A first *MatLab* code for post-stack inversion

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May 17, 2020

Physica A: Statistical Mechanics and its Applications
Volume 548, 15 June 2020, 124473

Robust full-waveform inversion using q-statistics

Sérgio Luiz Eduardo Ferreira da Silva [a], Carlos A.N. da Costa [a], Pedro Tiago C. Carvalho [a], João Medeiros de Araújo [a], Liacir dos Santos Lucena [a], Gilberto Corso [b]

entropy

MDPI

Article

Tsallis Entropy, Likelihood, and the Robust Seismic Inversion

Igo Pedro de Lima [1,†], Sérgio Luiz E. F. da Silva [2,*,†], Gilberto Corso [1,3,†] and João M. de Araújo [1,2,†]

Published: 19 April 2020. Entropy 2020, 22(4), 464;

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Purpose of this presentation

- Understand how the *MbPsiRefEnt2020* code works to estimate the reflectivity of the subsurface of a region of interest from post-stacked-data-driven;

- MbPsiRefEnt2020 $--> $ Model-based post-stack inversion - reflectivity - Entropy 2020.

Purpose of this presentation

- Understand how the *MbPsiRefEnt2020* code works to estimate the reflectivity of the subsurface of a region of interest from post-stacked-data-driven;

Solve a inverse problem!

- MbPsiRefEnt2020 $--> $ Model-based post-stack inversion - reflectivity - Entropy 2020.

Seismic inverse problem

Mathematical and statistical techniques for recovering the subsurface physical parameters from observed seismic data.

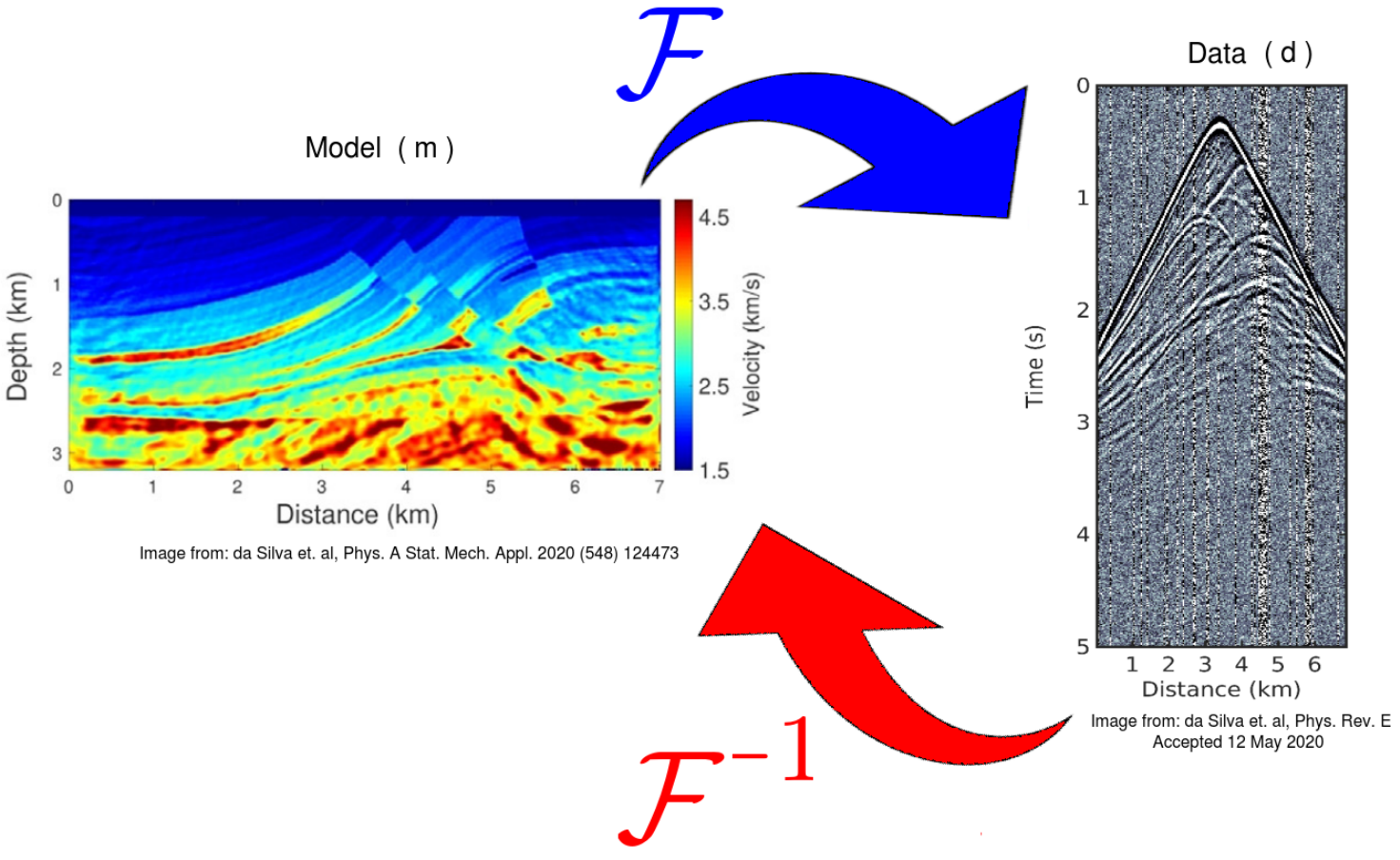

Image from: da Silva et. al, Phys. A Stat. Mech. Appl. 2020 (548) 124473

Image from: da Silva et. al, Phys. Rev. E
Accepted 12 May 2020

Forward Modelling

$d = \mathcal{F}(m)$: Given a model m, the simulated data d is computed using an operator that represents the relation between them.

