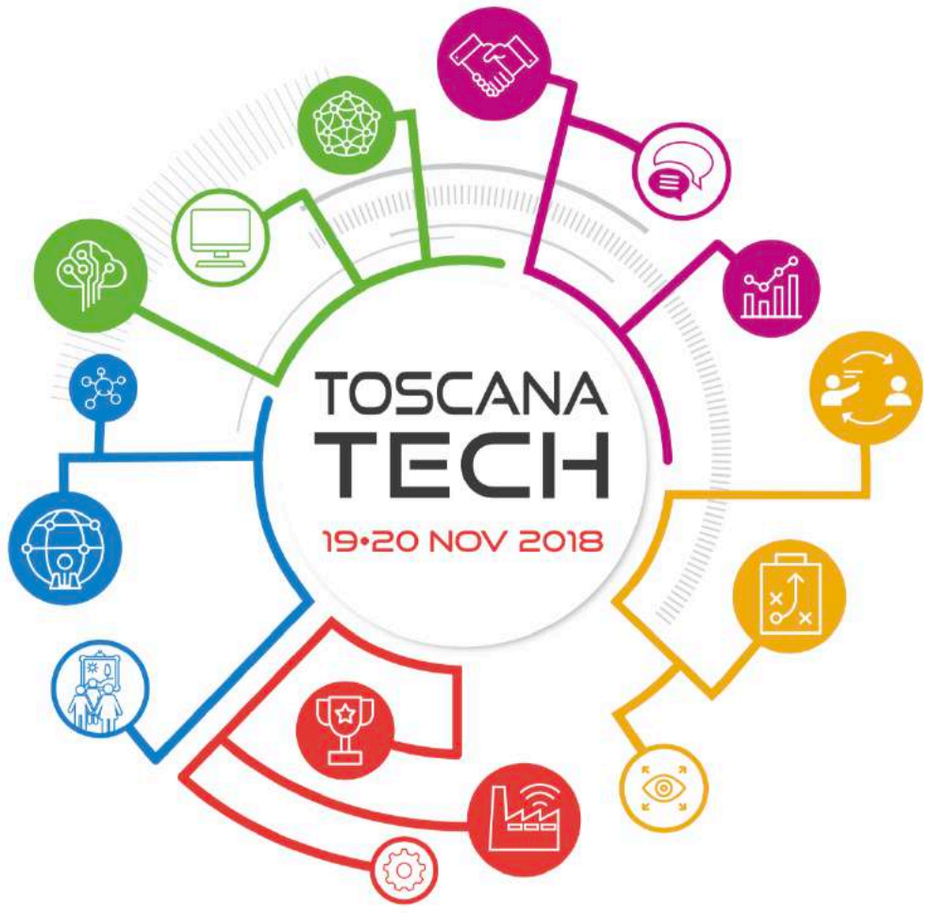
progetto/

Primis

Predictive maintenance in hostile environment

Marco Calderisi
Kode Srl



2014 2020 POR CreO REGIONE TOSCANA FONDO EUROPEO DI SVILUPPO REGIONALE
RIS3 RESEARCH AND INNOVATION STRATEGIES FOR SMART SPECIALISATION
PIATTAFORMA TOSCANA INDUSTRIA 4.0 DIH Digital Innovation Hub
invest in tuscany
UNIONE EUROPEA
REPUBBLICA ITALIANA
Regione Toscana


KODE

OUR HISTORY

February 2012: Kode was founded

June 2013: First commission for the application of AI in the industrial sector

December 2015: First person hired

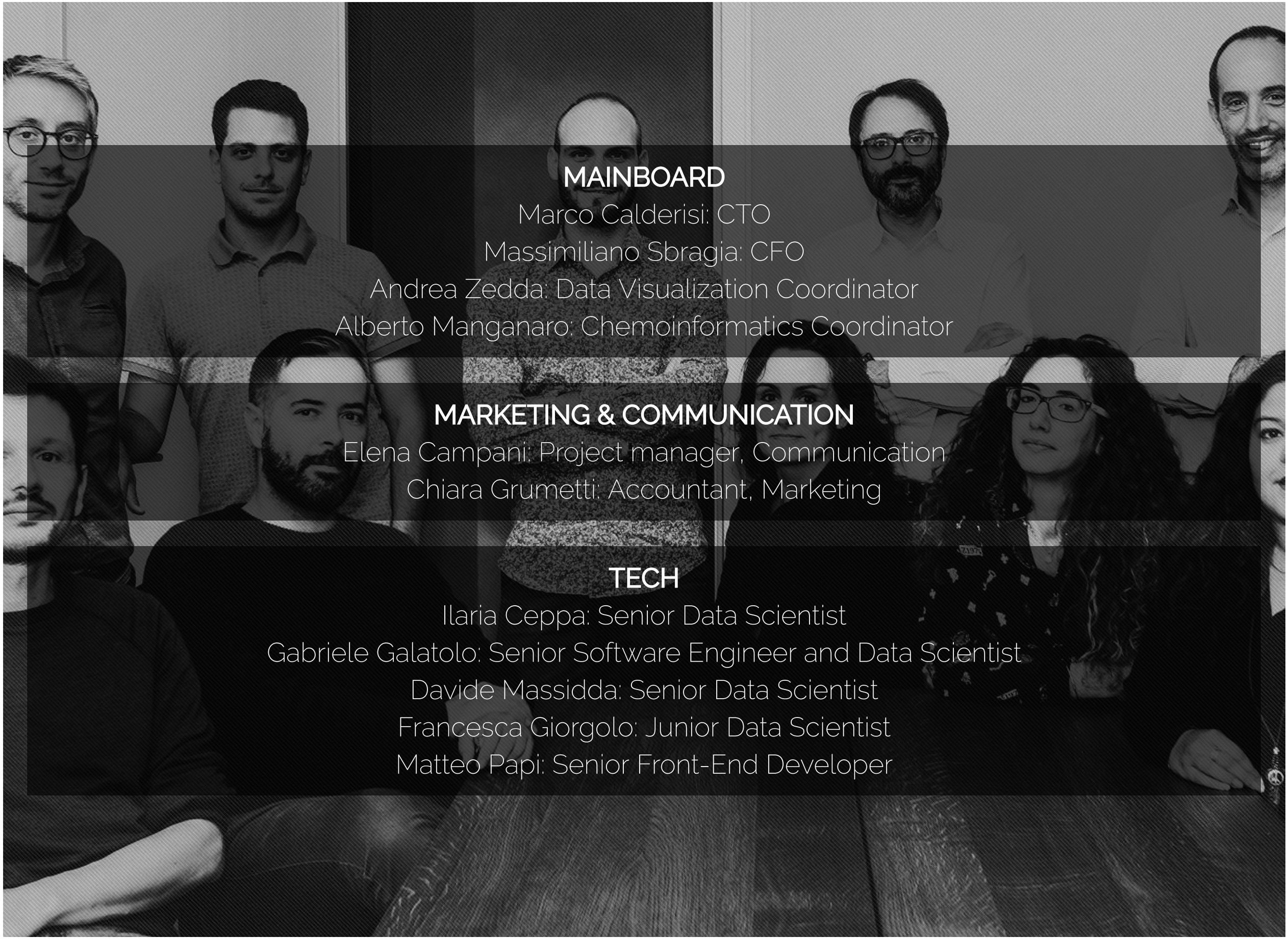
November 2016: First research project approved

