



The San Marino Scale:

Independence of Terms

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and Jamie Riggs

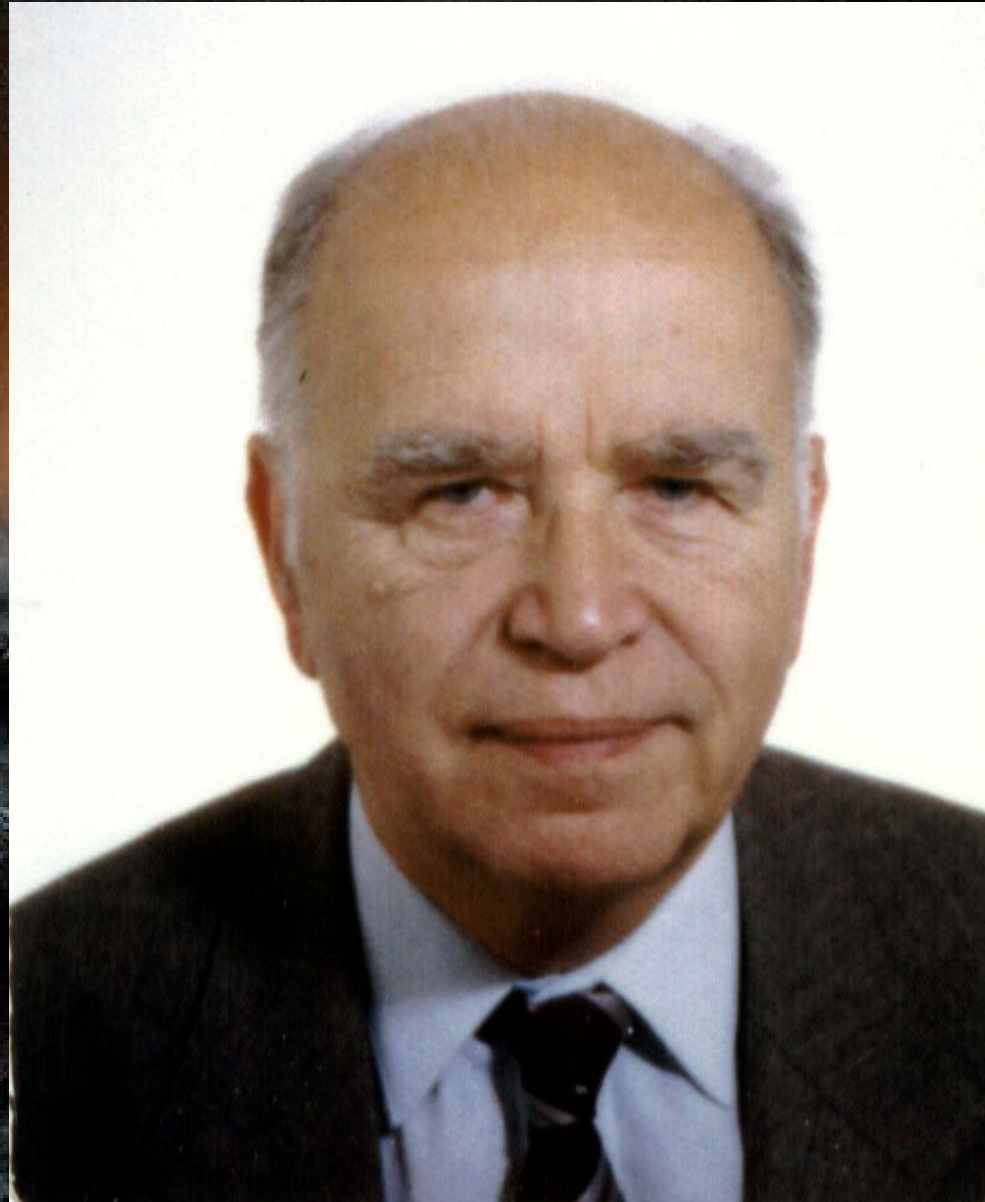
Senior Staff Statistician, Sun Microsystems