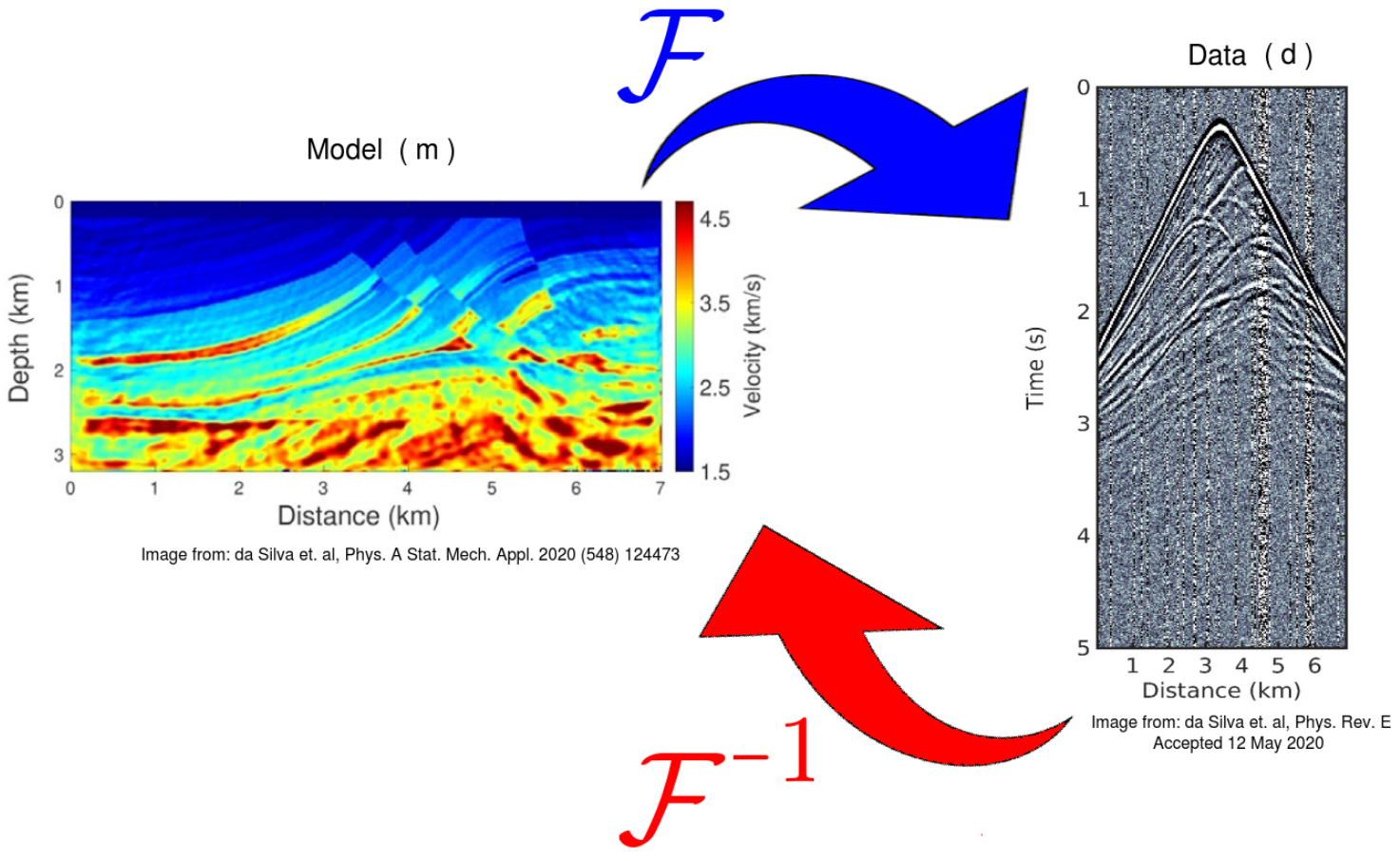

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Image from: da Silva et. al, Phys. Rev. E
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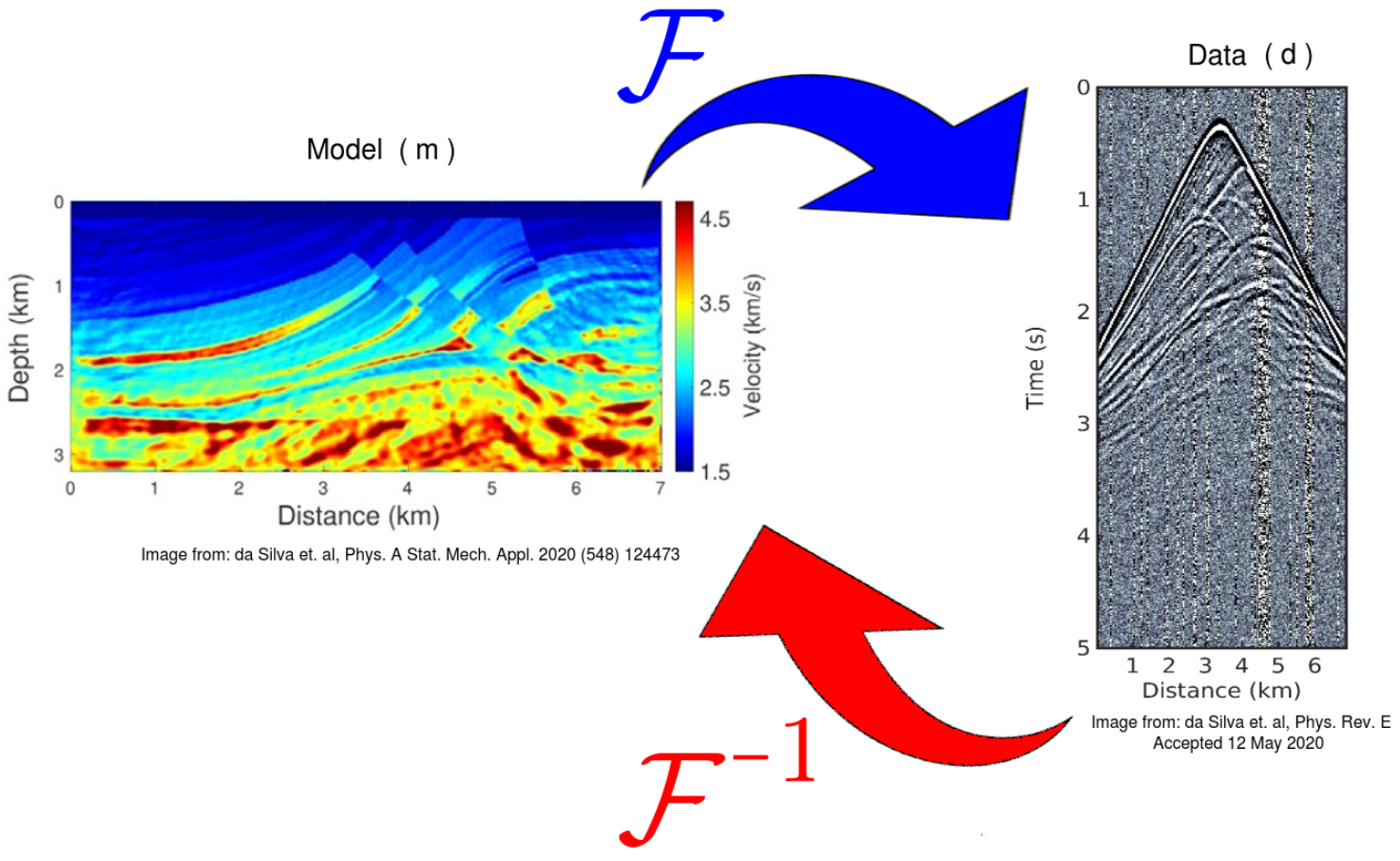
Inversion

$m = \mathcal{F}^{-1}(d)$: Given the observed data d, the predicting model m is computed using the inverse operation.



