ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Diffeomorphic Modeling of the Brain Aging Process

Master Thesis

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Tuesday 25th June, 2019

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Advisor: V. Wegmayr

Department of Computer Science, ETH Zürich

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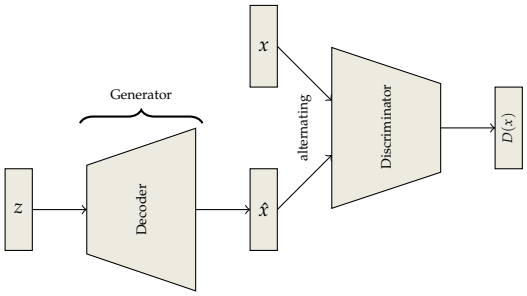
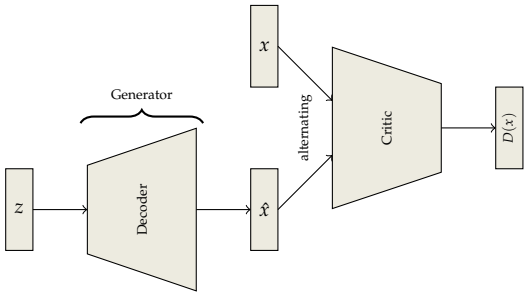
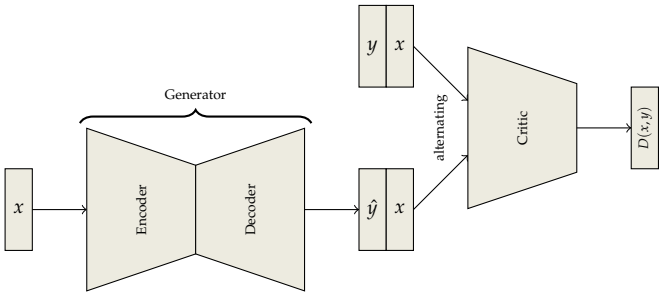
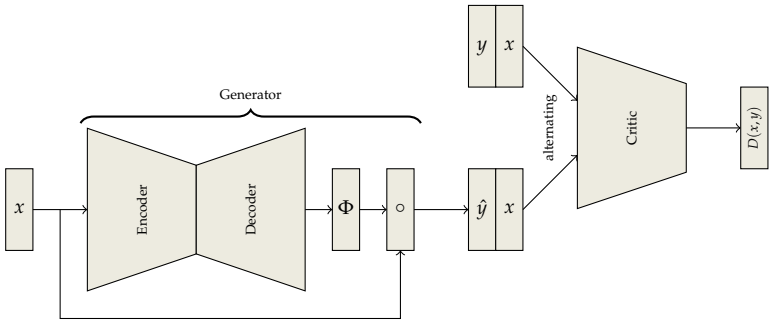
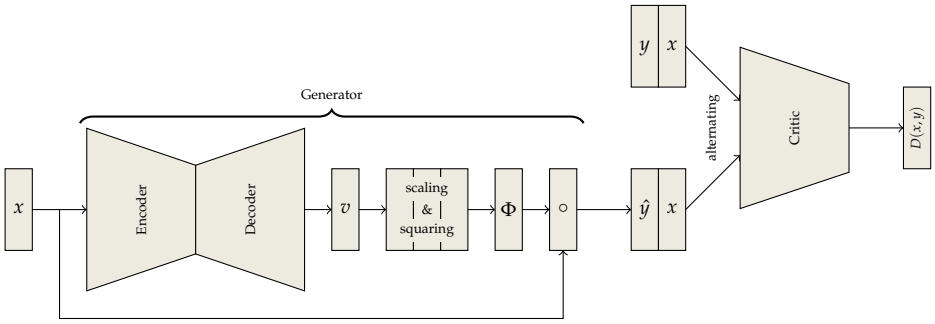
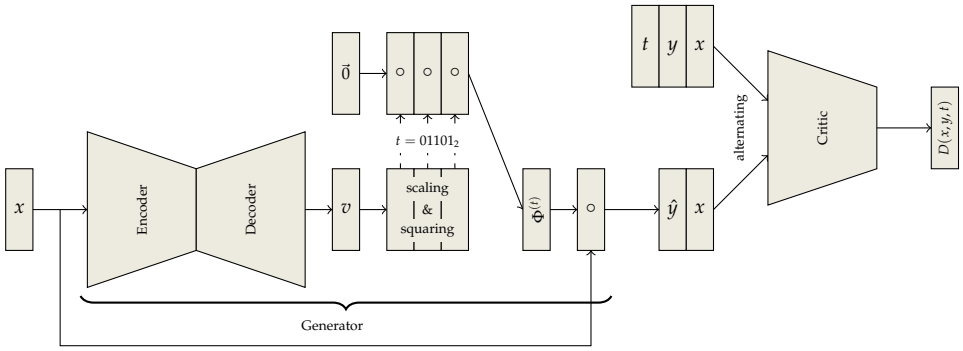