February 2017: Seintech was born

April 2017: First European research project approved (Life)

July 2018: Merger with ABA

September 2018: We are not a micro-enterprise anymore



MAINBOARD

Marco Calderisi: CTO

Massimiliano Sbragia: CFO

Andrea Zedda: Data Visualization Coordinator

Alberto Manganaro: Chemoinformatics Coordinator

MARKETING & COMMUNICATION

Elena Campani: Project manager, Communication

Chiara Grumetti: Accountant, Marketing

TECH

Ilaria Ceppa: Senior Data Scientist

Gabriele Galatolo: Senior Software Engineer and Data Scientist

Davide Massidda: Senior Data Scientist

Francesca Giorgolo: Junior Data Scientist

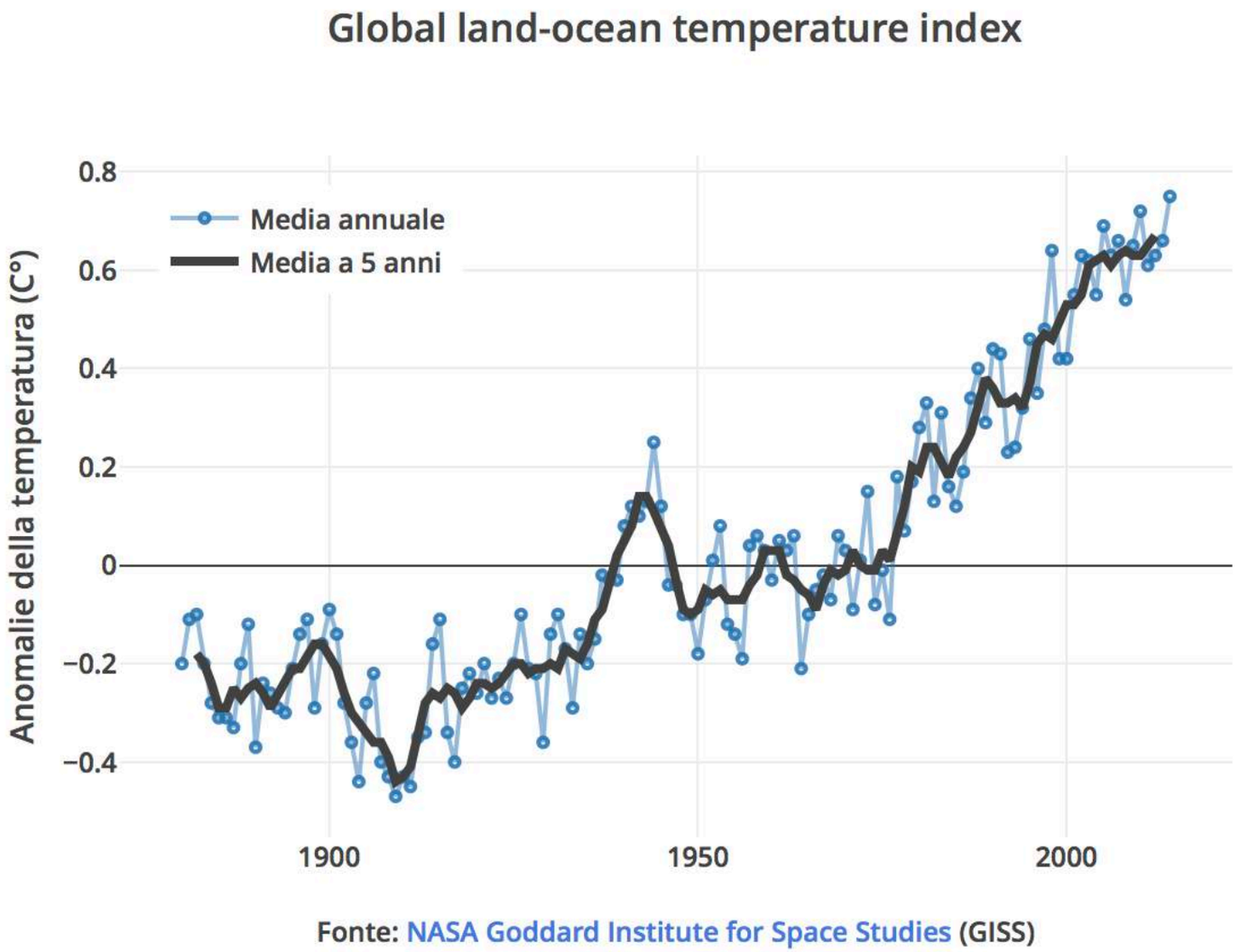
Matteo Papi: Senior Front-End Developer


Kode
from data to knowledge

Climate change - temperature data

1928	-0.19	-0.19
1929	-0.35	-0.18
1930	-0.15	-0.19
1931	-0.1	-0.19
1932	-0.17	-0.18
1933	-0.3	-0.18
1934	-0.14	-0.17
1935	-0.21	-0.15
1936	-0.16	-0.12
1937	-0.04	-0.08
1938	-0.03	-0.03
1939	-0.03	0.01
1940	0.11	0.05
1941	0.18	0.08
1942	0.05	0.09
1943	0.07	0.09
1944	0.21	0.07
1945	0.09	0.03
1946	-0.07	0
1947	-0.04	-0.04
1948	-0.11	-0.07
1949	-0.11	-0.09
1950	-0.19	-0.08
1951	-0.07	-0.08
1952	0.01	-0.08
1953	0.07	-0.08
1954	-0.15	-0.07
1955	-0.14	-0.06
1956	-0.2	-0.05
1957	0.04	-0.04
1958	0.07	-0.01
1959	0.03	0.02
1960	-0.02	0.03
1961	0.06	0.02
1962	0.04	0
1963	0.07	-0.02
1964	-0.2	-0.03
1965	-0.1	-0.04
1966	-0.05	-0.05
1967	-0.02	-0.04
1968	-0.07	-0.03
1969	0.07	-0.01