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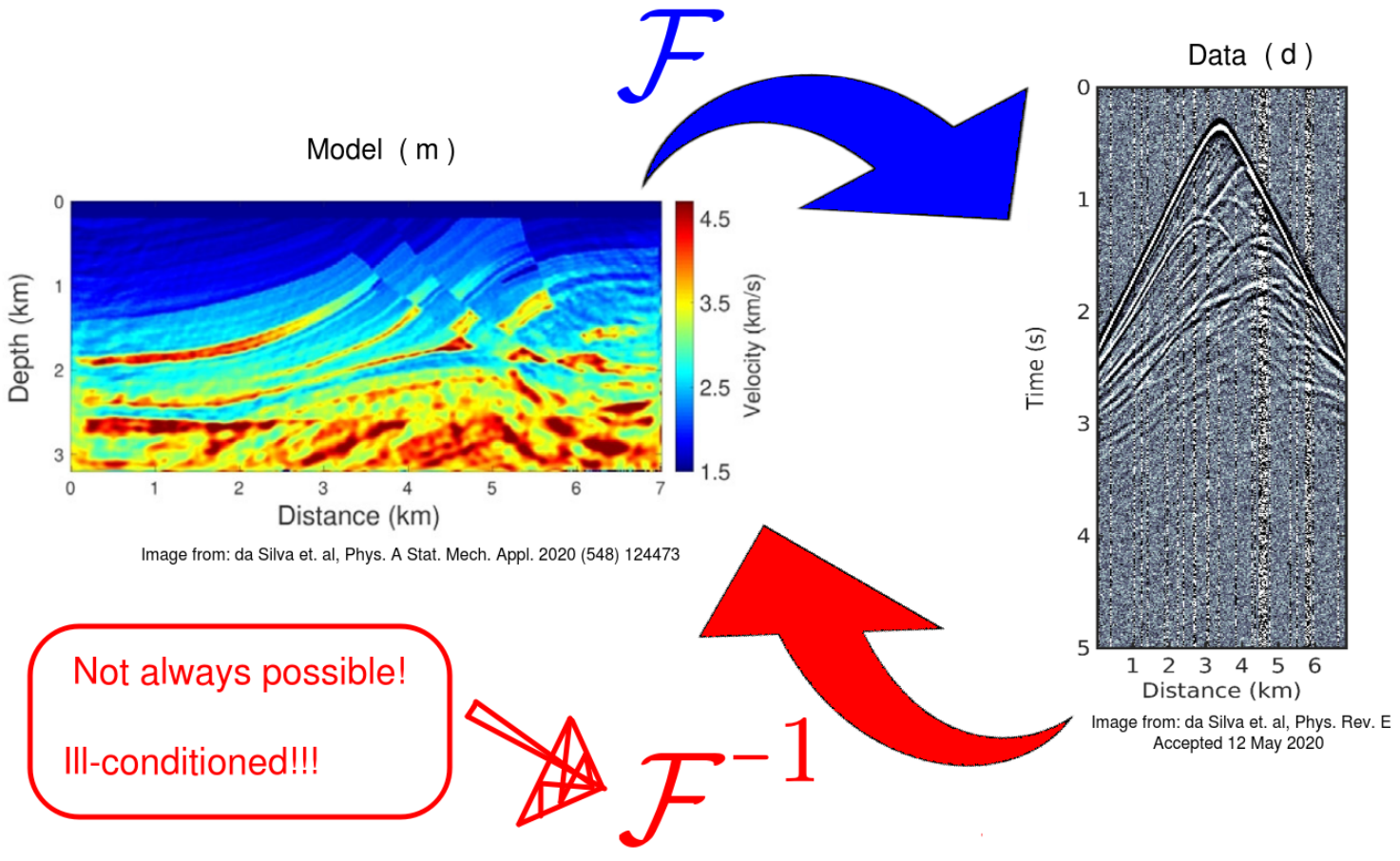
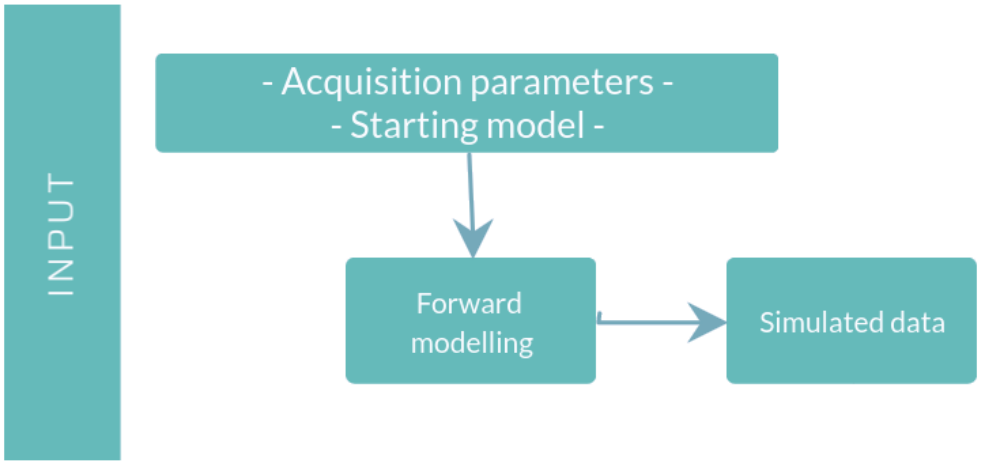
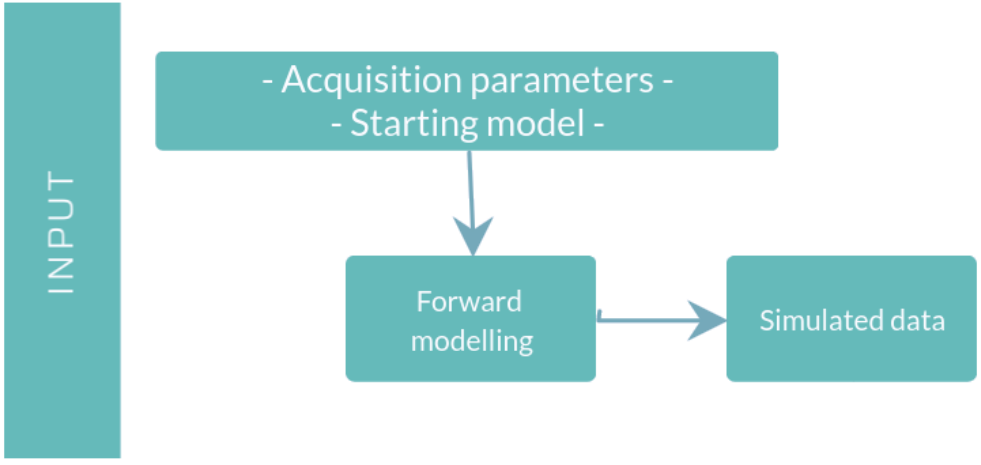


