

Bootcamp Demo Day

Team 2022

Data Analytics

Models for Management of
Congenital Heart Disease
in Mexico (ABC Hospital)

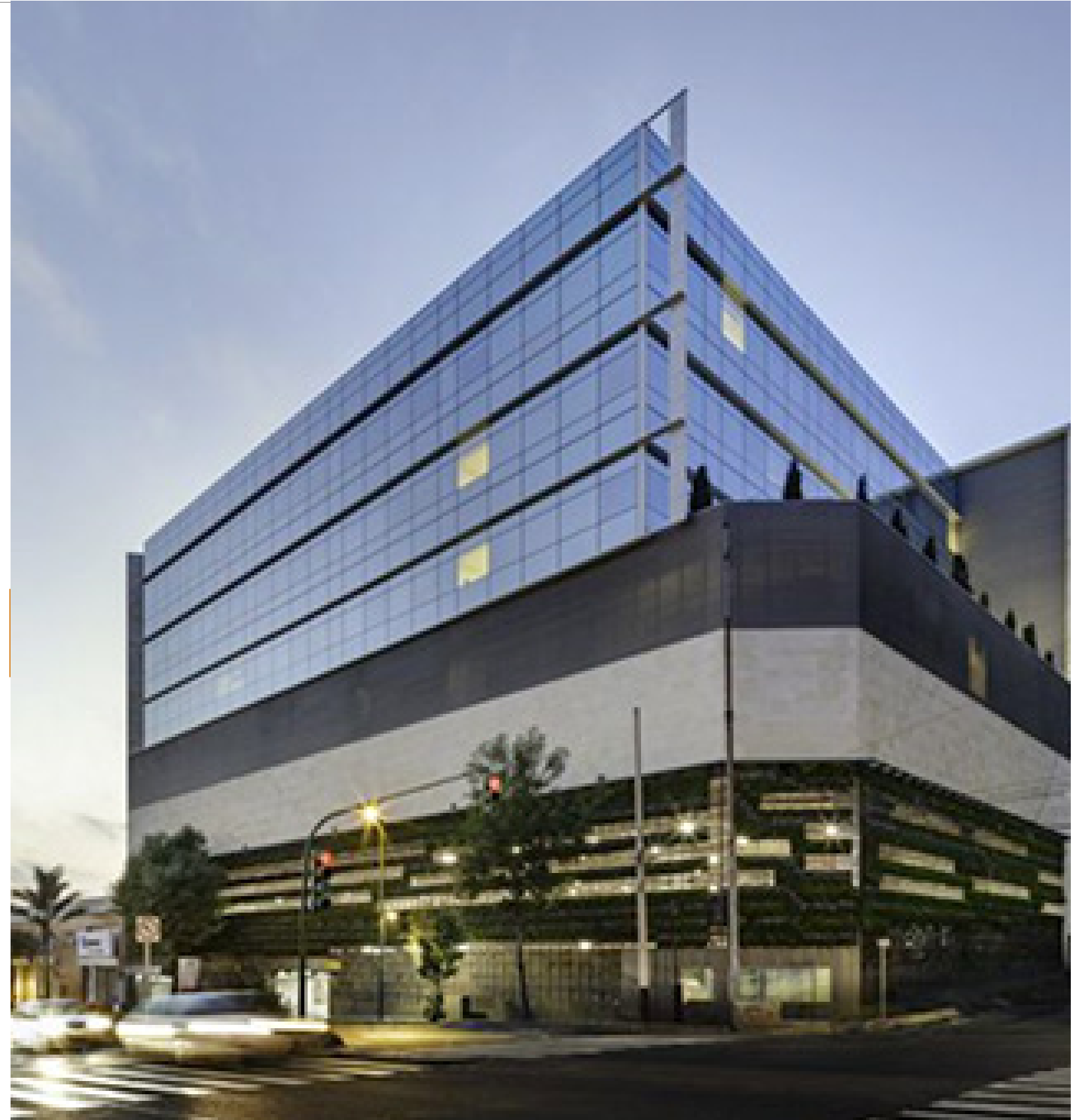
Daniela Soto
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Bootcamp Demo Day

Content

- 1 Introduction
- 2 Cleaning etl
- 3 Visualization
- 4 Machine Learning
- 5 Deployment



Congenital Heart Diseases

Congenital heart diseases (CHD) are a relatively common problem with an incidence of 6/1000 newborns. 30% of CHD are never diagnosed and approximately 25% of diagnosed children require surgery during the first year of life.

In Mexico, approximately 18,000 to 21,000 children are born each year with a cardiac malformation. Only 5% to 8% of the population have access to private insurance and 40% have access to specific government-run hospitals.



6/1000

Newborn incidence worldwide

30%

are never diagnosed

5-8%

Have private insurance

40%

Have access to government run hospitals

State of Care for Congenital Heart Diseases

According to the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database, in the United States with almost 40,000 operations per year. The overall mortality after congenital heart surgery in the United States is 8.8% for neonates.



40K

operations per year in the United States

8.8%

mortality after surgery



90%

patients receive suboptimal treatment in LMICs

15%

mortality after surgery

In many Low and Middle Income Countries is estimated that 30% of CHD are never diagnosed and 90% receive suboptimal treatment or don't receive it at all.