Climate change - temperature data



1880	-0.19	-0.11
1881	-0.1	-0.14
1882	-0.1	-0.17
1883	-0.19	-0.21
1884	-0.28	-0.24
1885	-0.31	-0.26
1886	-0.32	-0.27
1887	-0.35	-0.27
1888	-0.18	-0.27
1889	-0.11	-0.26
1890	-0.37	-0.26
1891	-0.24	-0.27
1892	-0.27	-0.27
1893	-0.32	-0.27
1894	-0.32	-0.24
1895	-0.22	-0.23
1896	-0.11	-0.21
1897	-0.12	-0.19
1898	-0.28	-0.17
1899	-0.18	-0.18
1900	-0.09	-0.21
1901	-0.15	-0.24
1902	-0.3	-0.27
1903	-0.39	-0.3
1904	-0.49	-0.32
1905	-0.28	-0.35
1906	-0.23	-0.37
1907	-0.4	-0.38
1908	-0.44	-0.4
1909	-0.48	-0.41
1910	-0.44	-0.41
1911	-0.43	-0.39
1912	-0.36	-0.35
1913	-0.35	-0.32
1914	-0.16	-0.3
1915	-0.12	-0.29
1916	-0.33	-0.28
1917	-0.43	-0.28
1918	-0.28	-0.28
1919	-0.27	-0.28
1920	-0.25	-0.26
1921	-0.17	-0.25
1922	-0.27	-0.24
1923	-0.24	-0.22
1924	-0.25	-0.21
1925	-0.21	-0.21
1926	-0.09	-0.2
1927	-0.2	-0.2
1928	-0.19	-0.19
1929	-0.35	-0.18
1930	-0.15	-0.19
1931	-0.1	-0.19
1932	-0.17	-0.18
1933	-0.3	-0.18
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1935	-0.21	-0.15
1936	-0.16	-0.12
1937	-0.04	-0.08
1938	-0.03	-0.03
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1940	0.11	0.05
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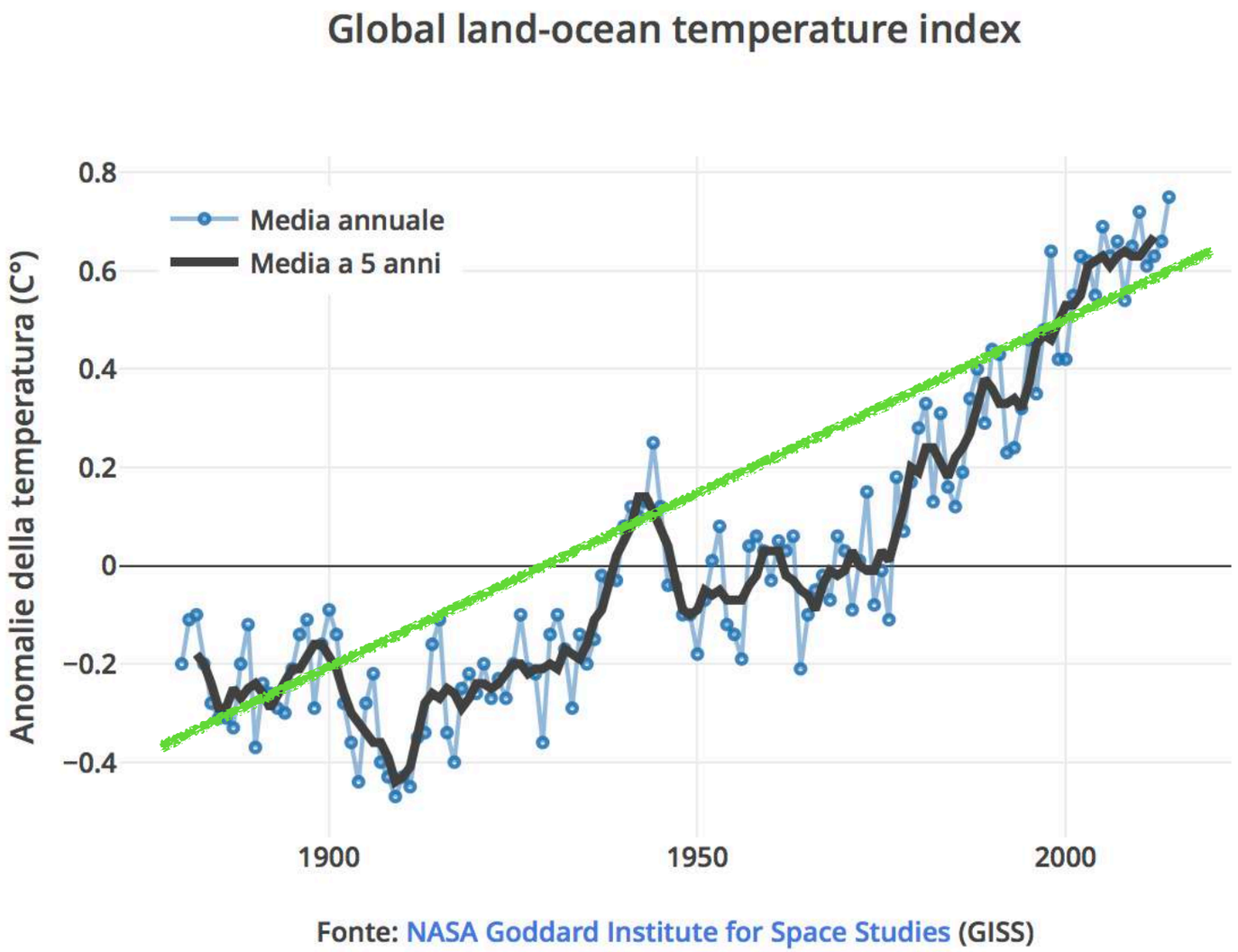
1943	0.07	0.09
1944	0.21	0.07
1945	0.09	0.03
1946	-0.07	0
1947	-0.04	-0.04
1948	-0.11	-0.07
1949	-0.11	-0.09
1950	-0.19	-0.08
1951	-0.07	-0.08
1952	0.01	-0.08
1953	0.07	-0.08
1954	-0.15	-0.07
1955	-0.14	-0.06
1956	-0.2	-0.05
1957	0.04	-0.04
1958	0.07	-0.01
1959	0.03	0.02
1960	-0.02	0.03
1961	0.06	0.02
1962	0.04	0
1963	0.07	-0.02
1964	-0.2	-0.03
1965	-0.1	-0.04
1966	-0.05	-0.05
1967	-0.02	-0.04
1968	-0.07	-0.03
1969	0.07	-0.01
1970	0.03	0
1971	-0.09	0
1972	0.01	0
1973	0.16	-0.01
1974	-0.08	0
1975	-0.02	0.01
1976	-0.11	0.03
1977	0.17	0.07
1978	0.06	0.12
1979	0.16	0.16
1980	0.27	0.19
1981	0.33	0.21
1982	0.13	0.22
1983	0.31	0.21
1984	0.16	0.21
1985	0.12	0.23
1986	0.18	0.25
1987	0.33	0.28
1988	0.41	0.31
1989	0.28	0.34
1990	0.44	0.34
1991	0.41	0.33
1992	0.22	0.33
1993	0.24	0.33
1994	0.31	0.34
1995	0.44	0.37
1996	0.33	0.4
1997	0.47	0.43
1998	0.62	0.45
1999	0.4	0.48
2000	0.4	0.5
2001	0.54	0.52
2002	0.62	0.55
2003	0.61	0.58
2004	0.53	0.6
2005	0.67	0.61
2006	0.62	0.61
2007	0.64	0.61
2008	0.52	0.62
2009	0.63	0.62
2010	0.7	0.62
2011	0.57	0.63
2012	0.61	0.67
2013	0.64	0.71
2014	0.73	0.77
2015	0.86	0.83
2016	0.99	0.89
2017	0.9	0.95