ITERATIVE SEISMIC INVERSION



BY SERGIO LUIZ EDUARDO

ITERATIVE SEISMIC INVERSION



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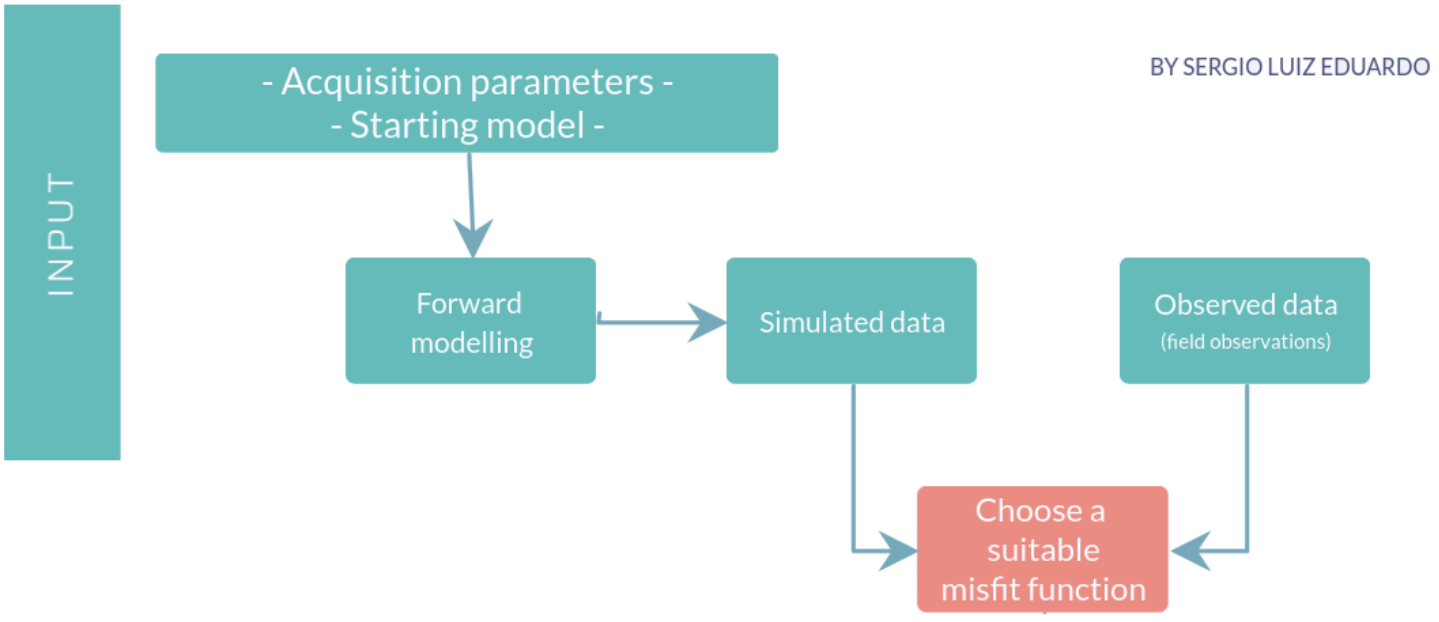
Seismic source

Reflectivity series (modelled)

$$d^{mod}(t,r) = s(t) * r(t) = Gr(t)$$

Convolution operator

ITERATIVE SEISMIC INVERSION



Least-squares approach

$$\min_{\mathbf{r}} \phi_G(\mathbf{r}) := \frac{1}{2} \sum_{i=1}^{n} \left(d_i^{mod}(t,r) - d_i^{obs}(t) \right)^T \left(d_i^{mod}(t,r) - d_i^{obs}(t) \right)$$