x
Generator
alternating
Discriminator
D(x)
z
Decoder
x̂

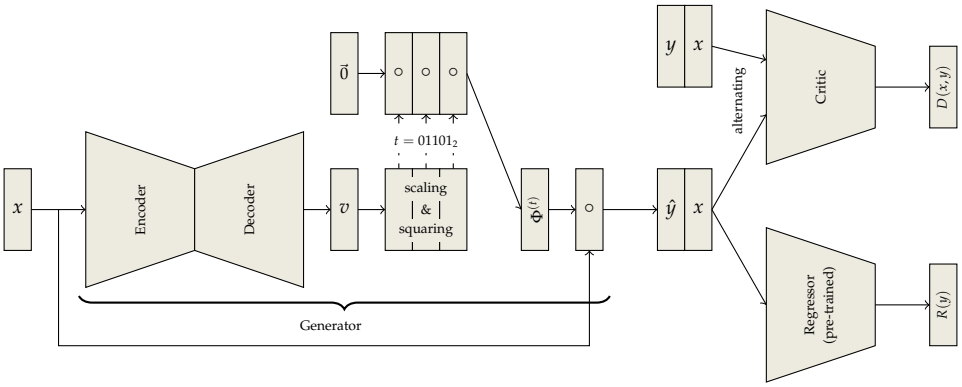

x
Generator
alternating
Critic
D(x)
z
Decoder
x̂

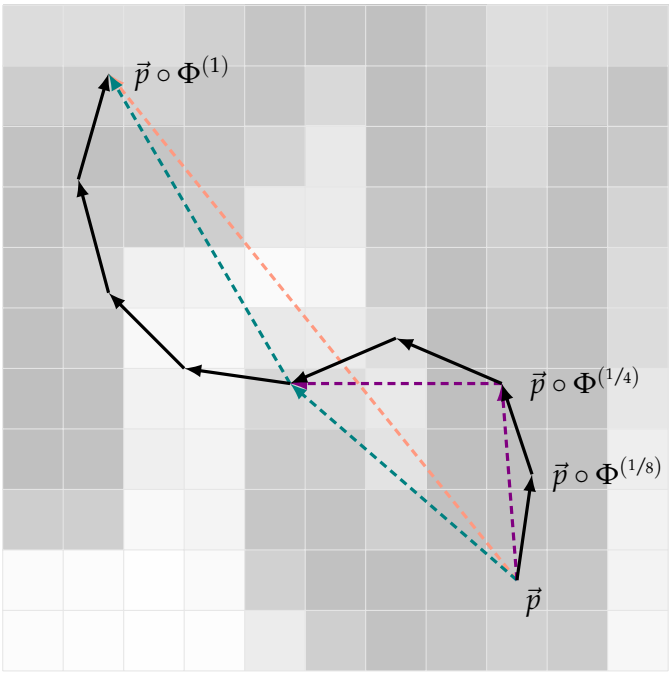

Generator
x
Encoder
Decoder
ŷ
x
y
x
alternating
Critic
D(x, y)