Climate change - temperature data



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1885	-0.31	-0.26
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1889	-0.11	-0.26
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1893	-0.32	-0.27
1894	-0.32	-0.24
1895	-0.22	-0.23
1896	-0.11	-0.21
1897	-0.12	-0.19
1898	-0.28	-0.17
1899	-0.18	-0.18
1900	-0.09	-0.21
1901	-0.15	-0.24
1902	-0.3	-0.27
1903	-0.39	-0.3
1904	-0.49	-0.32
1905	-0.28	-0.35
1906	-0.23	-0.37
1907	-0.4	-0.38
1908	-0.44	-0.4
1909	-0.48	-0.41
1910	-0.44	-0.41
1911	-0.43	-0.39
1912	-0.36	-0.35
1913	-0.35	-0.32
1914	-0.16	-0.3
1915	-0.12	-0.29
1916	-0.33	-0.28
1917	-0.43	-0.28
1918	-0.28	-0.28
1919	-0.27	-0.28
1920	-0.25	-0.26
1921	-0.17	-0.25
1922	-0.27	-0.24
1923	-0.24	-0.22
1924	-0.25	-0.21
1925	-0.21	-0.21
1926	-0.09	-0.2
1927	-0.2	-0.2
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1929	-0.35	-0.18
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1936	-0.16	-0.12
1937	-0.04	-0.08
1938	-0.03	-0.03
1939	-0.03	0.01
1940	0.11	0.05
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1945	0.09	0.03
1946	-0.07	0
1947	-0.04	-0.04
1948	-0.11	-0.07
1949	-0.11	-0.09
1950	-0.19	-0.08
1951	-0.07	-0.08
1952	0.01	-0.08
1953	0.07	-0.08
1954	-0.15	-0.07
1955	-0.14	-0.06
1956	-0.2	-0.05
1957	0.04	-0.04
1958	0.07	-0.01
1959	0.03	0.02
1960	-0.02	0.03
1961	0.06	0.02
1962	0.04	0
1963	0.07	-0.02
1964	-0.2	-0.03
1965	-0.1	-0.04
1966	-0.05	-0.05
1967	-0.02	-0.04
1968	-0.07	-0.03
1969	0.07	-0.01
1970	0.03	0
1971	-0.09	0
1972	0.01	0
1973	0.16	-0.01
1974	-0.08	0
1975	-0.02	0.01
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2007	0.64	0.61
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2009	0.63	0.62
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2011	0.57	0.63
2012	0.61	0.67
2013	0.64	0.71
2014	0.73	0.77
2015	0.86	0.83
2016	0.99	0.89
2017	0.9	0.95