- **Integer**
- **Ordinal**
- **Categorical**

Value	Potential Hazard
10	Extraordinary
9	Outstanding
8	Far-reaching
7	High
6	Noteworthy
5	Intermediate
4	Moderate
3	Minor
2	Low
1	Insignificant

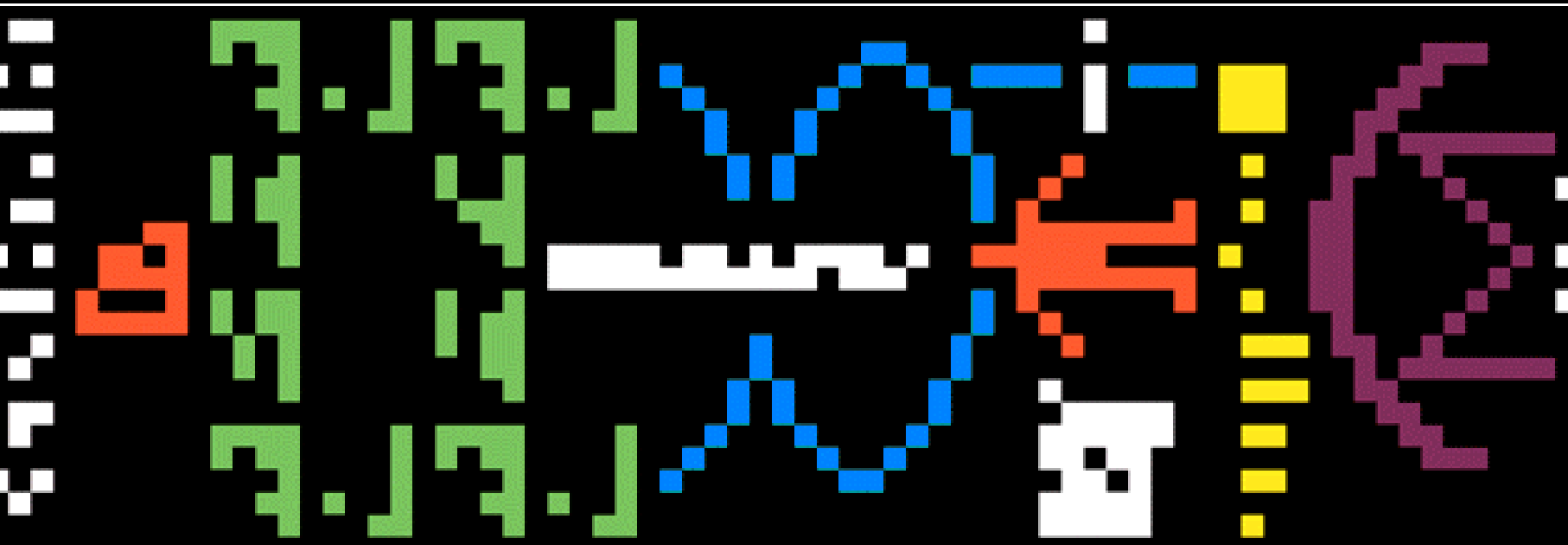


The San Marino Scale:



