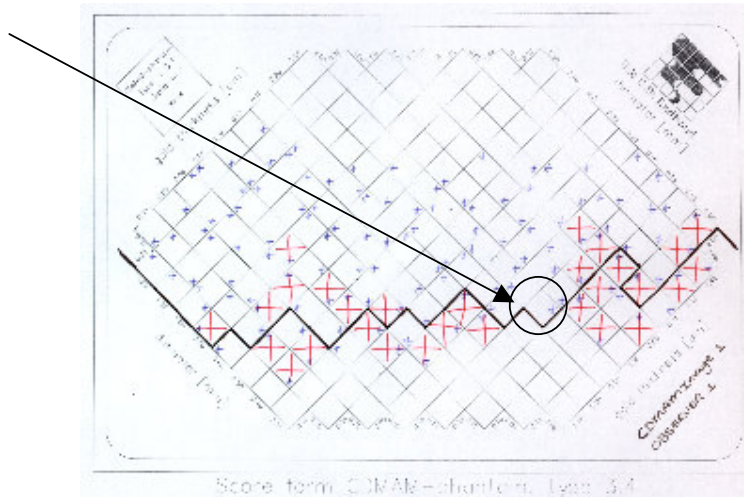
The purpose of each observation is to determine, for each disk diameter [mm], the threshold gold thickness [μm] (the just visible gold thickness [μm]). So in every column (diameter) the first correctly indicated eccentric disk has been determined. For every score there are three possibilities:

- **T**: the eccentric disk was indicated at the true position
- **F**: the eccentric disk was indicated at a false position
- **N**: the eccentric disk was not indicated at all

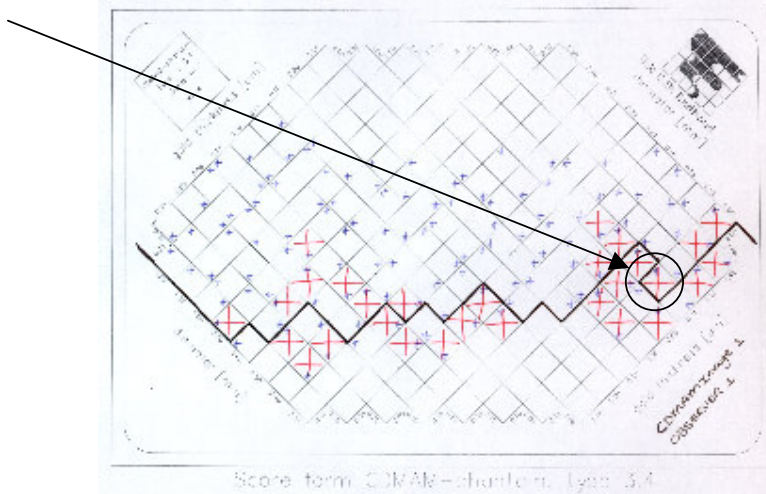
The “nearest Neighbours correction” has two main rules:

1. A **T** needs 2 or more correctly indicated nearest neighbours to remain a **T**.

Example:

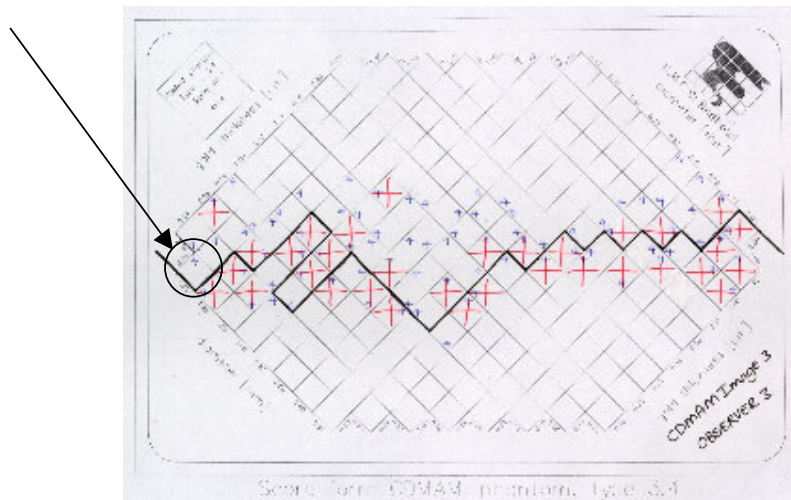


2. A **False** or **Not** indicated disk will be considered as **True** when it has 3 or 4 correctly indicated nearest neighbours.
Example:

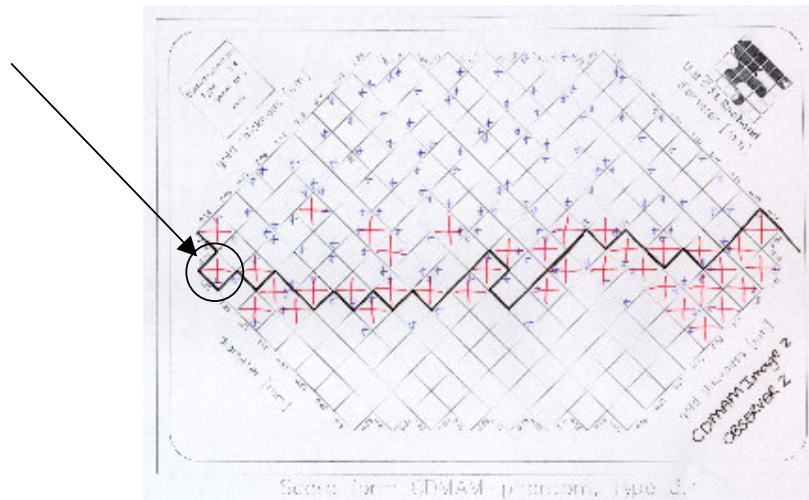


Exceptions on this two main rules are:

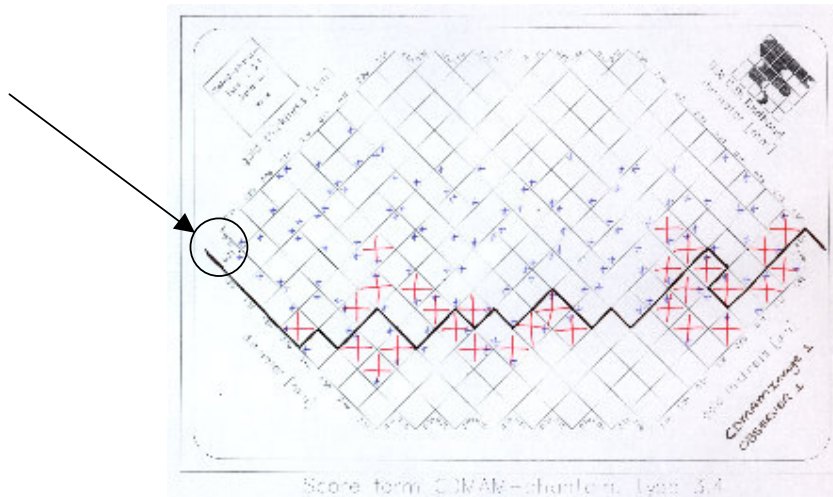
1. A **True** which has only 2 nearest neighbours (at the edges of the phantom) needs only 1 correctly indicated nearest neighbour to remain **True**.
Example:



2. A **False** or **Not** indicated disk which has only 2 nearest neighbours will be regarded **True** if both nearest neighbours are correctly indicated.
Example:



3. The absent corners of the phantom ($0.03\ \mu\text{m}/2.0\ \text{mm}$ and $2.00\ \mu\text{m}/0.06\ \text{mm}$) will be regarded **True** when both nearest neighbours are correctly indicated.
Example:



In the files "ScoreFormImage*.jpg" the results of the determination of the threshold gold thickness is shown by the black line.
The results of all images have been put in a table and the average threshold gold thickness has been calculated. This result can be used as a reference. See the next section.

The results

diameter (mm)	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	Image 7	Image 8	Average Threshold gold thickness (um)
	Observer 1	Observer 2	Observer 3	Observer 1	Observer 4	Observer 2	Observer 3	Observer 4	
	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	Threshold gold thickness (um)	
0.06	X	X	X	1.42	X	X	X	X	X
0.08	0.71	X	X	1.42	1.42	1.00	X	X	X
0.1	1.00	1.00	1.42	1.42	1.42	0.71	1.42	1.00	1.17
0.13	0.25	0.71	1.00	0.50	1.00	0.50	1.00	1.00	0.75
0.16	0.20	0.71	0.50	0.50	0.71	0.36	0.71	0.50	0.52
0.2	0.20	0.50	0.50	0.16	0.20	0.36	0.36	0.25	0.32
0.25	0.13	0.16	0.25	0.16	0.20	0.20	0.20	0.25	0.19
0.31	0.10	0.20	0.10	0.16	0.20	0.08	0.13	0.20	0.15
0.4	0.06	0.10	0.10	0.16	0.16	0.08	0.10	0.16	0.12
0.5	0.06	0.08	0.10	0.05	0.10	0.06	0.06	0.10	0.08
0.63	0.04	0.06	0.10	0.04	0.10	0.08	0.05	0.08	0.07
0.8	0.03	0.05	0.05	0.05	0.08	0.05	0.06	0.06	0.05
1	0.03	0.05	0.10	0.04	0.08	0.04	0.05	0.08	0.06
1.25	0.03	0.04	0.05	0.03	0.06	0.06	0.04	0.04	0.04
1.6	0.03	0.03	0.03	0.03	0.06	0.03	0.03	0.03	0.03
2	0.03	0.04	0.03	0.03	0.05	0.03	0.04	0.04	0.04

Remark: "X" means the threshold gold thickness lies outside the phantom.
The value 0.03 means that all gold disks with the concerning disk diameter are visible.

At the National Expert and Training Centre for Breast Cancer Screening, after the calculation of the average threshold gold thickness [μm] per disk diameter [mm], these values are converted to threshold radiation contrast [%] according to the equation:

$$C = 100 * (1 - e^{-\mu T})$$

C = threshold radiation contrast [%]

μ = attenuation coefficient of gold for the kVp and filtering used

T = threshold gold thickness [μm]

Finally a curve is fitted through the points of the threshold radiation contrast [%] per disk diameter [mm], so the fitted curve can be compared with the limits for threshold contrast visibility according to the "Addendum on digital mammography to chapter 3 of the European Guidelines, version 1.0".

Nijmegen, May 2004.