Postcode en Woonplaats: | Jaar van eerste inschrijving: | Datum: | Naam docent:

1 a A mapping φ is called increasing, if

$$X \subseteq Y \Rightarrow \varphi(X) \subseteq \varphi(Y).$$

Suppose we have binary images X and Y and $X \subseteq Y$. γ_λ removes connected foreground components of X, Y with area smaller than λ.

Suppose X ~~has~~ is connected foreground component set $\mathcal{C} = \{c_1, \dots, c_k\}$, then Y ~~has~~ is connected foreground component set $\mathcal{D} = \{d_1, \dots, d_\ell\}$, with ~~[illegible]~~ $\bigcup c_i \subseteq \bigcup d_j$

0.5

Now if γ_λ removes a set ~~of pixels~~ S from X, then it will remove a set $S' \subseteq S$ from $X \cap Y \subseteq Y$.

$$X \subseteq X \cap Y \subseteq Y \Rightarrow$$

$$\gamma_\lambda(X) = X \setminus S \subseteq (X \cap Y) \setminus S' \subseteq \gamma_\lambda(Y)$$

So γ_λ is increasing.

b Since γ_λ can only remove components, we have that $\gamma_\lambda(X) \subseteq X$ for every X.

0.5

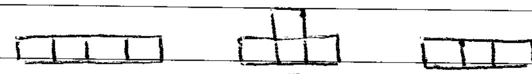
So γ_λ is anti-extensive.

c Opening : $X \circ A := (X \ominus A) \oplus A = \bigcup_{h \in E} \{A_h : A_h \subseteq X\}$

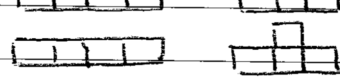
The opening is the union of all the translates of the structuring element which are included is the set X.

Ok, but you can also consider any increasing anti-extensive and idempotent mapping an opening

Take X as follows:



~~and~~ now $\gamma_4(X)$ is

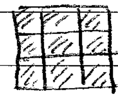
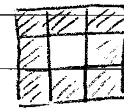


1

If γ_4 were an opening, A would ~~have~~ contain [illegible], because [illegible] $\subseteq \gamma_4(X)$ and [illegible] $\not\subseteq \gamma_4(X)$.

But if [illegible] $\subseteq A$, then [illegible] $\not\subseteq \gamma_4(X)$.

So we have a contradiction $\Rightarrow$ γ_4 is not an opening.

1 d Take A  and B , then

$B \subseteq A$ and perimeter for A is 12 and for B 13.
(here 4-connectivity is assumed).

Now $\psi_{13}(A) = \phi$ and $\psi_{13}(B) = B$.
So $\psi_{13}(B) \not\subseteq \psi_{13}(A)$.

$\Rightarrow \psi_\lambda$ is not increasing.

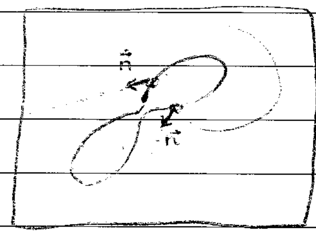
0.5

2.5

Postcode en Woonplaats:	Jaar van eerste inschrijving:	Datum: Naam docent:

2 a c: The snake will not encounter anything before it reaches the image boundary. So the snake will end up at the boundary and as a boundary of the image.

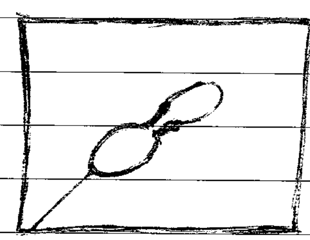
d: The snake will be the boundary of what we see in Fig. 1(b).

e: 

We have at start a part inside (purple) and apart outside (black).

The part of the snake that is inside the bacterium cannot get out of it and the part outside cannot get in.
The points on the contour of the bacterium will stay where they are.

0.75

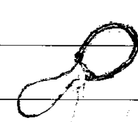
So we get: 

b c: The snake will be the on the boundary of Fig. 1(b).

d: The snake will be something like
(the black is the snake in its initial position).
It just contracts until it meets itself
could even be in a single point

0.5

e: We get the part of the bacterium contour that is inside the snake:

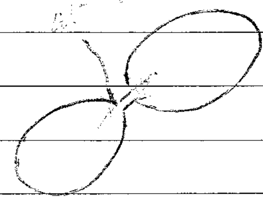


a bit more likely

2 c

0.5

1.75



at the purple points,
because the normal of the
contour changes much there.