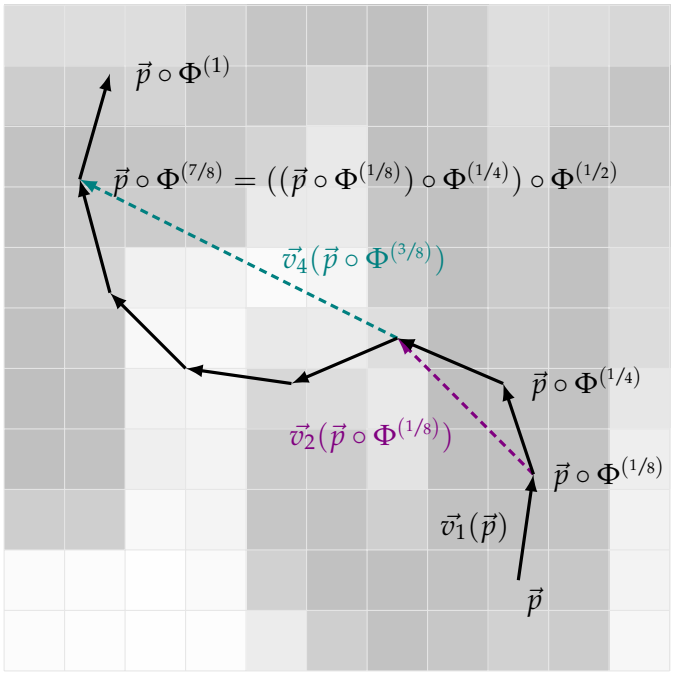

Generator
Encoder
Decoder
Φ
∘
x
ŷ
x
y
x
alternating
Critic
D(x, y)

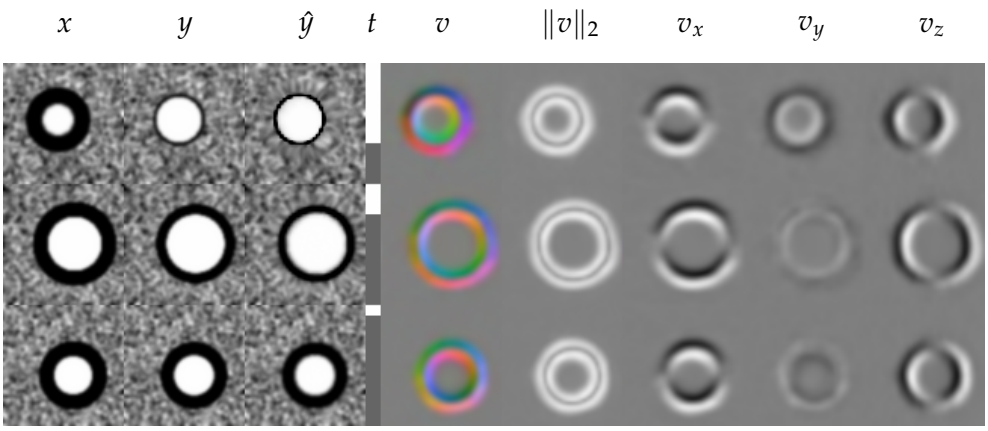

Generator
Encoder
Decoder
scaling
&
squaring
alternating
Critic

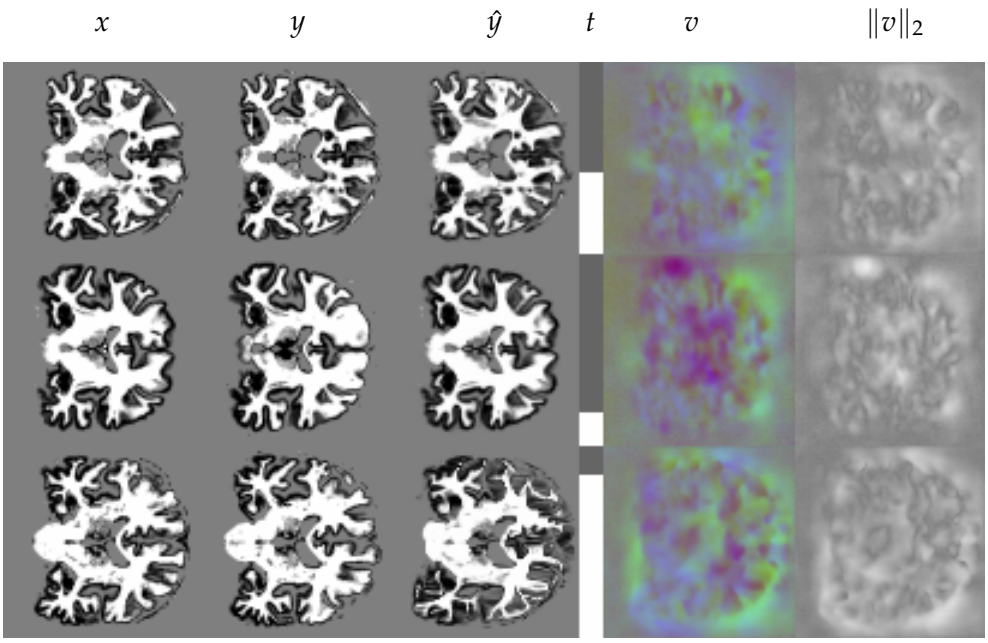

$\vec{0}$
$t = 01101_2$
t y x
alternating
Critic
$D(x, y, t)$
x
Encoder
Decoder
v
scaling
&
squaring
$\Phi^{(t)}$
$\hat{y}$ x
Generator