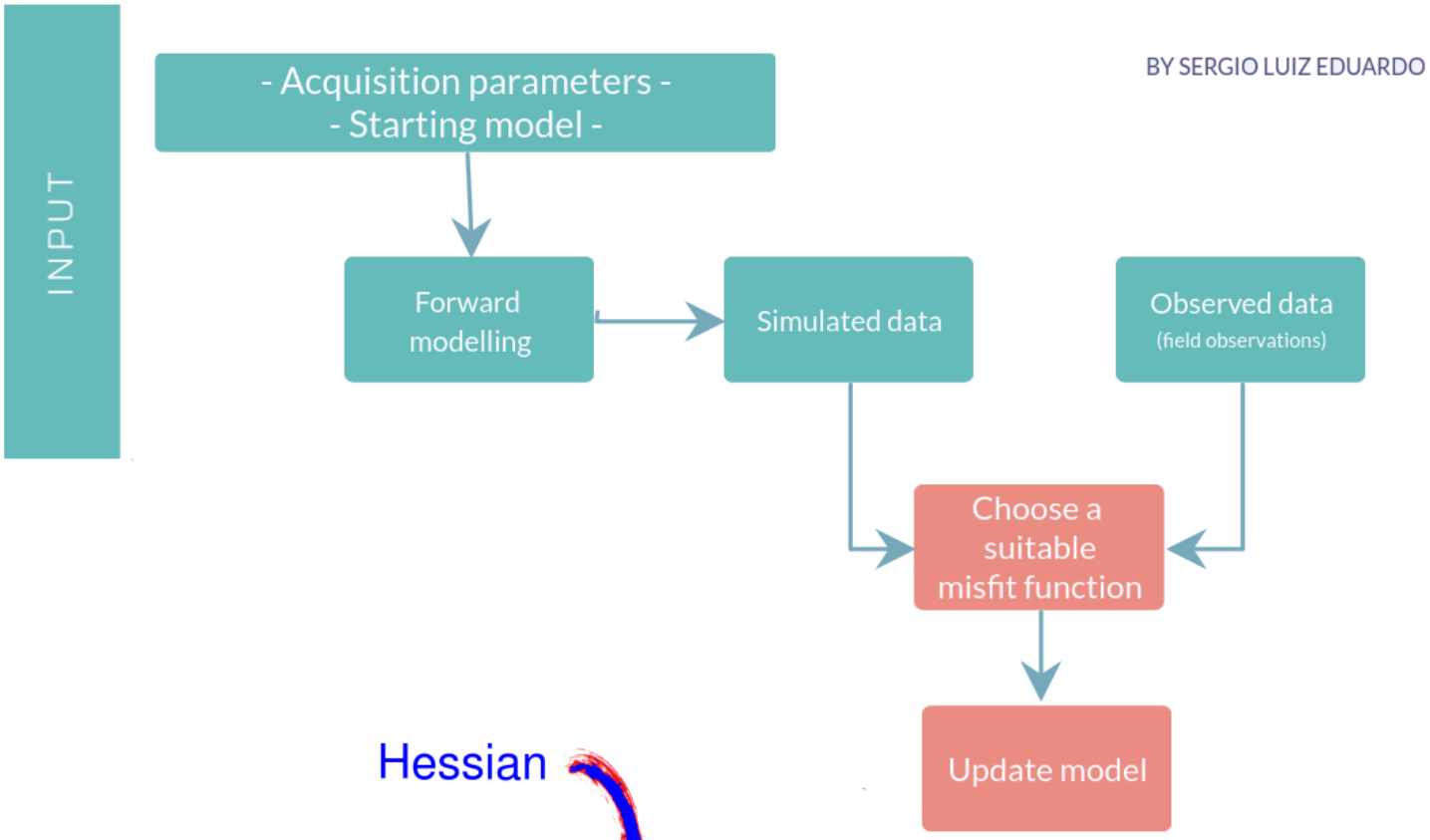
Tsallis approach

$$\min_{\mathbf{r}} \phi_q(\mathbf{r}) := \frac{1}{q-1} \sum_{i=1}^{n} \ln \left[1 + \left(\frac{q-1}{3-q} \right) \left(Gr_i(t) - d_i^{obs}(t) \right)^T \left(Gr_i(t) - d_i^{obs}(t) \right) \right]_+$$

da Silva et. al, (2020) Phys. A. Stat. Mech. Appl. (548) 124473; de Lima et. al, (2020) Entropy 22(4) 464

$$[a]_+ = \max\{0, a\}$$

ITERATIVE SEISMIC INVERSION



Hessian

$$\mathbf{r}_{k+1} = \mathbf{r}_k - \alpha_k \mathbf{H}^{-1} \nabla_{\mathbf{r}} \phi(\mathbf{r}_k)$$

steplength

Gradient

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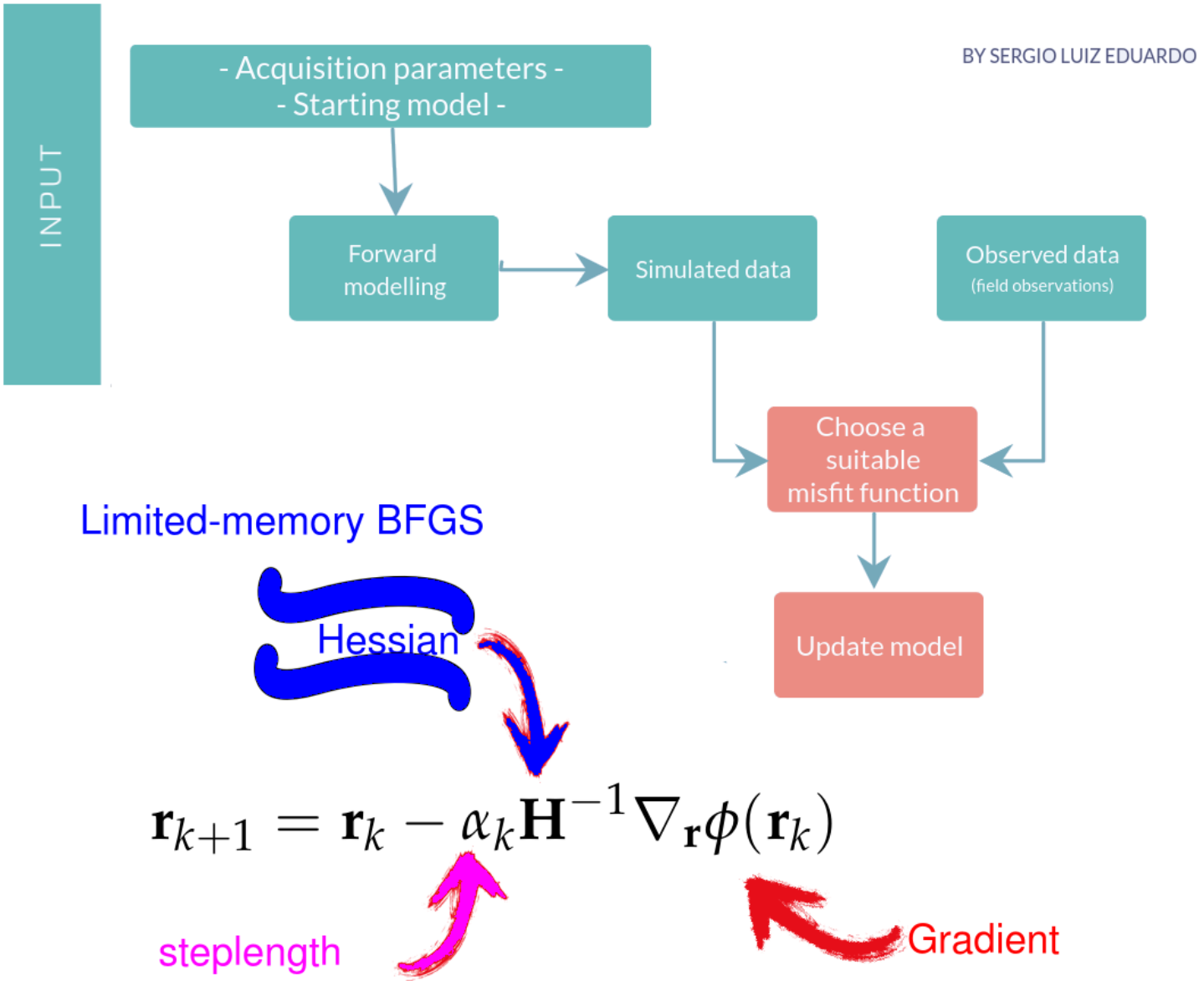