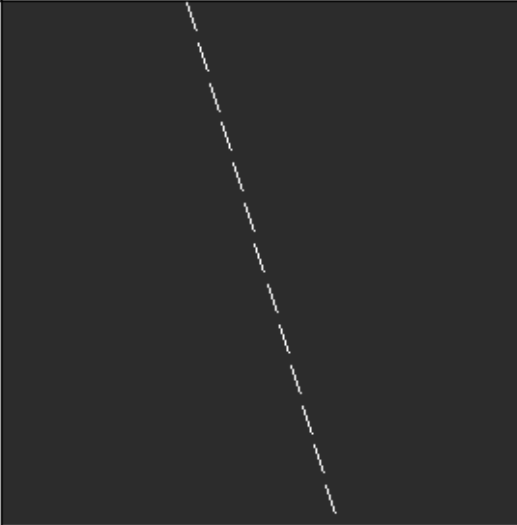
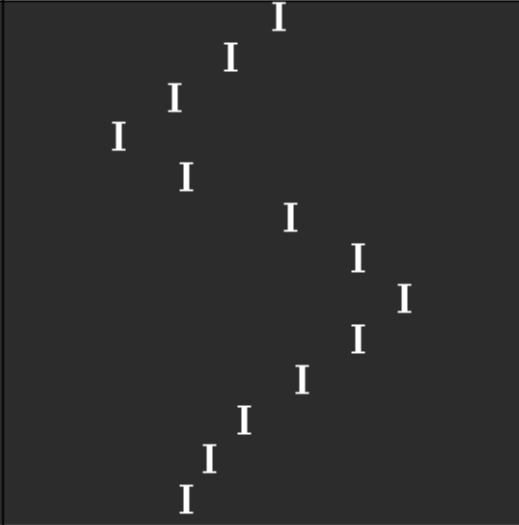
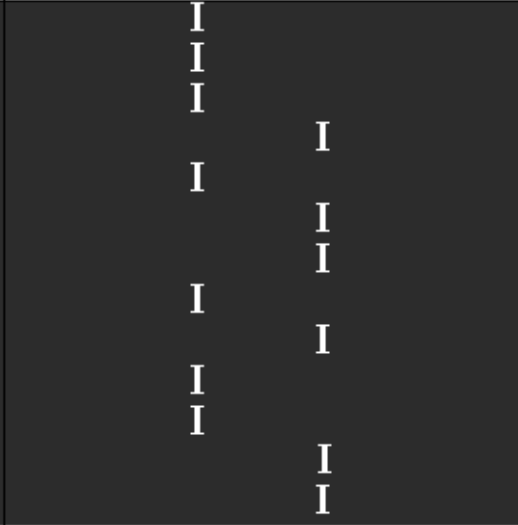


The San Marino Scale:



Spectral Structure of Interstellar Radio Messages

Three Types of Single-valued Frequency Functions:

Type	1. Constant	2. Continuous Function	3. Discrete Function
Author	Radio Engineer	Artist	Scientist
Sonogram			
Name	Language of Nature	Language of Emotions	Language of Logic
Decoding	Astrophysical	By Art Jury	Linguistic



The San Marino Scale:

IAA SETI Permanent Study Group - Netscape



International Academy of Astronautics SETI Permanent Study Group

Quick Search of IAA SETI

Advanced Search



Overview

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Establishment

The International Academy of Astronautics (IAA) formally established a Permanent SETI Study Group, as well as a SETI Program Committee, under its Commission on Space Physical Sciences, at the 52nd International Astronautical Congress in Toulouse, France. Together, the Permanent Study Group and the Program Committee replace the long-standing IAA SETI Committee, which was phased out (along with various other IAA Committees) on 1 October 2001, as part of an overall restructuring of the IAA.

Click [here](#) to obtain the Proposal which established this Study Group, in Portable Document Format. You are welcome to download the free [Adobe Acrobat](#)® reader to allow you to view PDF files.



Duties

The SETI Permanent Study Group, designated IAA SG 1.3, assumes many of the duties formerly performed by the late IAA SETI Committee. The primary task of the Study Group is to organize and conduct two SETI sessions at the annual International Astronautical Congresses. Study Group members also conduct workshops and Cosmic Studies for the International Academy of Astronautics, and publish papers on topics related to the scientific Search for Extra-Terrestrial Intelligence.