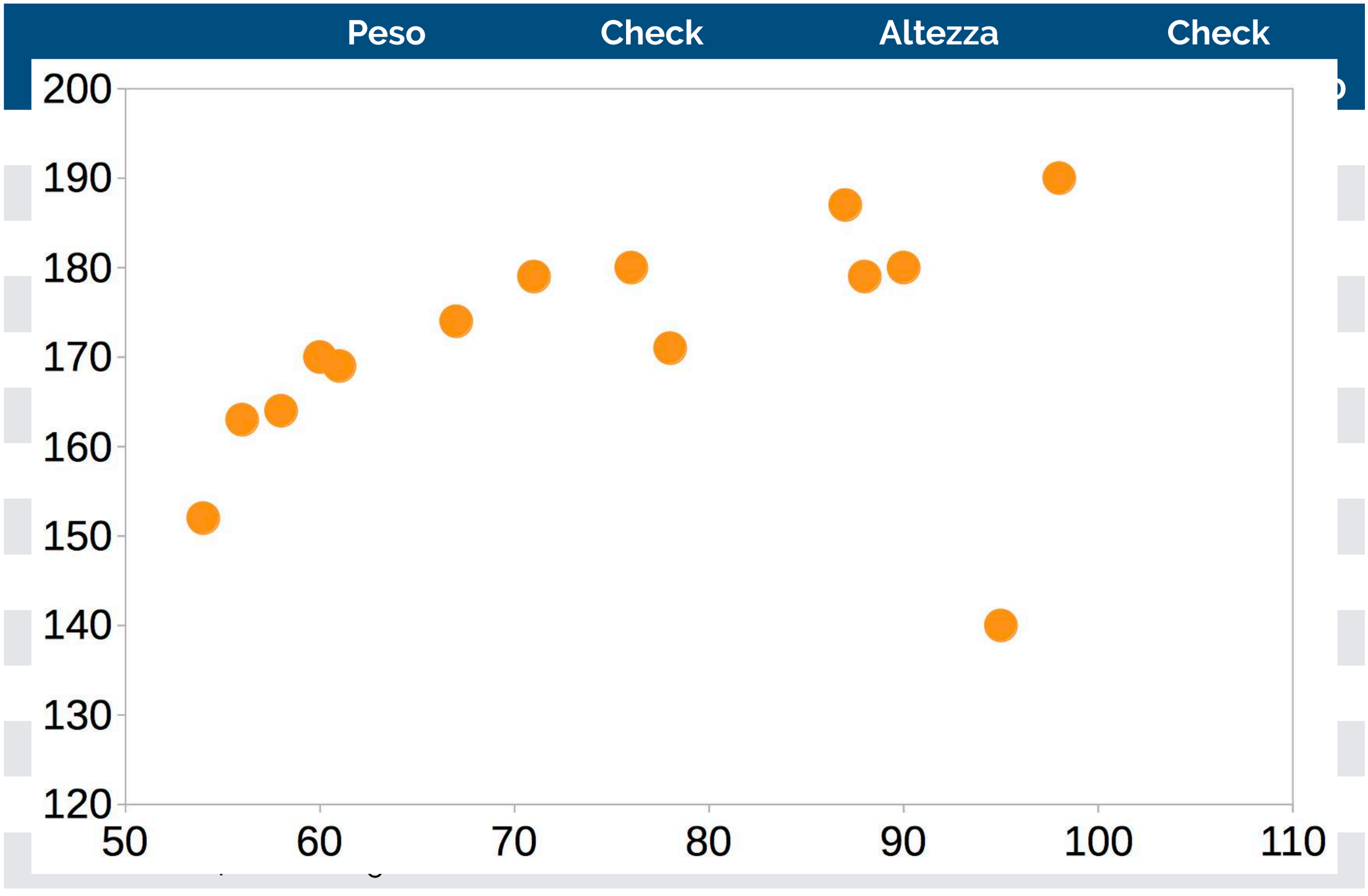
One variable at a time … evil

	Peso	Altezza
Persona 1	60	170
Persona 2	56	163
Persona 3	54	152
Persona 4	98	190
Persona 5	76	180
Persona 6	58	164
Persona 7	95	140
Persona 8	87	187
Persona 9	67	174
Persona 10	88	179
Persona 11	78	171
Persona 12	71	179
Persona 13	61	169
Persona 14	90	180

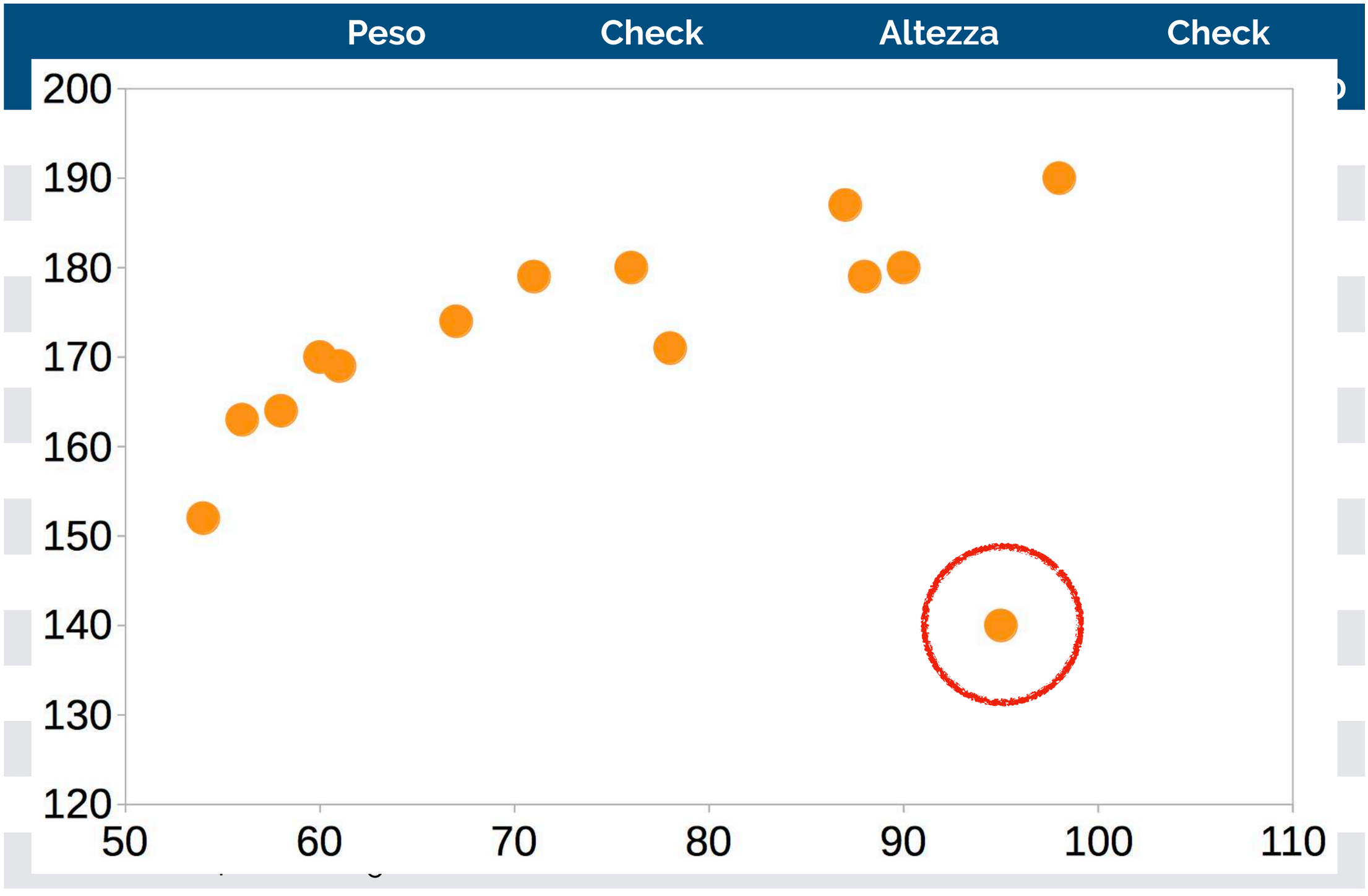
One variable at a time … evil

	Peso	Check range: 50 - 100 kg	Altezza	Check range: 150 - 190 cm
Persona 1	60	ok	170	ok
Persona 2	56	ok	163	ok
Persona 3	54	ok	152	ok
Persona 4	98	ok	190	ok
Persona 5	76	ok	180	ok
Persona 6	58	ok	164	ok
Persona 7	95	ok	140	ok
Persona 8	87	ok	187	ok
Persona 9	67	ok	174	ok
Persona 10	88	ok	179	ok
Persona 11	78	ok	171	ok
Persona 12	71	ok	179	ok
Persona 13	61	ok	169	ok
Persona 14	90	ok	180	ok