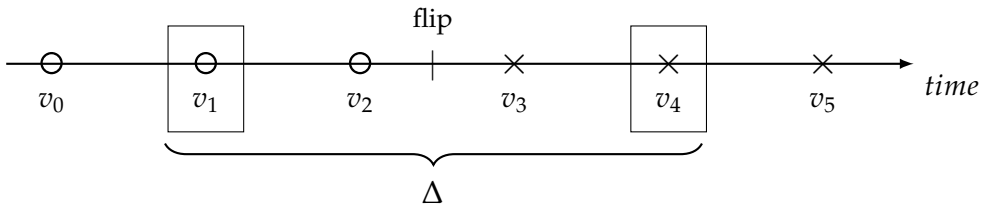

x
Encoder
Decoder
v
$\vec{0}$
$t = 01101_2$
scaling
&
squaring
$\Phi^{(t)}$
$\circ$
$\hat{y}$ x
y x
alternating
Critic
$D(\hat{x}, y)$
Regressor
(pre-trained)
$\mathcal{R}(\hat{y})$
Generator

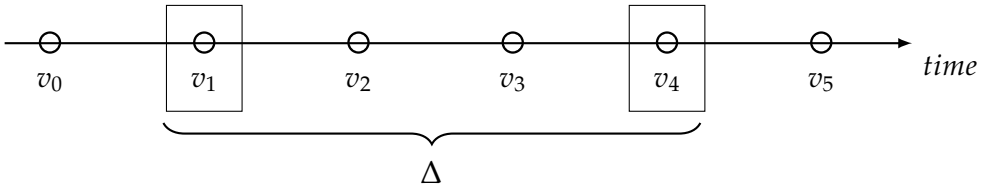

$\vec{p} \circ \Phi^{(1)}$
$\vec{p} \circ \Phi^{(1/4)}$
$\vec{p} \circ \Phi^{(1/8)}$
$\vec{p}$


$\vec{p} \circ \Phi^{(1)}$
$\vec{p} \circ \Phi^{(7/8)} = ((\vec{p} \circ \Phi^{(1/8)}) \circ \Phi^{(1/4)}) \circ \Phi^{(1/2)}$
$\vec{v}_4(\vec{p} \circ \Phi^{(3/8)})$
$\vec{p} \circ \Phi^{(1/4)}$
$\vec{v}_2(\vec{p} \circ \Phi^{(1/8)})$
$\vec{p} \circ \Phi^{(1/8)}$
$\vec{v}_1(\vec{p})$
$\vec{p}$


x
y
$\hat{y}$
t
v
$\|v\|_2$
v_x
v_y
v_z


x
y
$\hat{y}$
t
v
$\|v\|_2$


flip
v_0
v_1
v_2
v_3
v_4
v_5
time
Δ


v_0
v_1
v_2
v_3
v_4
v_5
time
Δ

$$\frac{\partial \Phi^{(t)}}{\partial t} = v(\Phi^{(t)}) \tag{0.1}$$

Split	absolute		difference	
	μ	σ	μ	σ
$\mathcal{S}_0$	3.58	2.92	1.37	1.65
$\mathcal{S}_1$	3.69	2.93	1.20	1.55
$\mathcal{S}_2$	4.07	3.01	1.30	1.58
$\mathcal{S}_3$	4.07	3.07	1.36	1.55
$\mathcal{S}_4$	3.90	3.31	1.37	1.72
	3.86	3.05	1.32	1.61

	Accuracy			F_1-Score		
		μ	σ		μ	σ
x		63.81	1.67		54.76	2.77
y	+12.09	75.90	0.90	+14.61	69.37	1.14
GAN	+2.95	66.75	2.33	+5.07	59.83	2.77

Config		Accuracy		Classifier				
		μ	σ	1	2	3	4	5
x		63.81	1.67	64.17	65.41	64.18	61.06	64.25
y	+12.09	75.90	0.90	74.52	76.17	76.69	75.80	76.31
GAN	+2.95	66.75	2.33	69.76	65.83	69.02	64.59	64.58

Config		F_1-Score		Classifier				
		μ	σ	1	2	3	4	5
x		54.76	2.77	52.48	56.36	55.33	51.49	58.14
y	+14.61	69.37	1.14	67.77	69.71	70.26	68.93	70.20
GAN	+5.07	59.83	2.77	63.10	60.32	61.81	58.34	55.60