The San Marino Scale:

$$\mathbf{SMI = I + C}$$

Ordinal Index

Parametric Term

Categorical Term

I: intensity of the transmission

Average solar flux density in the frequency band of the transmission (I_0)	0
$10 I_0$	1
$100 I_0$	2
$1000 I_0$	3
$10\ 000 I_0$	4
$\geq 100\ 000 I_0$	5

I is the Common Logarithm of the Intensity Ratio
(think: "Bels over Background")

C: character of the transmission

- | | |
|--|---|
| A beacon without any message, e.g. planetary radar | 1 |
| Message with the intention to reach ETI – at arbitrary directions for minutes or hours, | 2 |
| Special signal in a preselected direction at a preselected time in order to draw the attention of ET astronomers | 3 |
| Continuous, broadband transmission of a message to ETI | 4 |
| Reply to an extraterrestrial signal or message (if they are not aware of us yet!) | 5 |

C is a numerical value assigned to a Categorical Designator

$$SMI = I + C$$

The additive model **assumes** the two terms are independent random variables

But...

- **Signal character depends on information content**
- **which influences bandwidth**
- **which determines SNR**
- **which changes the Intensity term**

So...

I and C should **not
be independent!**

Testing six transmitters

- **CommSat uplink**
- **UHF Broadcast TV**
- **Ham Radio Moonbounce**
- **NASA Goldstone DSN**
- **Evpatoria Planetary Radar**
- **Arecibo Planetary Radar**

**against four
modulation modes**

- **CW carrier**
- **Narrowband voice**
- **Mid-bandwidth video**
- **Broadband digital data**

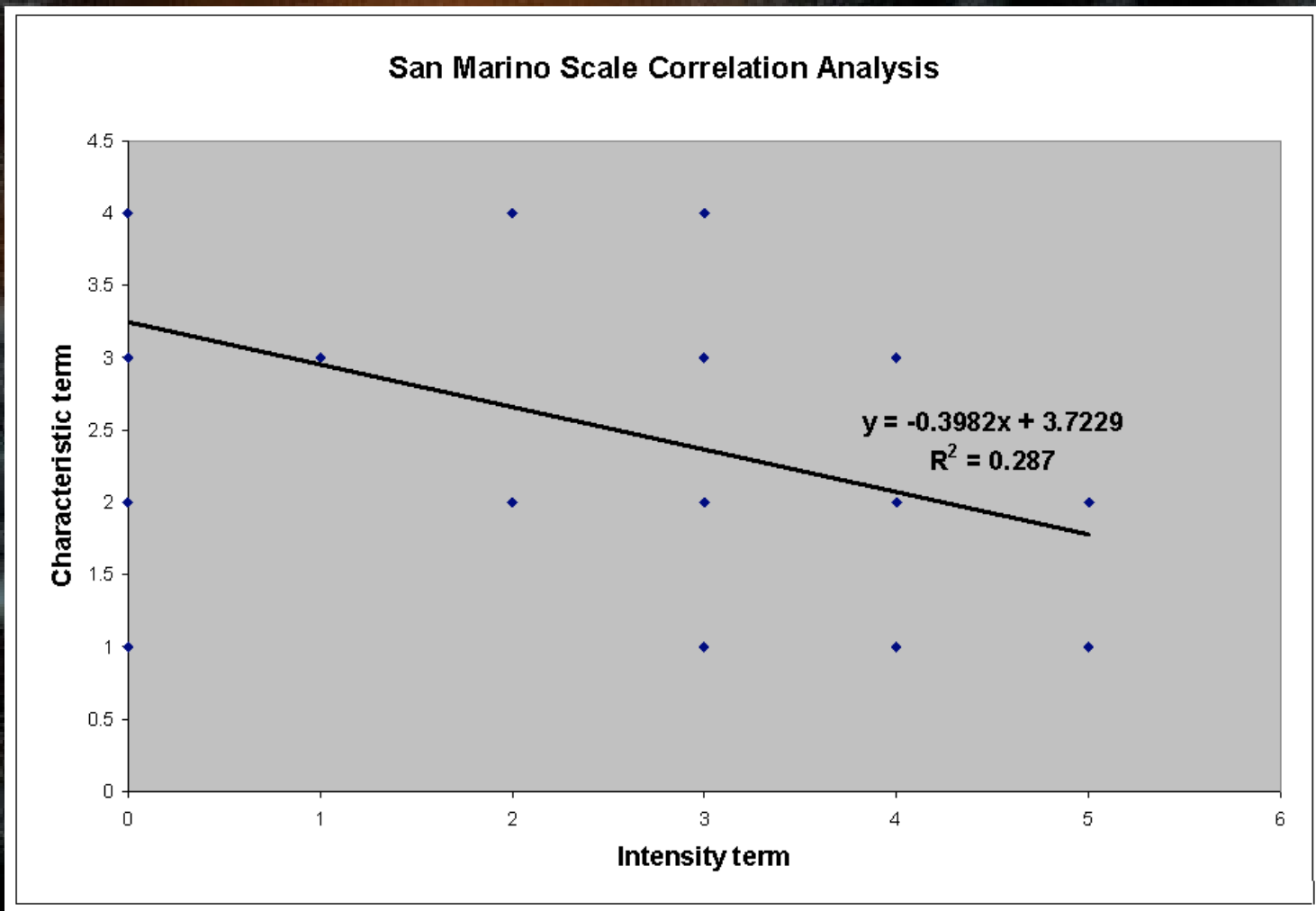
**We get a sample of 24
different transmissions**