One variable at a time … evil



One variable at a time … evil



Predictive maintenance in hostile environment

Predictive maintenance in hostile environment

CAEN
Tools for Discovery

INFN
Istituto Nazionale di Fisica Nucleare

kode
from data to knowledge

net7

UNIVERSITÀ DI PISA

Predictive maintenance in hostile environment

DUE PROGETTI PILOTA

Realizzazione di **power supplies** (alimentatori) e **digitizers** (digitalizzatori) per esperimenti di fisica nucleare e subnucleare presso

CERN di Ginevra

FermiLab negli Stati Uniti

Predictive maintenance

Allarmi su soglia?

Elenco malfunzionamenti?

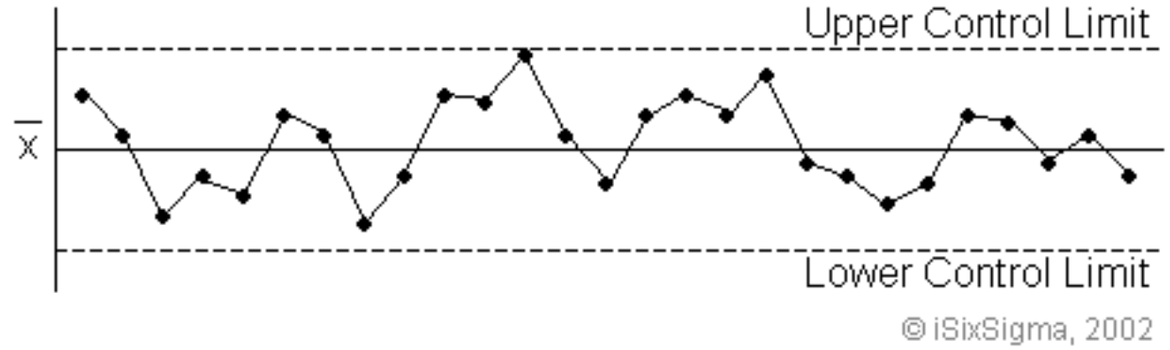
Predictive maintenance

Allarmi su soglia?

Elenco malfunzionamenti?

Predictive maintenance

Carte di controllo?