Kardias Private–Public (Hybrid) Program

Kardias Foundation from Mexico has a specialized program in two hospitals: the National Institute of Pediatrics (INP) and the ABC-Kardias Pediatric Heart Center (in partnership with the ABC Medical Center).

This program is committed to excellence, so it shares the best practices with the most important pediatric heart centers in the world and has the most advanced technology to perform surgeries of the highest complexity and quality.



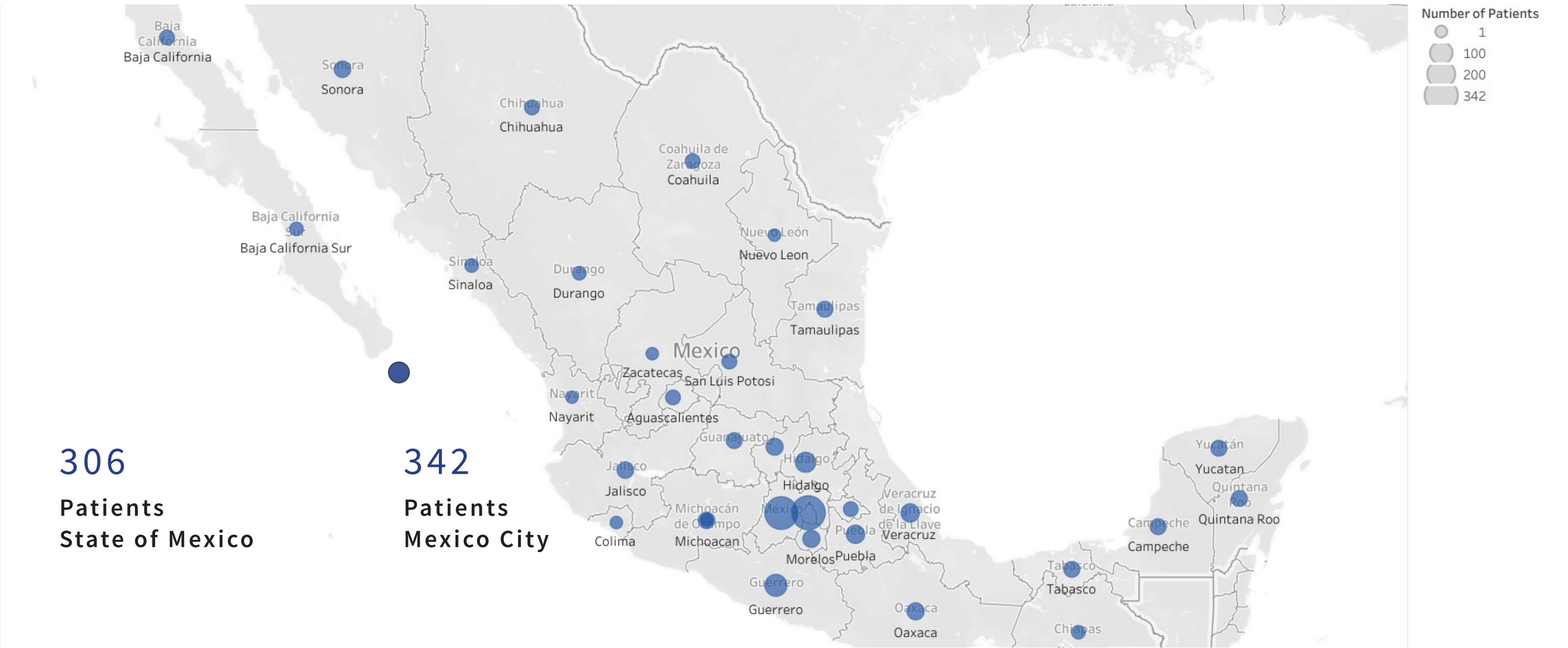
U.S. Food & Drug Administration's Artificial Intelligence Challenges