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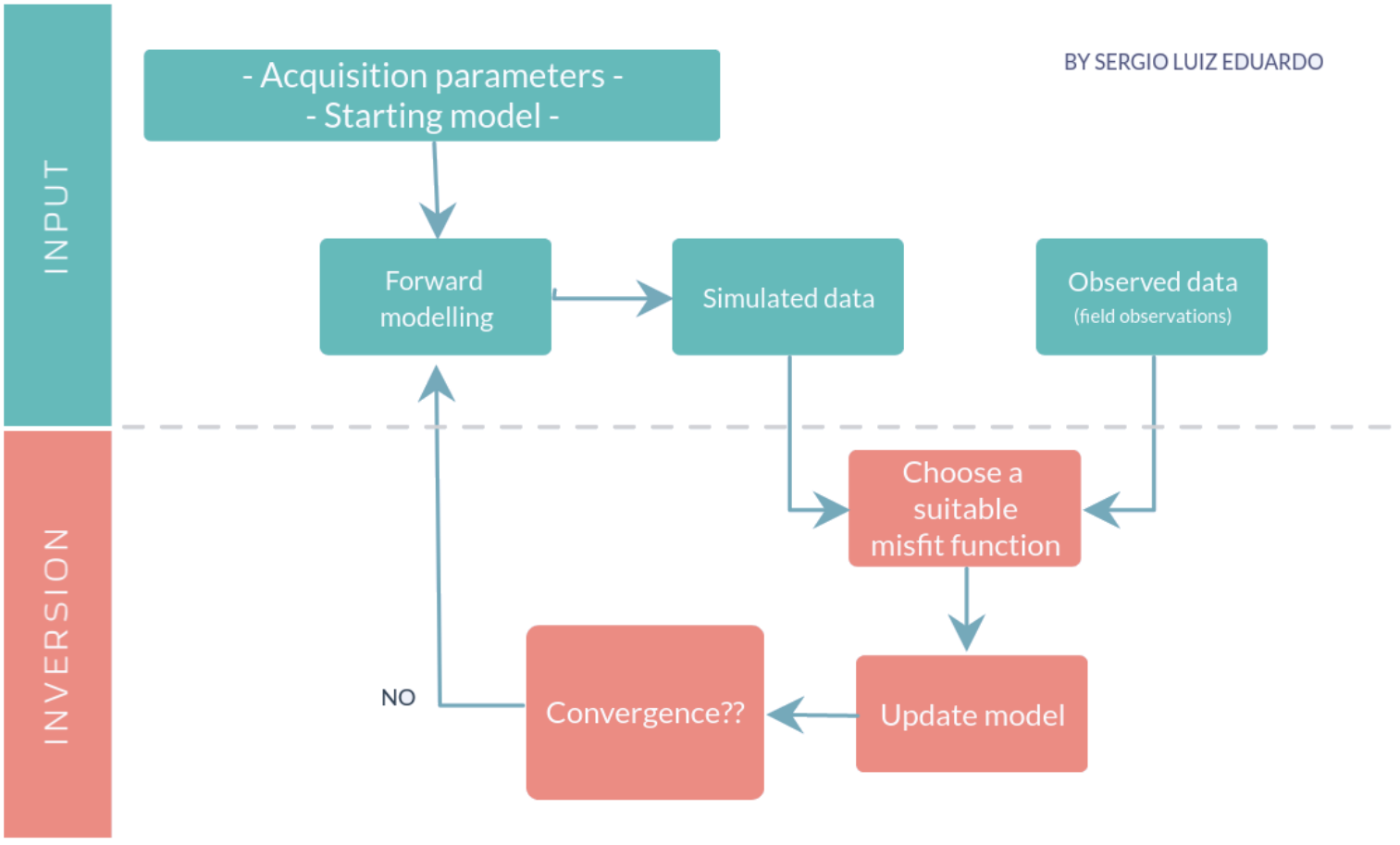