Postcode en Woonplaats:

Jaar van eerste inschrijving:

Datum: 10 - 11 - 2005

Naam docent:

4 a $\vec{w} = \frac{1}{\sqrt{2^2+1^2+f^2}}\begin{pmatrix}2\\1\\f\end{pmatrix}$ direction vector of AB

$\vec{w}' = \frac{1}{\sqrt{2^2+(-1)^2+f^2}}\begin{pmatrix}2\\-1\\f\end{pmatrix}$ direction vector of AD

then we have $\vec{w}\cdot\vec{w}' = \cos\alpha$

$$\frac{1}{\sqrt{5+f^2}}\frac{1}{\sqrt{5+f^2}}\begin{pmatrix}2\\1\\f\end{pmatrix}\cdot\begin{pmatrix}2\\-1\\f\end{pmatrix} = \cos\alpha$$

$$\frac{1}{5+f^2}(4-1+f^2) = \cos\alpha$$

$$1-\frac{2}{5+f^2} = \frac{3+f^2}{5+f^2} = \cos\alpha$$

$$\frac{2}{5+f^2} = 1-\cos\alpha$$

$$5+f^2 = \frac{2}{1-\cos\alpha}$$

$$f^2 = \frac{2}{1-\cos\alpha}-5$$

$$f = \sqrt{\frac{2}{1-\cos\alpha}-5}$$

b $\alpha = \frac{\pi}{2} \rightarrow f = \sqrt{2-5} = \sqrt{-3} \notin \mathbb{R}$

Suppose we have a rectangle, then f would not be a real value. But this is not possible, f must be real, so the parallelogram can't be a rectangle.

$7 - 0$

$(p, q) = \left(\frac{\partial z}{\partial x}, \frac{\partial z}{\partial y}\right) = (-2x, -2y)$

$\vec{n} = (p, q, -1) = (-2x, -2y, -1)$

$\|\vec{n}\| = \sqrt{(-2x)^2 + (-2y)^2 + (-1)^2} = \sqrt{4(x^2+y^2)+1}$

1.5 $R(p, q) = \frac{\vec{n} \cdot \vec{s}}{\|\vec{n}\| \|\vec{s}\|} = \frac{(-2x, -2y, -1) \cdot (a, b, c)}{\sqrt{4(x^2+y^2)+1}}$

$= \frac{-2ax - 2by - c}{\sqrt{4(x^2+y^2)+1}} = E(x, y)$

correct; error in (1) exercise (sorry!)

b take $\vec{s} = (1, 0, 0)$, then with the result above we have that

$$E(x, y) = \frac{-2x}{\sqrt{4(x^2+y^2)+1}}$$

which is positive for negative x and negative for positive x, which does not seem right since the light source is in the direction of the positive x-axis

with (1) we have

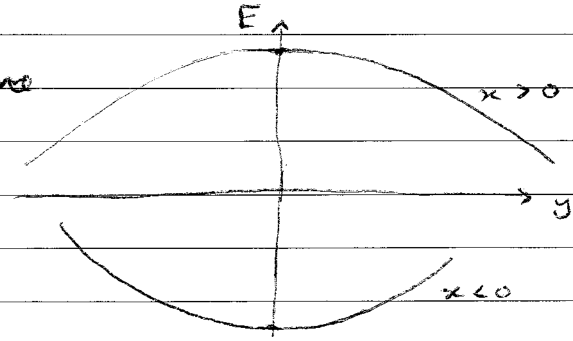
$$E(x, y) = \frac{2x}{4(x^2+y^2)+1}$$

which is positive for $x > 0$ and negative for $x < 0$ (and 0 for $x = 0$)

0.5 $E(x, y)$ is symmetric in the ~~y~~ x-axis

For a fixed x we have that $E(x, y) = \frac{2x}{(4x^2+1)+4y^2}$

~~$\frac{\partial E}{\partial y}$~~ so ~~[illegible]~~ we have something like →



→ but what does a negative value