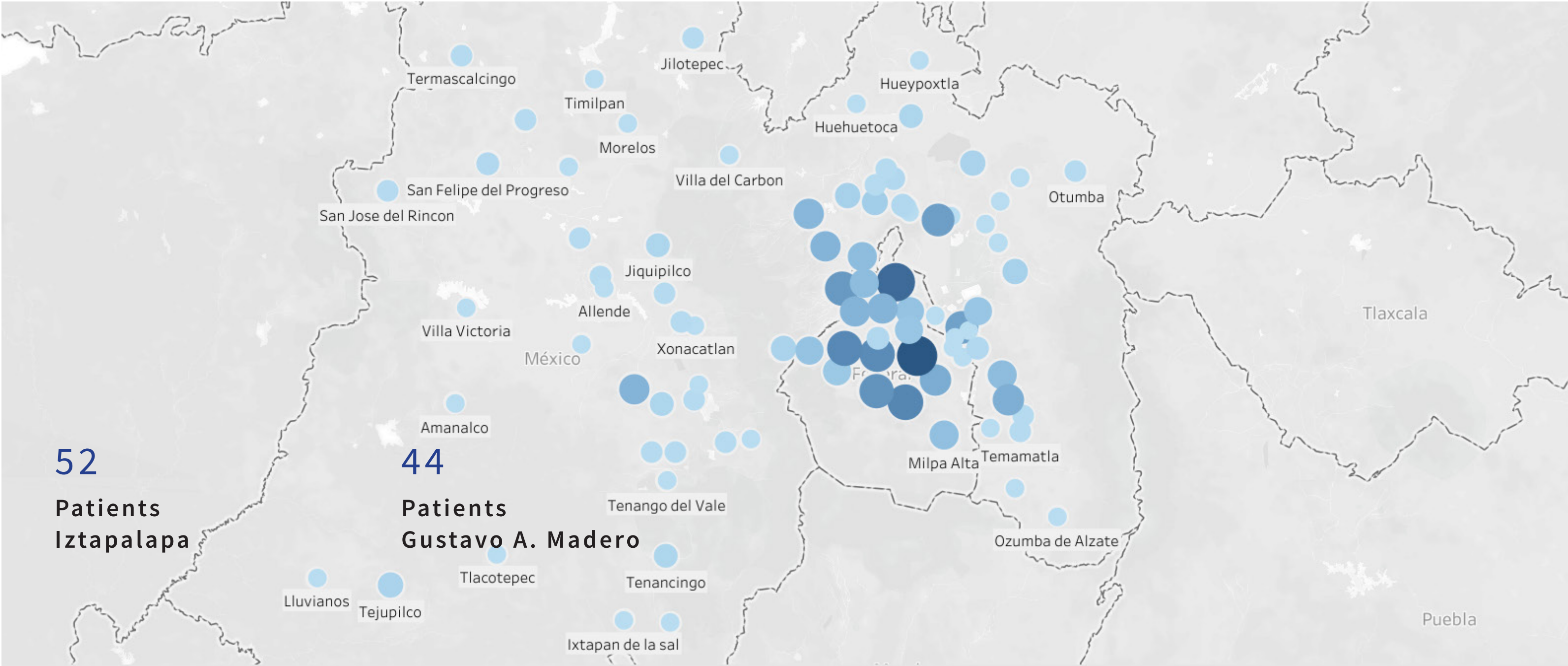
According to the U.S. Food & Drug Administration's Artificial Intelligence (AI) and Machine Learning Program the main AI Challenges are:

- * Image acquisition and processing
- * Earlier disease detection
- * **More accurate diagnosis, prognosis, and risk assessment**
- * New patterns identification on human physiology
- * Personalized diagnostics and therapeutics

Congenital Heart Disease in Mexico (Kardias Patients)



Congenital Heart Disease in Mexico (Kardias Patients)



World Database for Congenital Heart Surgery 2011-2012

880

Patients

1

Year

Archivos
de Cardiología
de México





CLINICAL INVESTIGATION

The world database for pediatric and congenital heart surgery:
A collaboration with the Registro Nacional de Cirugía Cardíaca
Pediátrica

*La base de datos mundial de cirugía cardíaca pediátrica y congénita: una colaboración
con el Registro Nacional de Cirugía Cardíaca Pediátrica (RENACCAPE)*

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Abstract

Objective: Following the notable work accomplished by the Mexican Association of Specialists in Congenital Heart Disease (Asociación Mexicana de Especialistas en Cardiopatías Congénitas) with the development of a national registry for congenital cardiac surgery, the World Society for Pediatric and Congenital Heart Surgery has implemented an international platform