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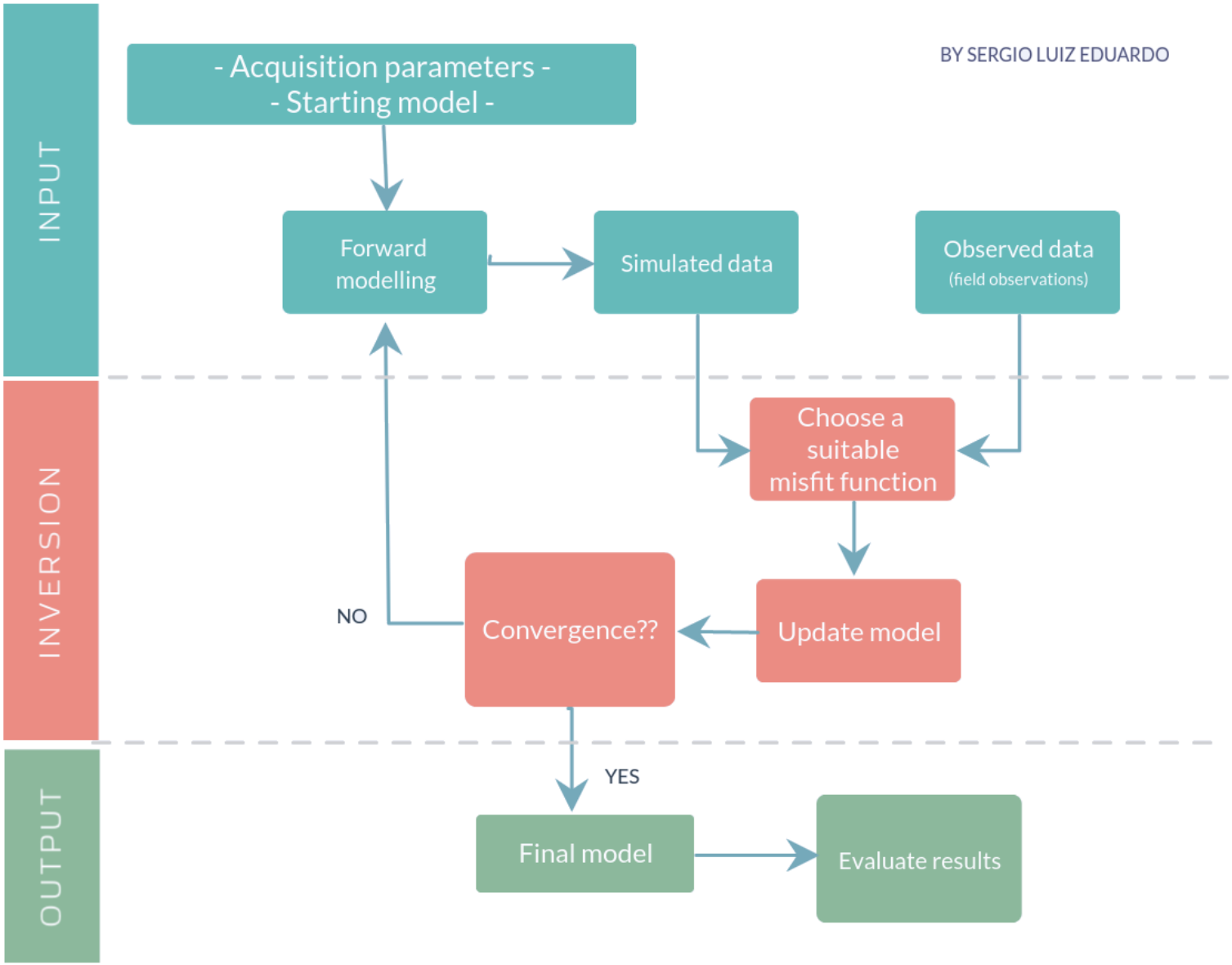
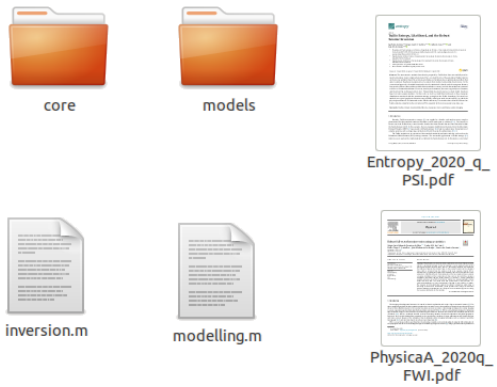


Github account sergioluizedu. Source: https://github.com/sergioluizedu/MbPsiRefEnt2020.git



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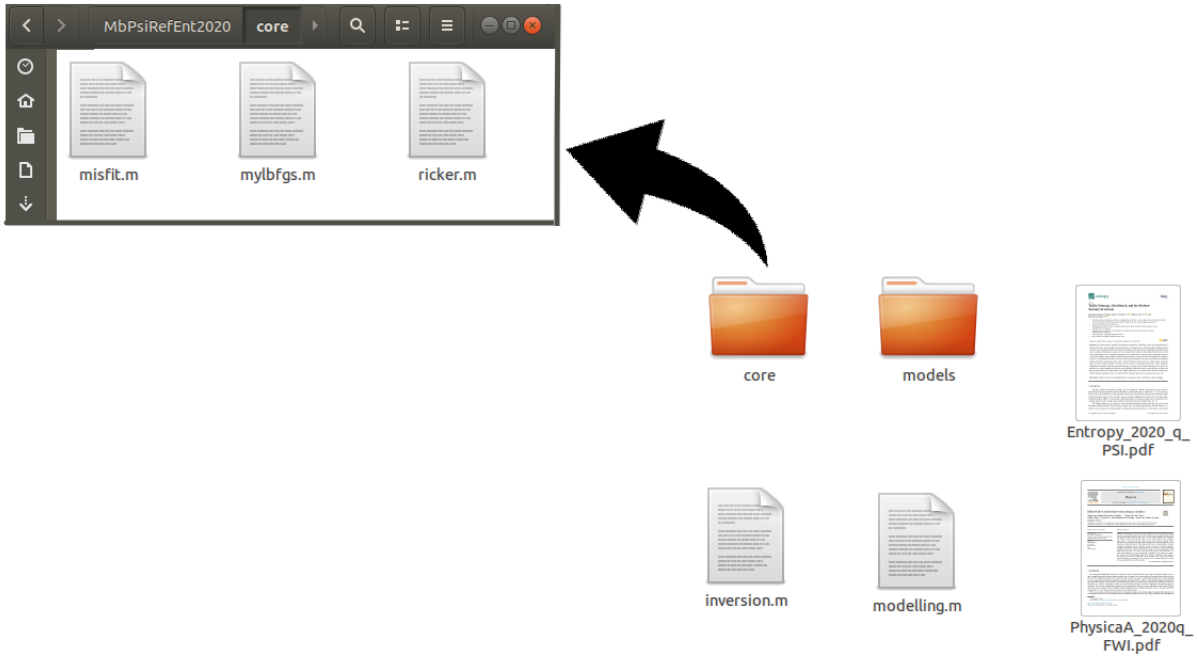

