

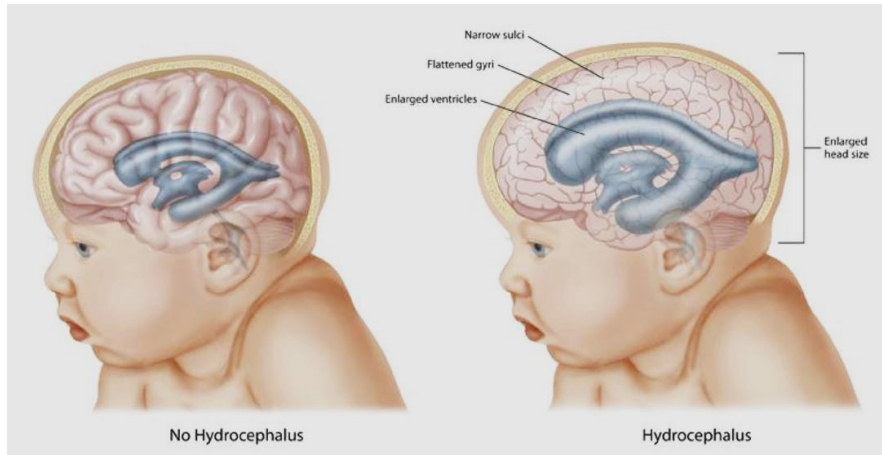
GENERACIÓN DE DATOS SINTÉTICOS PARA APLICACIONES EN MEDICINA

Lionel Cervera Gontard

Área de conocimiento: Física de la materia condensada



DESARROLLO CEREBRAL EN NEONATOS

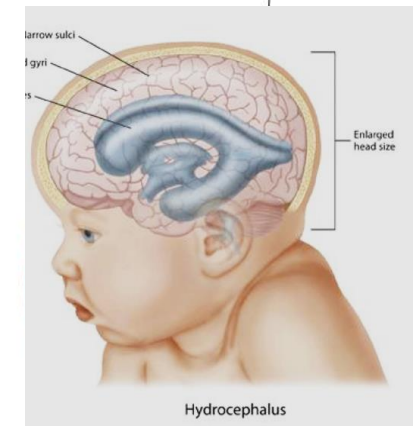
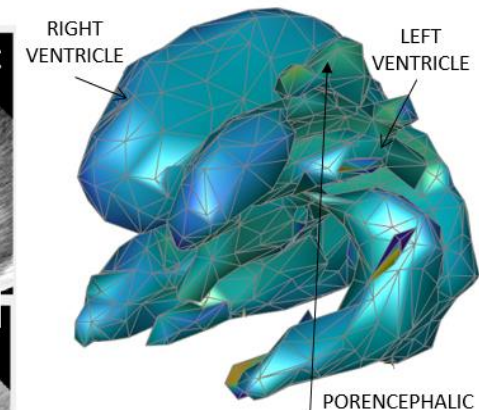
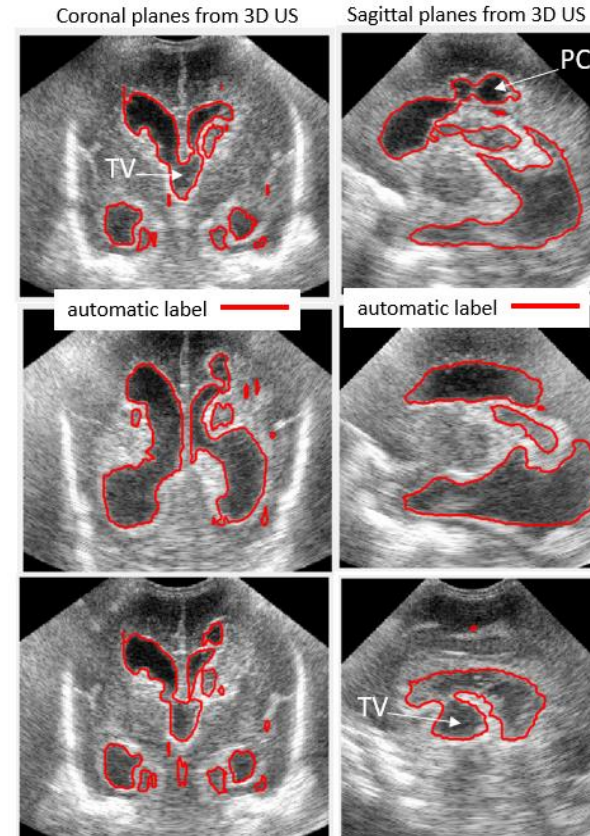