Databases

Kardias Database
2012-2022

1,039
Patients

10
Years

Base para diplomado TEC.xlsx - Excel																			
Gato Cazares																			
¿Qué desea hacer?																			
Inicio Insertar Disposición de página Fórmulas Datos Revisar Vista Programador Ayuda																			
Cortar Copiar Copiar formato Pegar Portapapeles Fuente Alineación Número Formato condicional Dar formato como tabla Estilos Celdas Edición																			
T37																			
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	
masculino=	estado	municipio	Altura	edad en días	Peso (kg)	Talla (cm)	Apariencia	Diagnóstico	Cx Previas	Diagnóstico Principal	RACHS	Estancia	muer						
0	Estado de México	Huixquilucan	2726	3942	35	134	Normal	Ninguno	0	Comunicación interauricular, secundum	22/08/2001	25/02/2011	04/08/2012	Reparación c	1	2	0		
1	Estado de México	Timilpan	2741	3202	18	117	Desnutrido	Ninguno	0	Comunicación interauricular, secundum	19/09/2003	29/01/2010	11/08/2012	Reparación c	1	2	0		
4	0	Ciudad de México	Coyoacán	2240	3147	22	120	Normal	Ninguno	0	Comunicación interauricular, secundum	21/11/2003	26/01/2011	18/08/2012	Reparación c	1	2	0	
5	0	Estado de México	Nezahualcoyotl	2220	4005	42	147	Normal	Ninguno	0	Comunicación interauricular, secundum	10/07/2001	11/02/2006	25/08/2012	Reparación c	1	2	0	
6	0	Ciudad de México	Alvaro Obregón	2373	5289	40	157	Normal	Ninguno	0	Comunicación interauricular, secundum	22/12/1997	25/02/2011	01/09/2012	Reparación c	1	3	0	
7	1	Ciudad de México	Iztapalapa	2100	2888	34.4	134	Normal	Ninguno	0	Comunicación interauricular, secundum	31/08/2004	16/07/2007	08/09/2012	Reparación c	2	2	0	
8	0	Estado de México	Metepec	2620	3828	37	141	Normal	Ninguno	0	Comunicación interauricular, secundum	04/02/2002	04/02/2003	22/09/2012	Reparación c	2	2	0	
9	0	Ciudad de México	Xochimilco	2250	1583	13.5	102	Normal	Ninguno	0	Comunicación interauricular, secundum	06/05/2008	18/06/2010	29/09/2012	Reparación c	1	2	0	
10	1	Estado de México	Coacalco	2257	3549	37	137	Normal	Ninguno	0	Comunicación interauricular, secundum	04/12/2002	25/02/2011	13/10/2012	Reparación c	2	5	0	
11	1	Estado de México	Chalco	2240	5536	62	162	Normal	VACTER	0	Comunicación interauricular, secundum	04/06/1997	25/02/2011	20/10/2012	Reparación c	1	2	0	
12	1	Estado de México	Toluca	2660	4655	44	142	Normal	Trisomía 21	0	Comunicación interauricular, secundum	27/11/1999	27/11/1999	02/11/2012	Reparación c	2	3	0	
13	1	Estado de México	Tlaxtepec	900	2490	12.5	160	Normal	Síndrome Di	0	Comunicación interauricular, secundum	20/12/2005	25/02/2011	10/11/2012	Reparación c	2	6	0	
14	1	Estado de México	San Antonio	2591	1668	14	98	Normal	Ninguno	0	Comunicación interauricular, secundum	29/03/2008	19/05/2011	17/11/2012	Reparación c	1	2	0	
15	0	Ciudad de México	Xochimilco	2250	2025	17.6	114	Normal	Ninguno	0	Comunicación interauricular, secundum	30/04/2007	25/02/2011	15/12/2012	Reparación c	2	2	0	
16	0	Ciudad de México	Coyoacán	2240	769	8.7	74	Normal	Trisomía 21	0	Comunicación interauricular, secundum	16/11/2010	29/07/2011	05/01/2013	Reparación c	2	3	0	
17	0	Estado de México	Chimalhuacán	2240	596	9.4	78	Normal	Trisomía 21	0	Comunicación interauricular, secundum	16/05/2011	16/05/2011	12/01/2013	Reparación c	2	3	0	