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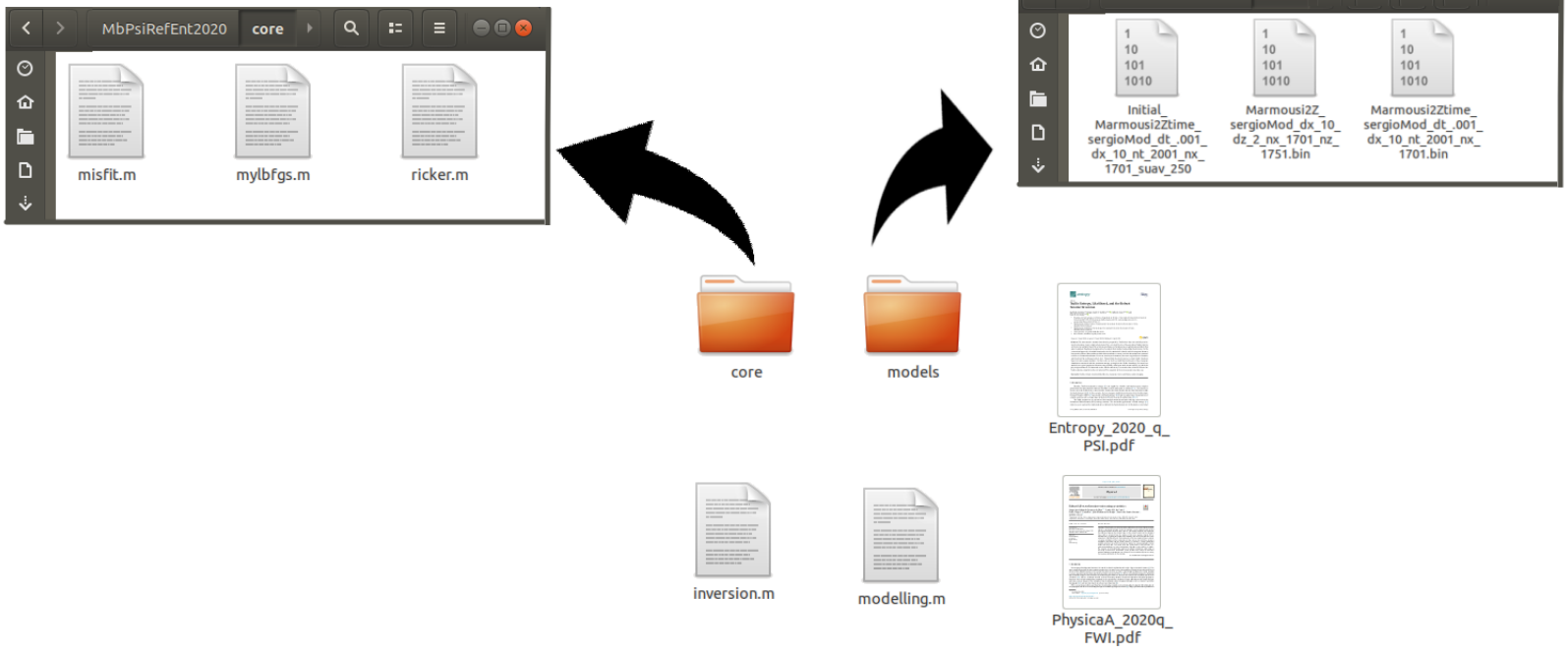

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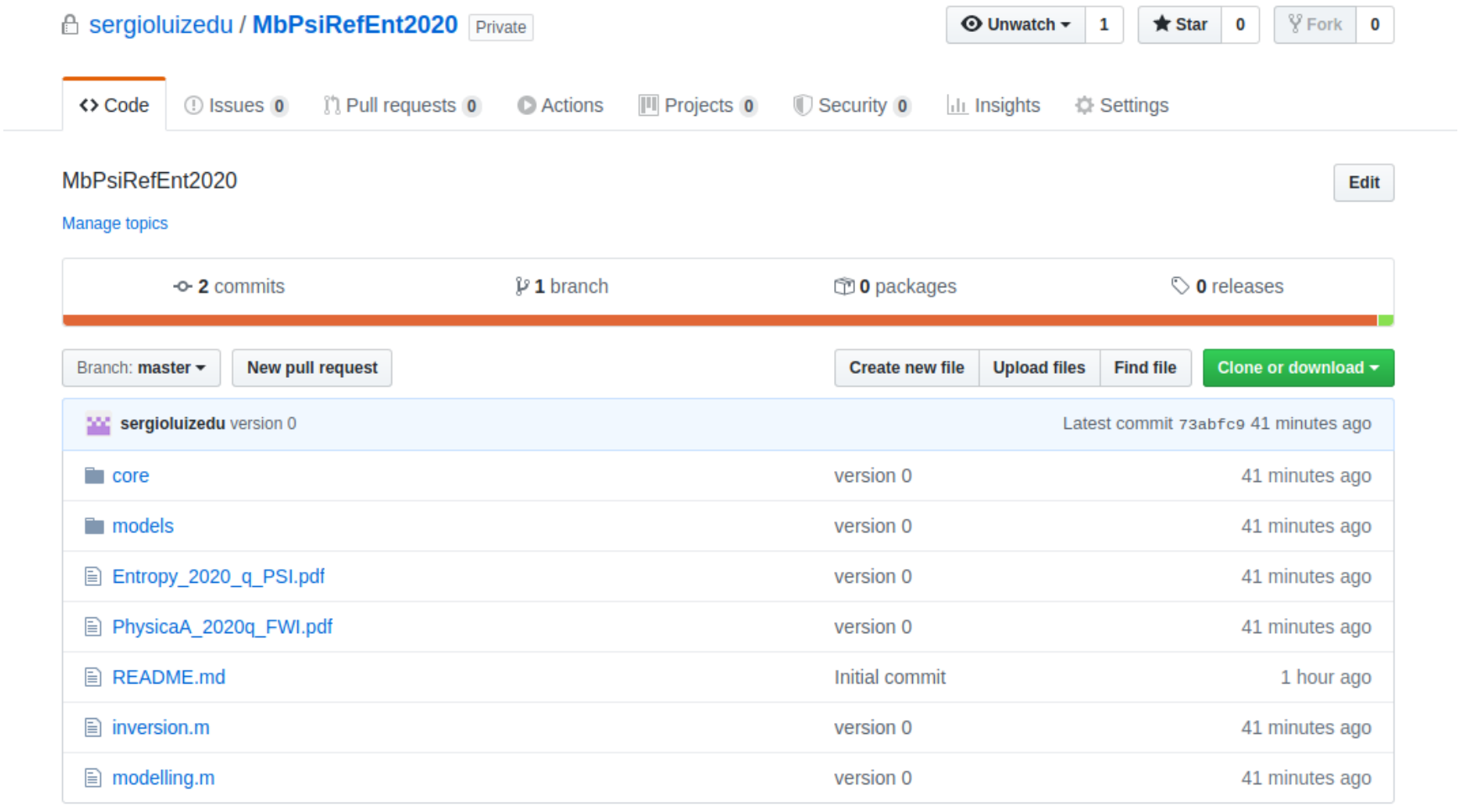

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Let's go!