- La hemorragia intraventricular de la matriz germinal (GM-IVH) es la forma más común de hemorragia intracraneal en los recién nacidos prematuros.
- Puede ocurrir en hasta el 20% de los bebés que nacen con menos de 32 semanas de gestación.
- La dilatación ventricular post-hemorrágica excesiva (PHVD) **puede dañar el neurodesarrollo normal del bebé.**

MONITORIZACIÓN DEL DESARROLLO CEREBRAL

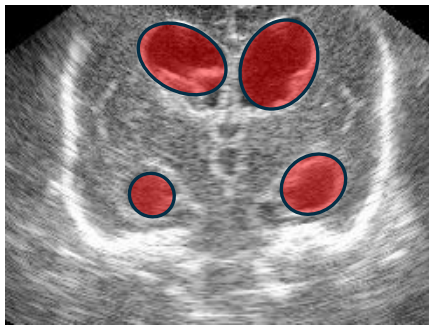
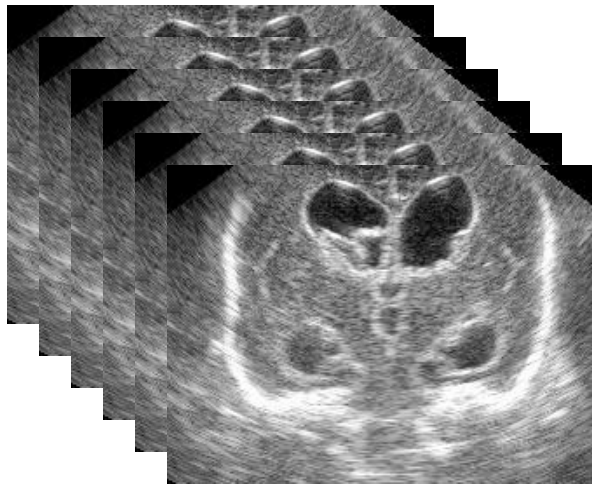


El enfoque más generalizado para monitorear la progresión de PHVD en un entorno clínico se basa en imágenes de Ultrasonidos (US).



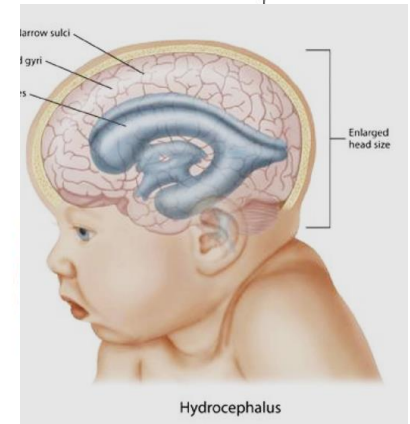
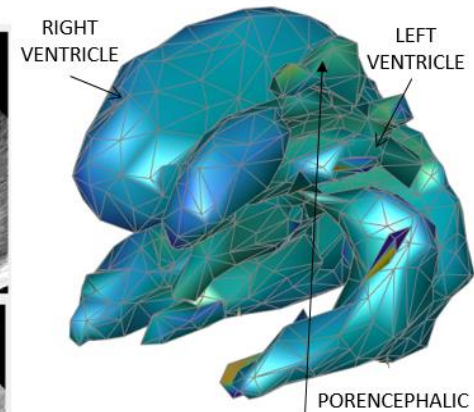
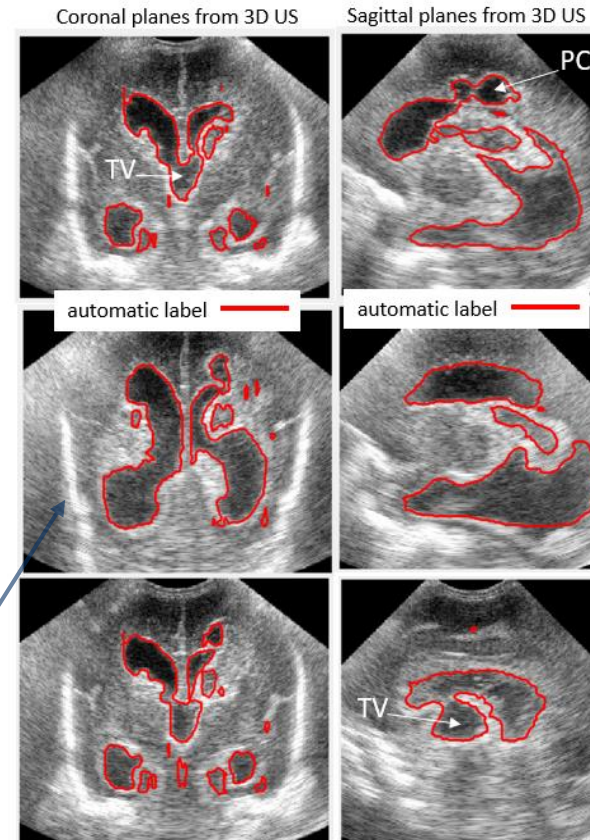
MONITORIZACIÓN AUTOMÁTICA DEL DESARROLLO CEREBRAL CON IA