18	0	Ciudad de México	Tláhuac	2200	2013	14.6	109	Normal	Ninguno	0	Persistencia de Conducto Arterioso	29/06/2007	25/02/2011	02/02/2013	Cierre quirúrgico	1	2	0	
19	1	Ciudad de México	Iztapalapa	2100	3384	25.3	130	Normal	Ninguno	0	Comunicación interauricular, secundum	08/10/2003	03/02/2011	02/03/2013	Reparación c	1	2	0	
20	0	Ciudad de México	Iztapalapa	2100	2965	17.6	110	Normal	Trisomía 21	0	Persistencia de Conducto Arterioso	14/12/2004	25/02/2011	09/03/2013	Cierre quirúrgico	1	2	0	
21	0	Estado de México	Los Olivos	75	3901	36.5	130	Normal	Síndrome Di	0	Estenosis pulmonar, valvular + Estenosis pulmonar, supra	22/05/2002	22/05/2002	23/03/2013	Ampliación t	2	3	0	
22	0	Ciudad de México	Coyoacán	2240	1883	18.5	109	Normal	Trisomía 21	0	Comunicación interauricular, secundum	05/01/2008	25/02/2011	28/03/2013	Reparación c	1	2	0	
23	0	Ciudad de México	Alvaro Obregón	2373	1570	15.4	104	Normal	Seno dermo	0	Persistencia de Conducto Arterioso	26/11/2008	16/03/2012	06/04/2013	Cierre quirúrgico	1	2	0	
24	1	Ciudad de México	Tláhuac	2200	1210	12	96	Normal	Ninguno	0	Comunicación interauricular, secundum	03/12/2009	03/06/2010	13/04/2013	Reparación c	2	2	0	
25	1	Ciudad de México	Xochimilco	2250	785	10.6	86	Normal	Ninguno	0	Comunicación interauricular, secundum	15/02/2011	29/06/2011	20/04/2013	Reparación c	2	8	0	
26	0	Ciudad de México	Iztapalapa	2100	4704	46	153	Normal	Ninguno	0	Comunicación interauricular, secundum	03/04/2000	03/04/2000	27/04/2013	Reparación c	2	2	0	
27	1	Ciudad de México	Milpa Alta	2420	2481	22	130	Normal	Ninguno	0	Comunicación interauricular, secundum	13/06/2006	25/02/2011	04/05/2013	Reparación c	1	2	0	
28	0	Ciudad de México	Xochimilco	2250	3349	35	144	Sobrepeso	Ninguno	0	Comunicación interauricular, secundum	29/01/2004	21/05/2012	18/05/2013	Reparación c	1	2	0	
29	0	Chihuahua	Juárez	1137	4294	27	153	Normal	Ninguno	0	Comunicación interauricular, secundum	21/06/2001	20/05/2012	25/05/2013	Reparación c	1	3	0	
30	1	Guerrero	Cutzamala de	263	935	12.5	91	Normal	Ninguno	0	Comunicación interauricular, secundum	26/10/2010	13/06/2012	01/06/2013	Reparación c	2	2	0	
31	0	Estado de México	Chalco	2240	1850	19.1	117	Normal	Ninguno	0	Persistencia de conducto arterioso	18/04/2008	25/02/2011	08/06/2013	Cierre quirúrgico	1	3	0	
32	1	Hidalgo	Pachuca de S	2432	3786	32.5	152	Normal	Ninguno	0	Comunicación interauricular, secundum	09/12/2002	18/11/2010	15/06/2013	Reparación c	1	2	0	
33	0	Ciudad de México	Tláhuac	2200	2844	22	129	Normal	Ninguno	0	Comunicación interauricular, secundum	28/07/2005	25/02/2011	22/06/2013	Reparación c	2	2	0	
34	0	Ciudad de México	Tlalpan	2260	2094	20	117	Normal	Ninguno	0	Comunicación interauricular, secundum	12/09/2007	14/08/2012	06/07/2013	Reparación c	1	2	0	
35	0	Estado de México	Nezahualcoyotl	2220	484	7.8		Normal	Ninguno	0	Comunicación interauricular, secundum	06/03/2012		12/07/2013	Reparación c	1	3	0	
36	1	Estado de México	San José del	2747	1550	11	90	Desnutrido	Ninguno	0	Comunicación interauricular, secundum	23/03/2009	23/06/2009	13/07/2013	Reparación c	2	2	0	
37	1	Ciudad de México	Coyoacán	2240	2961	18.5	105	Desnutrido	Trisomía 21	0	Comunicación interauricular, secundum	29/04/2005	25/02/2011	20/07/2013	Reparación c	1	2	0	
38	0	Guerrero	Chilpancingo	1253	2321	16	95	Normal	Trisomía 21	0	Comunicación interauricular, secundum	22/02/2007	03/04/2007	03/08/2013	Reparación c	2	5	0	