$$(6 \times 4 = 24)$$

**To evaluate for
independence of I and C**

<u>Transmitter</u>	<u>Modulation</u>	<u>I</u>	<u>C</u>	<u>SMI</u>
CommSat	CW	0	1	1
CommSat	voice	0	2	2
CommSat	video	0	3	3
CommSat	data	0	4	4
UHF TV	CW	4	1	5
UHF TV	voice	3	2	5
UHF TV	video	1	3	4
UHF TV	data	0	4	4
23 cm EME	CW	3	1	4
23 cm EME	voice	2	2	4
23 cm EME	video	1	3	4
23 cm EME	data	0	4	4
Goldstone DSN	CW	5	1	6
Goldstone DSN	voice	4	2	6
Goldstone DSN	video	4	3	7
Goldstone DSN	data	3	4	7
Evpatoria Radar	CW	5	1	6
Evpatoria Radar	voice	4	2	6
Evpatoria Radar	video	3	3	6
Evpatoria Radar	data	2	4	6
Arecibo Radar	CW	5	1	6
Arecibo Radar	voice	5	2	7
Arecibo Radar	video	4	3	7
Arecibo Radar	data	3	4	7

Are I and C Independent?



For interdependent terms, a better choice would be a log-linear model.

$$\ln(e_{ic}) = \mu + \alpha_i + \beta_c + \gamma_{ic},$$

$$i=0,1,\dots,5, \quad c=1,2,\dots,5 \quad (1)$$

Where $\ln(e_{ij})$ is the naperian log of the expected frequencies of the **I** and **C** cell combinations, μ is the overall mean of the log of the expected frequencies, α , β , and γ are the parameters to be estimated for **I**, **C**, and **I**×**C**, respectively, and i and j are the category levels for **I** and **C**.

Is sample size adequate?

$$n = \frac{\chi^2_{2(30);0.025}}{4d} = \frac{59.34}{(4)(0.3177)} = 46.69 \approx 47.$$

(for 95% confidence level)

But, our n is only 24.

CONCLUSIONS

- **San Marino Scale is valid, but flawed**
- **I and C terms are interdependent**
- **Log-Linear Model is a better choice**
- **Sample size is too small for significance**
- **Not recommending changes at this time**
- **Need more data**



The San Marino Scale:



International Academy of Astronautics

SETI Permanent Study Group

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Search



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San Marino Scale Calculator

Rev. 0.1, proposed March 2005

Instructions:

Use the boxes below to describe the active SETI transmission you wish to analyze. Select one option in each of the two boxes. The potential hazard associated with the event, estimated on a scale of one (insignificant) to ten (extraordinary), is displayed at the bottom of the page.

- ***<http://liaaseti.org>***

***Click on 'Protocols'
Follow the link to the
'San Marino Scale'***



The San Marino Scale:

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