(Es posible automatizar el análisis de las imágenes US entrenando redes neuronales)



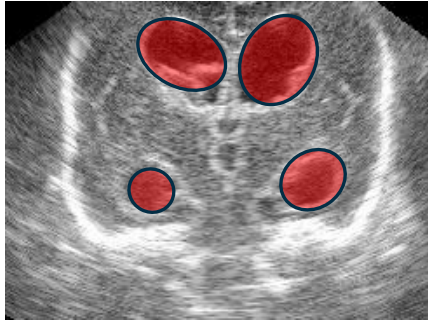
(**muchas** imágenes y etiquetas)

IA



DATOS EXPERIMENTALES y ETIQUETADO MANUAL

(Los datos de entrenamiento (imágenes y etiquetas) hay que extraerlos de imágenes reales)



- Requiere disponer de miles de imágenes
- Trabajo intensivo de etiquetado
- Variabilidad
- Problemas para generar grandes bases de datos compartidas

DATOS SINTÉTICOS CON IA

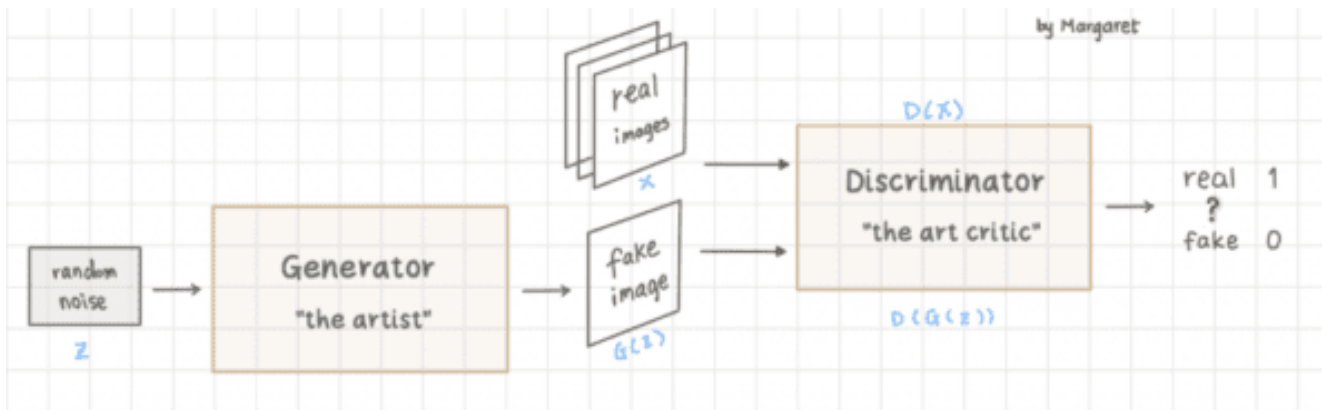
(Generar imágenes con modelos matemáticos de distribuciones)



Imágenes creadas por GANs:

<https://thispersondoesnotexist.com>, <https://thiscatdoesnotexist.com>, <https://thisartworkdoesnotexist.com>