Database Cleaning

Original Database



Step 1

kardiasclean

Python Libraries
&
Algorithms

20% variance reduction

Step 2

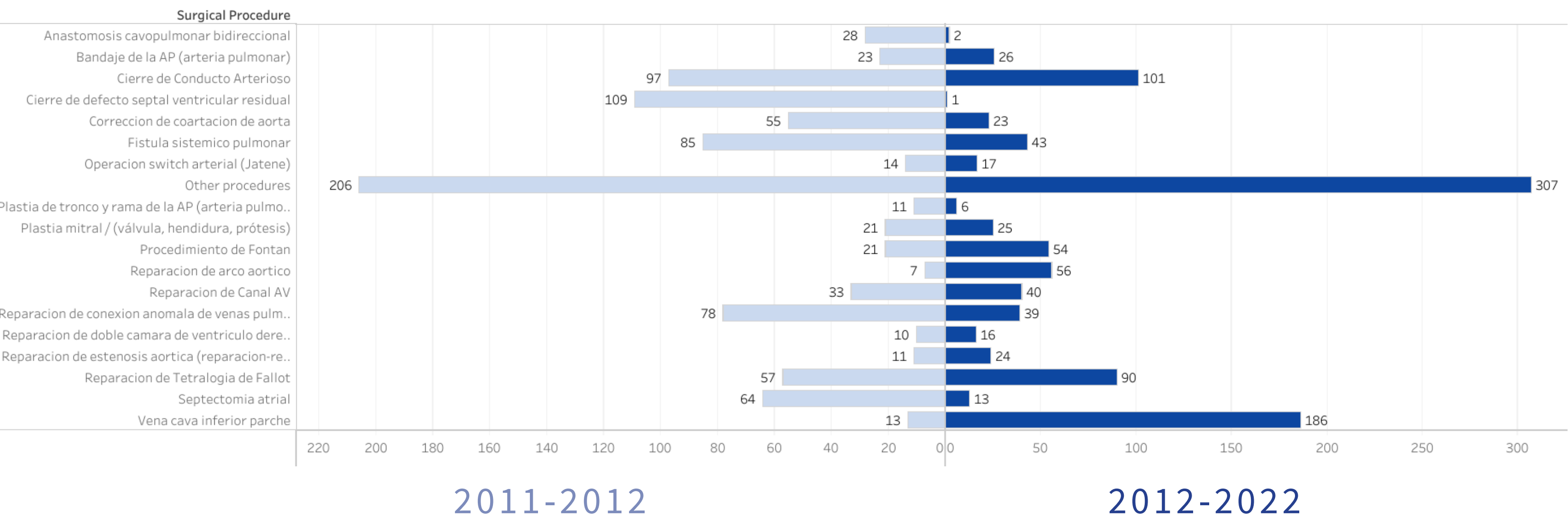
RegEx

Cleaned Database



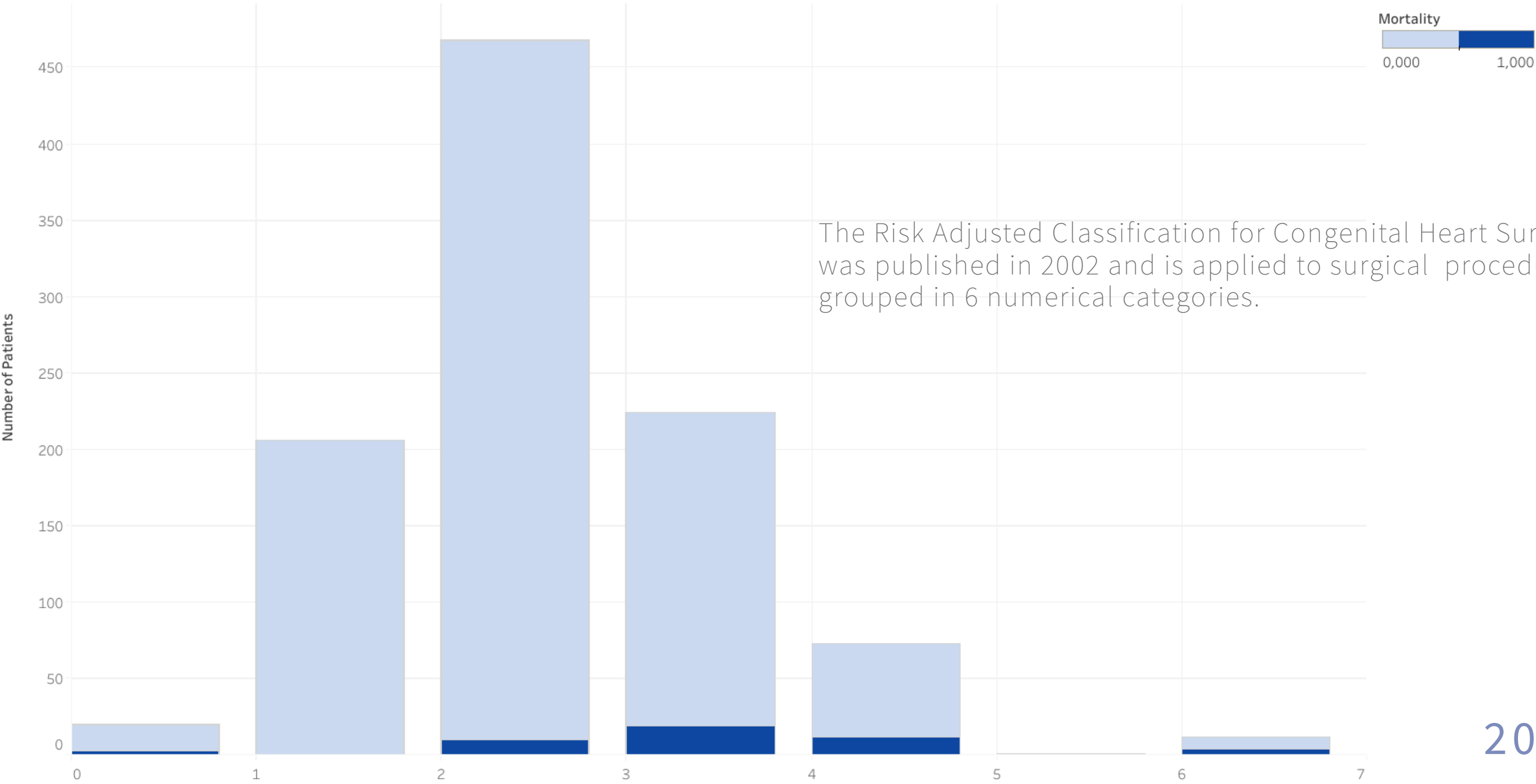
Top 10 Surgical Procedures

Surgical Procedures



RACHS-01 Score vs Mortality

RACHS vs Mortality

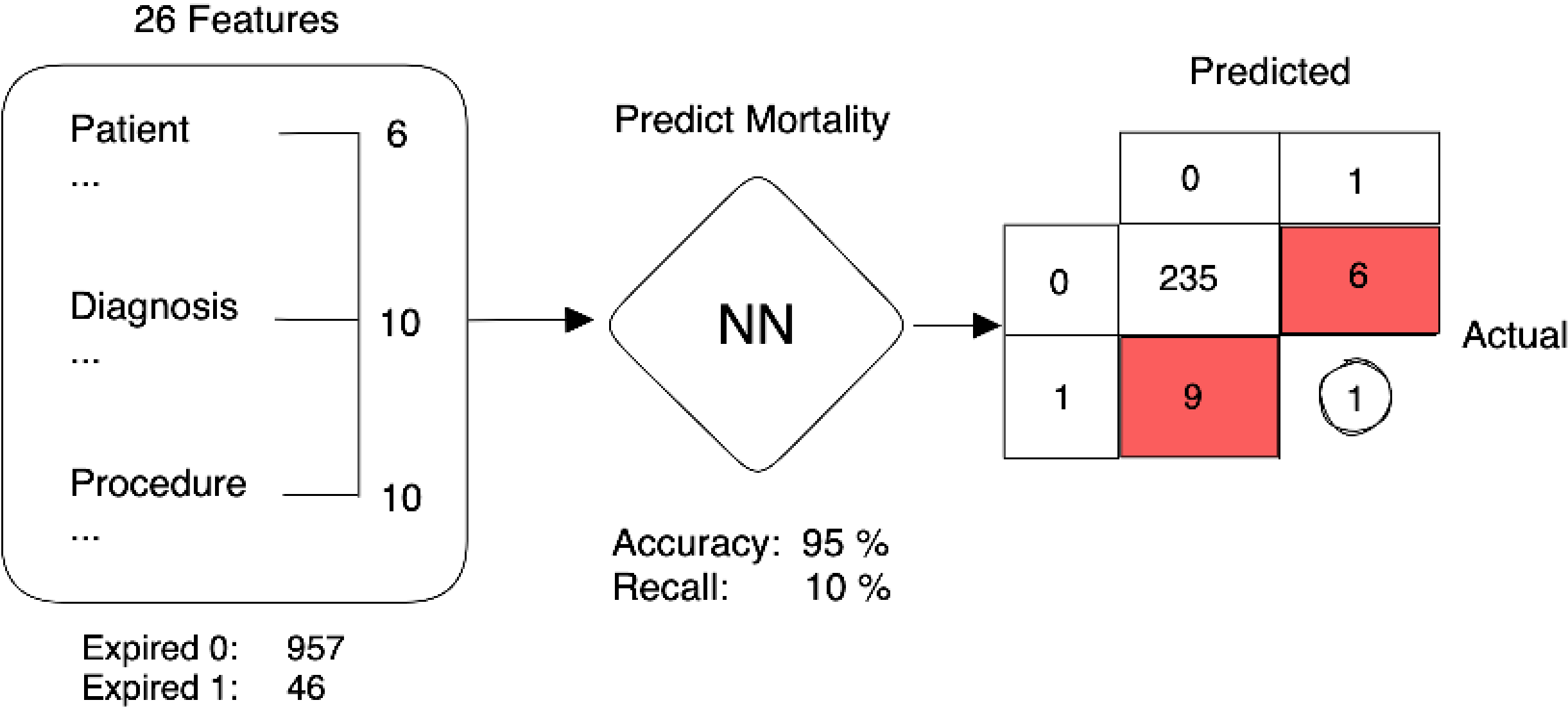


The Risk Adjusted Classification for Congenital Heart Surgery (RACHS-1) was published