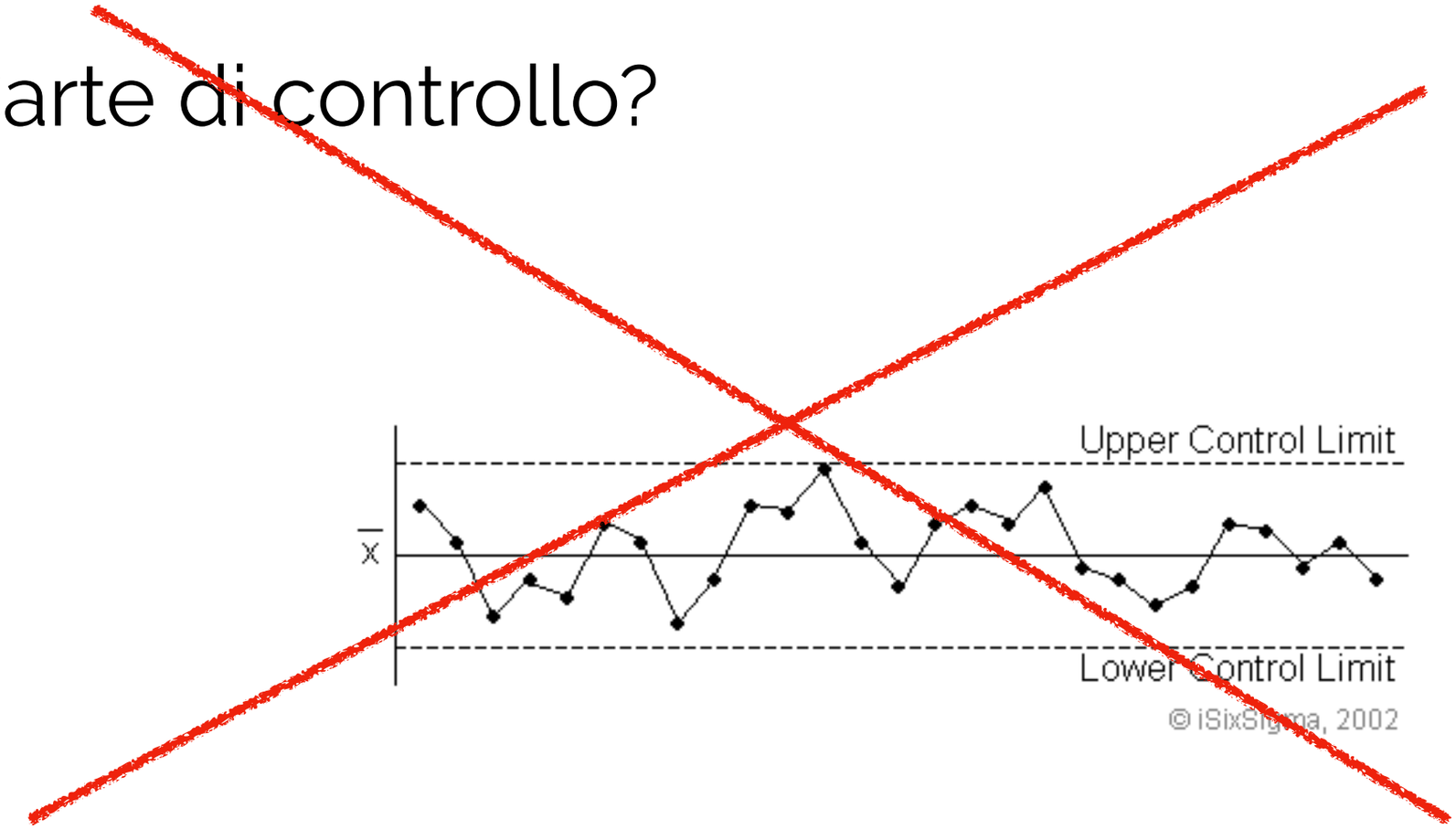


…un po’ di numeri

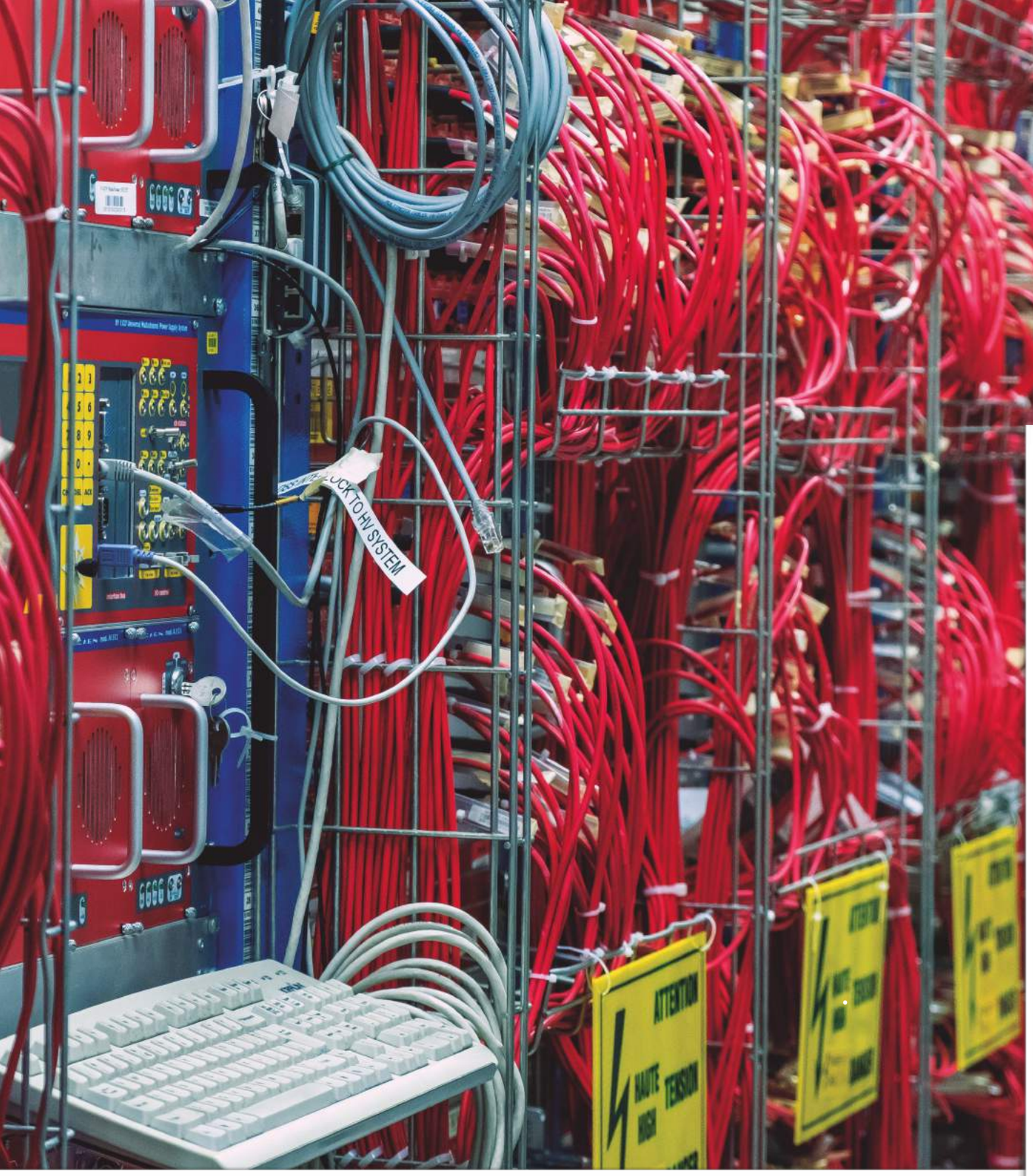
Power supply forniscono più di **8000 canali**, ciascuno espone circa **30 variabili** (temperature, i, V, status…). complessivamente il dataset finora raccolto contiene oltre **3 miliardi di record**!!!