- Problemas de convergencia
- Confiabilidad de las imágenes
- No hay etiquetas

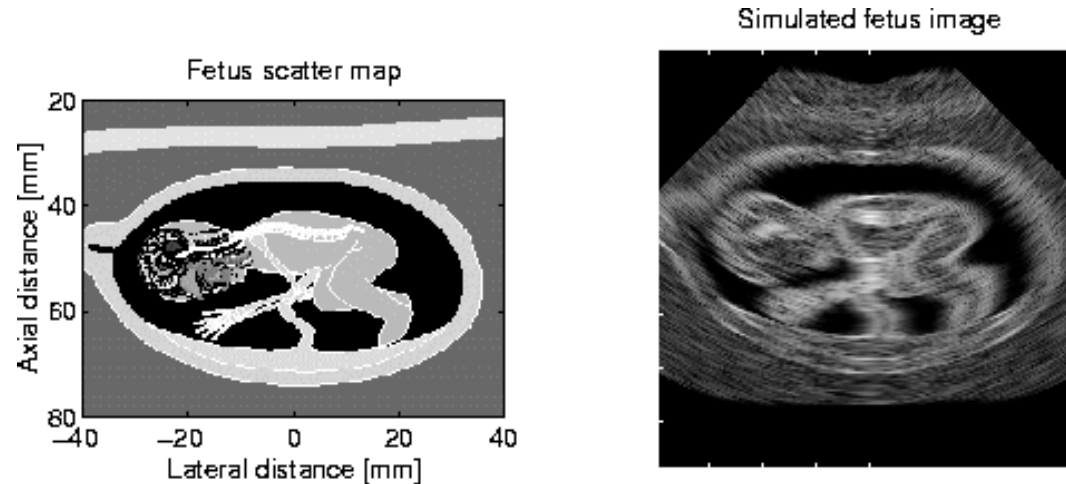


$$\min_G \max_D V(D, G) = \underbrace{\mathbb{E}_{x \sim p_{\text{data}}(x)} [\log D(x)]}_{\text{real data}} + \underbrace{\mathbb{E}_{z \sim p_z(z)} [\log(1 - D(G(z)))]}_{\text{fake data}}$$

Credit: <https://pyimagesearch.com/2021/09/13/intro-to-generative-adversarial-networks-gans/>

DATOS SINTÉTICOS CON SIMULACIONES

(Generar etiquetas y sobre ellas hacer simulaciones físicas de las imágenes)



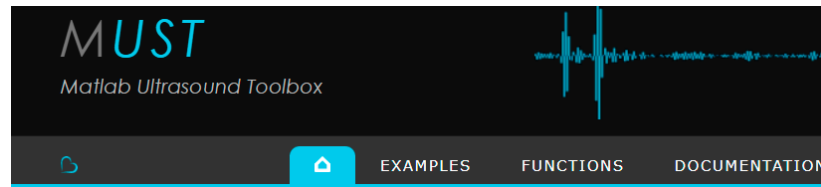
- Confiabilidad de las imágenes
- Cómo generamos los modelos

$$h(\vec{r}, t) = \int_S \frac{\delta(t - \frac{|\vec{r}|}{c})}{2\pi|\vec{r}|} dS \quad p(\vec{r}, t) = \rho \frac{\partial v_n(t)}{\partial t} * h(\vec{r}, t)$$

$$p_r(\vec{r}, t) = v_{pe}(t) \star_t f_m(\vec{r}) \star_r h_{pe}(\vec{r}, t) \quad h_{pe}(\vec{r}, t) = h_t(\vec{r}, t) * h_r(\vec{r}, t)$$

$$v_{pe}(t) = \frac{\rho}{2c^2} E_m(t) \star_t \frac{\partial^3 v(t)}{\partial t^3}, \quad f_m(\vec{r}_1) = \frac{\Delta \rho(\vec{r})}{\rho} - \frac{2\Delta c(\vec{r})}{c}$$

SIMULACION DE ULTRASONIDOS



The 2.2 version is now available (2022/04).
Update your MUST toolbox and discover two new functions!