in 2002 and is applied to surgical procedures and it's grouped in 6 numerical categories.

2011-2012

Neural Network

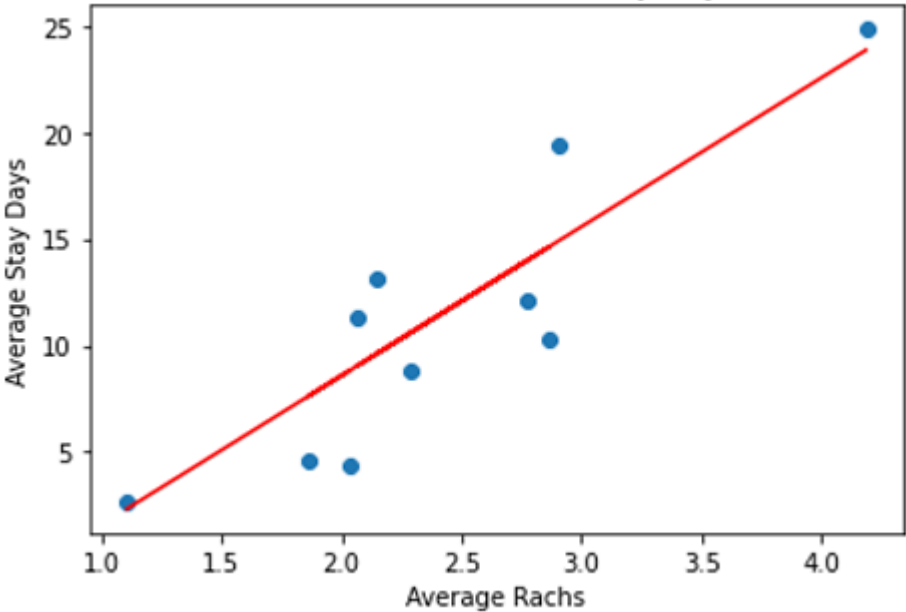
high accuracy, low sensitivity



Linear Regression



Variables removed
 Stay Days
 Mortality



After dimensionality Reduction

Clustering

We used the K-Means algorithm to make clusters from patients with similar characteristics. The algorithm correlates all variables to obtain the following clusters:

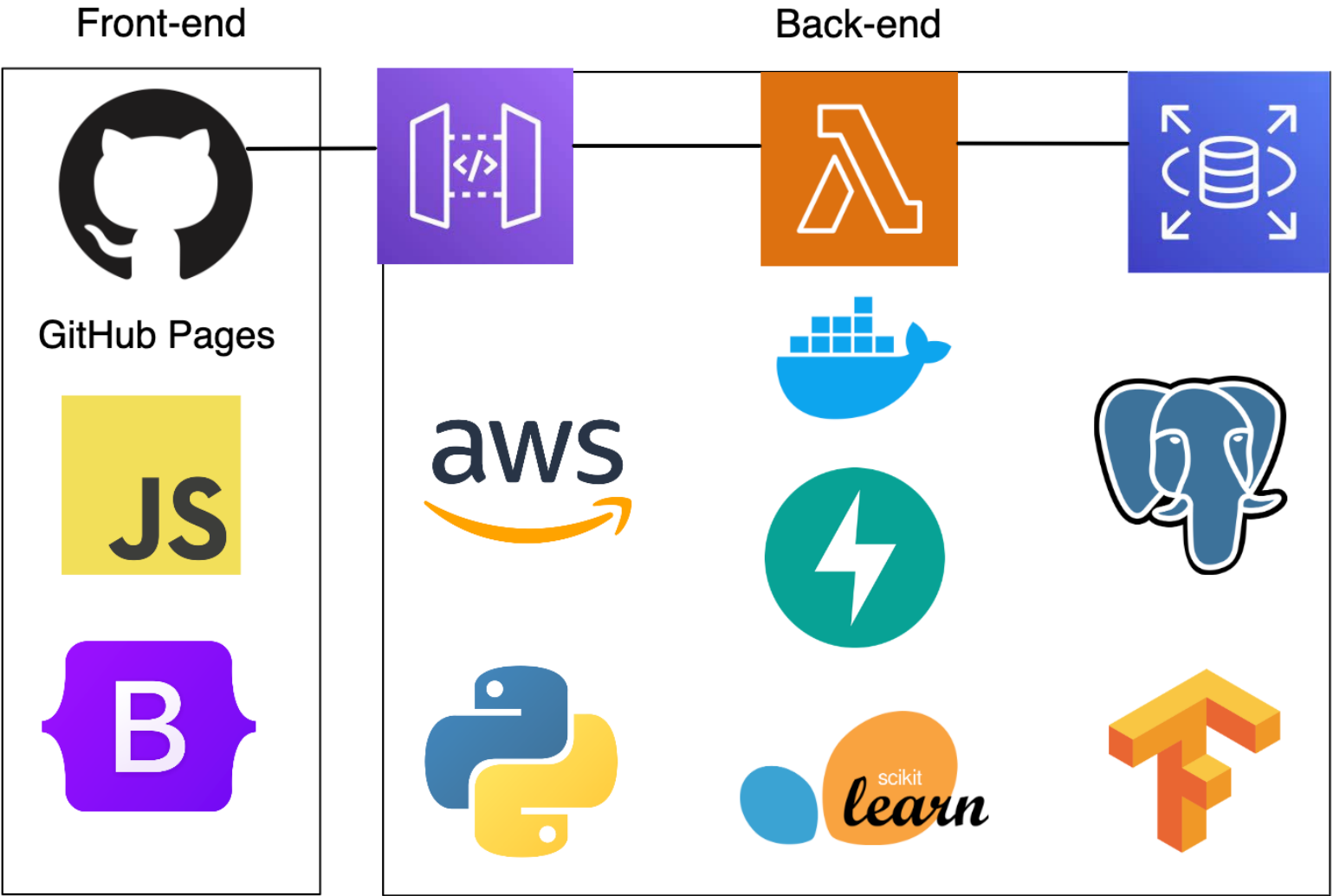
	n_patients	stay_days	rachs	cx_previous	age_days	weight_kg	height_cm	expired
Cluster								
01	41.0	19.390244	2.902439	0.292683	346.731707	5.874146	62.292683	0.170732
02	151.0	2.682119	1.105960	0.019868	2419.304636	20.303974	112.718543	0.000000
03	59.0	24.830508	4.186441	0.016949	422.847458	6.659831	62.381356	0.101695

CLUSTER: 1						
	stay_days	rachs	age_days	weight_kg	height_cm	expired
mean	19.390244	2.902439	346.731707	5.874146	62.292683	0.170732
std	20.160454	0.943527	531.333606	4.339480	20.395151	0.380949
min	0.000000	0.000000	2.000000	2.300000	43.000000	0.000000
max	100.000000	6.000000	1721.000000	18.000000	115.000000	1.000000
CLUSTER: 2						
	stay_days	rachs	age_days	weight_kg	height_cm	expired
mean	2.682119	1.105960	2419.304636	20.303974	112.718543	0.0
std	1.348435	0.367919	1249.083680	9.610278	21.621022	0.0
min	1.000000	1.000000	264.000000	5.300000	57.000000	0.0
max	9.000000	3.000000	6489.000000	50.000000	159.000000	0.0
CLUSTER: 3						
	stay_days	rachs	age_days	weight_kg	height_cm	expired
mean	24.830508	4.186441	422.847458	6.659831	62.381356	0.101695
std	35.235245	0.860525	1056.228665	9.766134	25.922188	0.304841
min	1.000000	1.000000	1.000000	2.100000	41.000000	0.000000
max	173.000000	6.000000	5295.000000	54.900000	169.000000	1.000000

Variables

- Stay Days
- RACHS-01
- Previous Surgeries
- Age
- Weight
- Height
- Mortality (expired)

Deployment



Thank You!