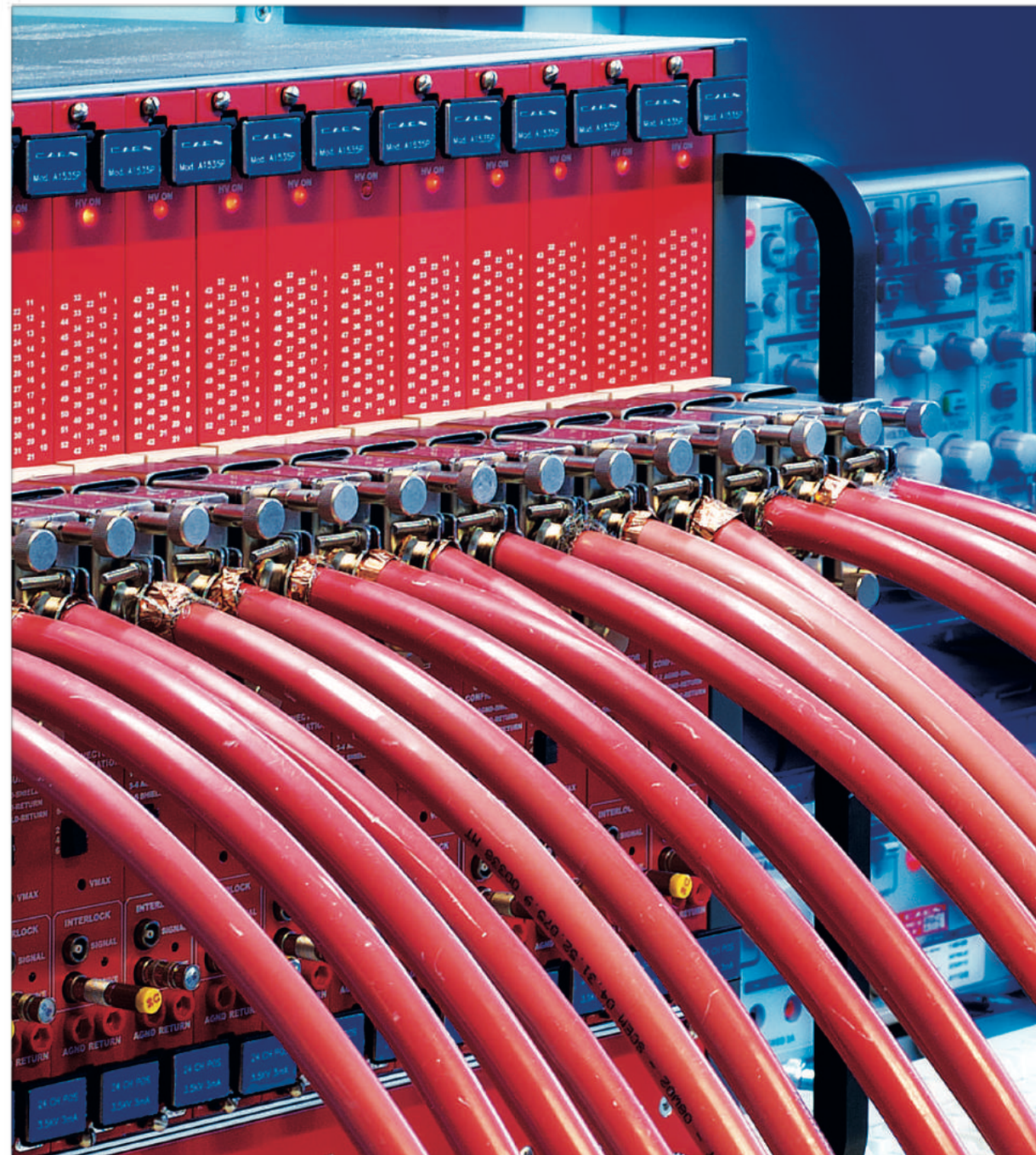
Predictive maintenance

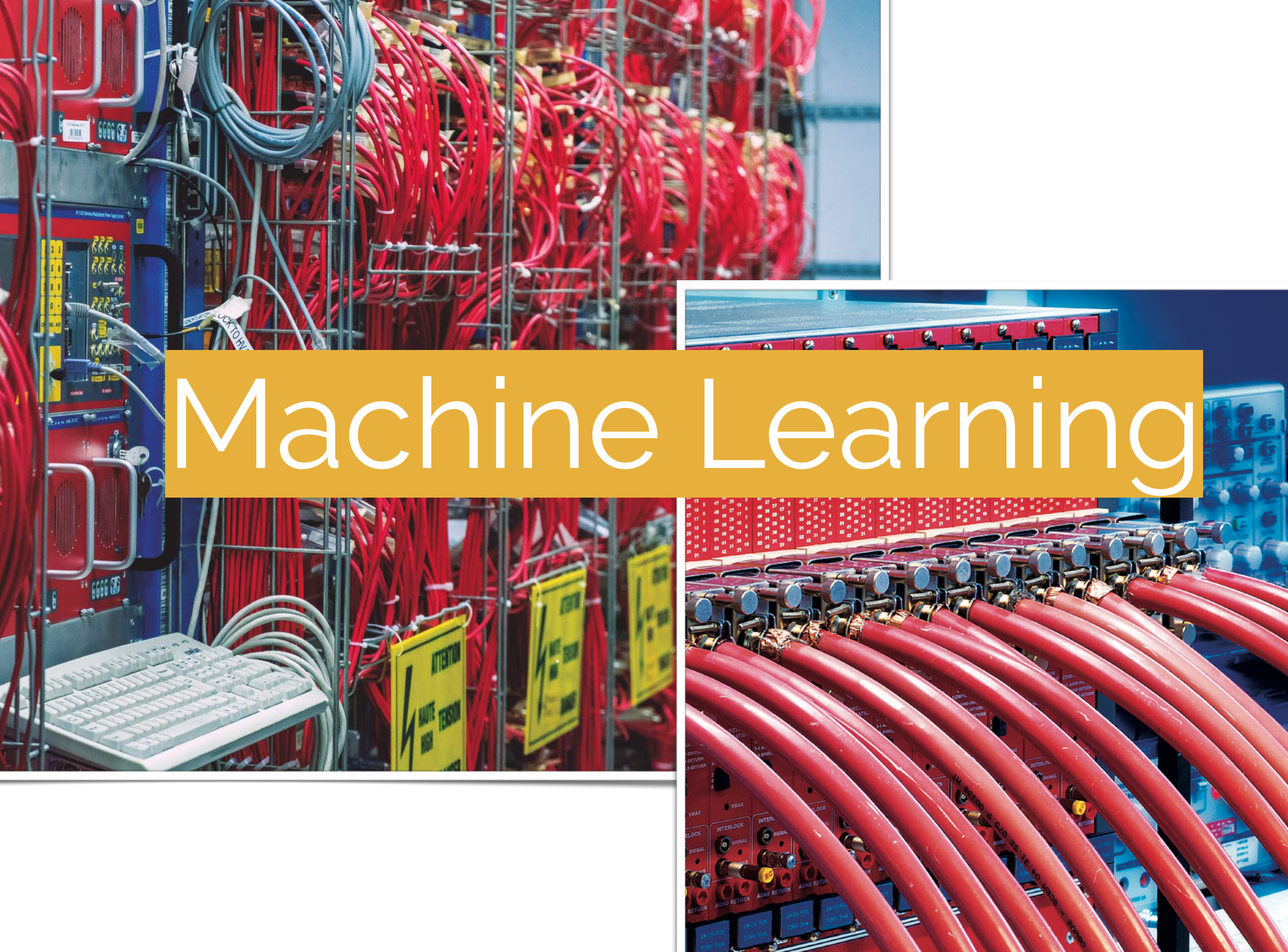
Carte di controllo?



…ne servirebbero migliaia…


ATTENTION
HAUTE TENSION





Machine Learning

Machine Learning

Le risorse HW e SW permettono di lavorare con grandissime quantità di dati

Non devo postulare le regole del sistema, ma me le faccio dire dal sistema stesso

Machine Learning

Creo indici di sintesi

Sviluppo un modello di riferimento che mi indica la condizione operativa ottimale

Prevedo le necessità di manutenzione prima che si presenti la problematica

Grazie

m.calderisi@kode-solutions.net