MUST — MATLAB ULTRASOUND TOOLBOX

- Post-process experimental RF and I/Q ultrasound data
- Simulate acoustic pressure fields and ultrasound signals for uniform linear and convex arrays
- Make movies
- Well-documented
- 100% open-source
- Fast, easy and



FIELD II HOME PAGE

Field II Simulation Program

Center for Fast
Ultrasound Imaging

Ultrasound and
Biomechanics Section

JAJ

Main page

- Background information
- Download
- Users guide
- Faq
- Papers
- Examples
- Copyright
- News

Field IIpro

Site

Print Version



Welcome to the home page for Field II! Here you will find all the information about the program along with executables and examples that you can download.

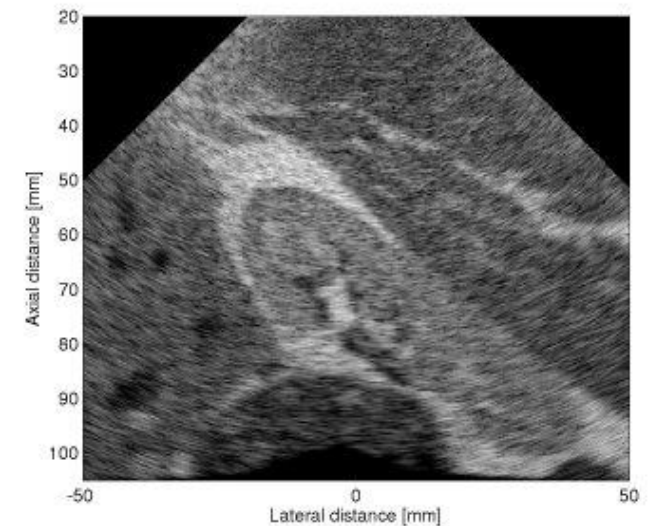
This year Field II celebrates its 25 year of service to the ultrasound community. The initial C version was developed in 1991-92 at Duke University on my sabbatical, which was the foundation for Field II developed in 1995-1996 for general use. The program has been available since then on the Web for free download.

The Field IIpro parallel version has now been released for use on Matlab 2021a and a new Python version has been made, which will be released soon. Currently it is found in versions for both Matlab and Octave, and it also exist in a C library version usable for building stand-alone executables. More information about the program can be found at: [Field IIpro](#) in the left menu. Here you can also find a paper about the performance of Field IIpro.

Version 3.30 of Field II for windows has been released for Matlab 2021a. You can find the code at: [Download/For Matlab 2021](#) in the left menu.

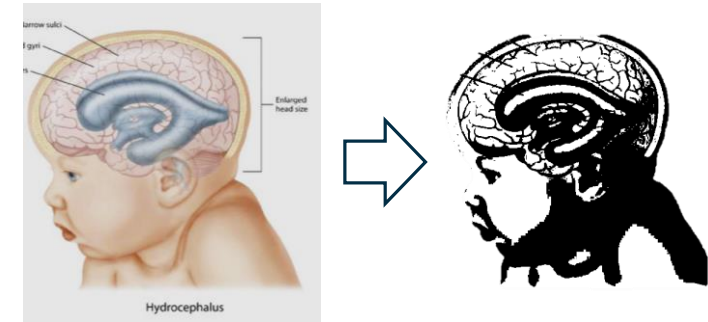
You can now follow Field II on LinkedIn and post comments and discussions. You can freely join the group named: [Linkedin-Field II Ultrasound Simulation Program](#), where news about new version of Field II will be posted.

Simulated fetus image

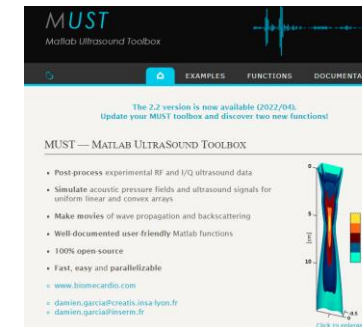


PROPUESTA DE TFG/TFM

1. Generación de modelos de cerebros



2. Simulación de ultrasonidos



3. Validación de imágenes simuladas

(Fréchet Inception Distance, noise statistics, histogram distributions, Siamese networks ...)

$$\text{FID}(r, g) = \|\mu_r - \mu_g\|_2^2 + \text{tr}(\Sigma_r + \Sigma_g - 2(\Sigma_r \Sigma_g)^{\frac{1}{2}})$$