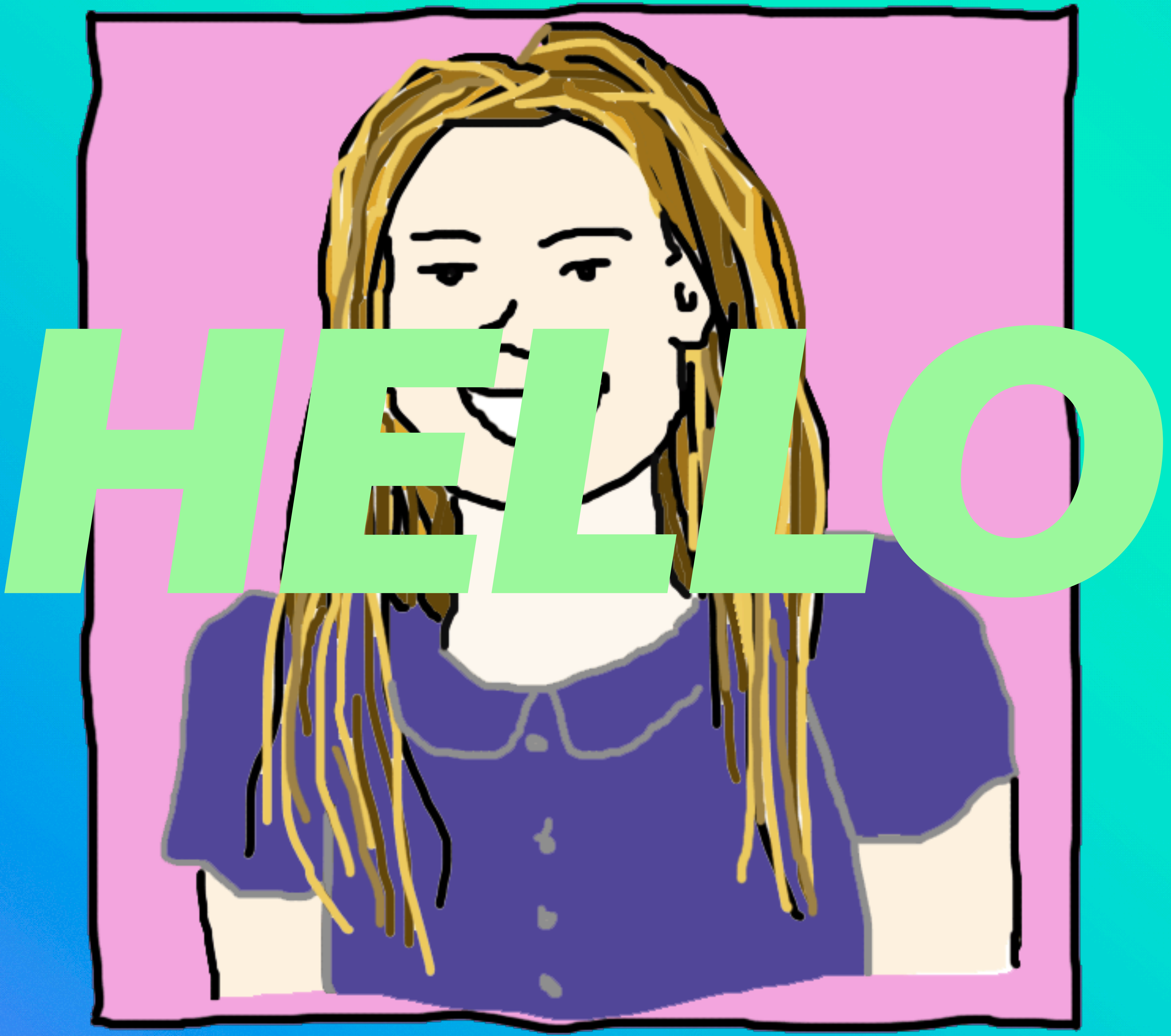
MAKING MUSIC WITH MARKOV (MMM...)

GINA COLLECCHIA /// 08.12.23 /// THEORY CLUB NO. 1


HELLO

Nudge
Buy for $9.99!
Numbers & Notes
JAUNT
SENNHEISER
N samples
H(z)=Y(z)/U(z)
Heuser Hearing Institute
UNIVERSITY OF LOUISVILLE
CCRMA
AES
SPATIAL
REED COLLEGE


"THE ENTROPY OF MUSIC CLASSIFICATION"
OR, MY REED COLLEGE UNDERGRADUATE THESIS IN MATHEMATICS, 2009
Chapter 3. Information, Entropy,

The Beatles (whole discography + solo work)

Beethoven, Piano Sonata No. 8, "Pathetique"

The Beatles (whole discography + solo work)

Wire, *Pink Flag* (1977)

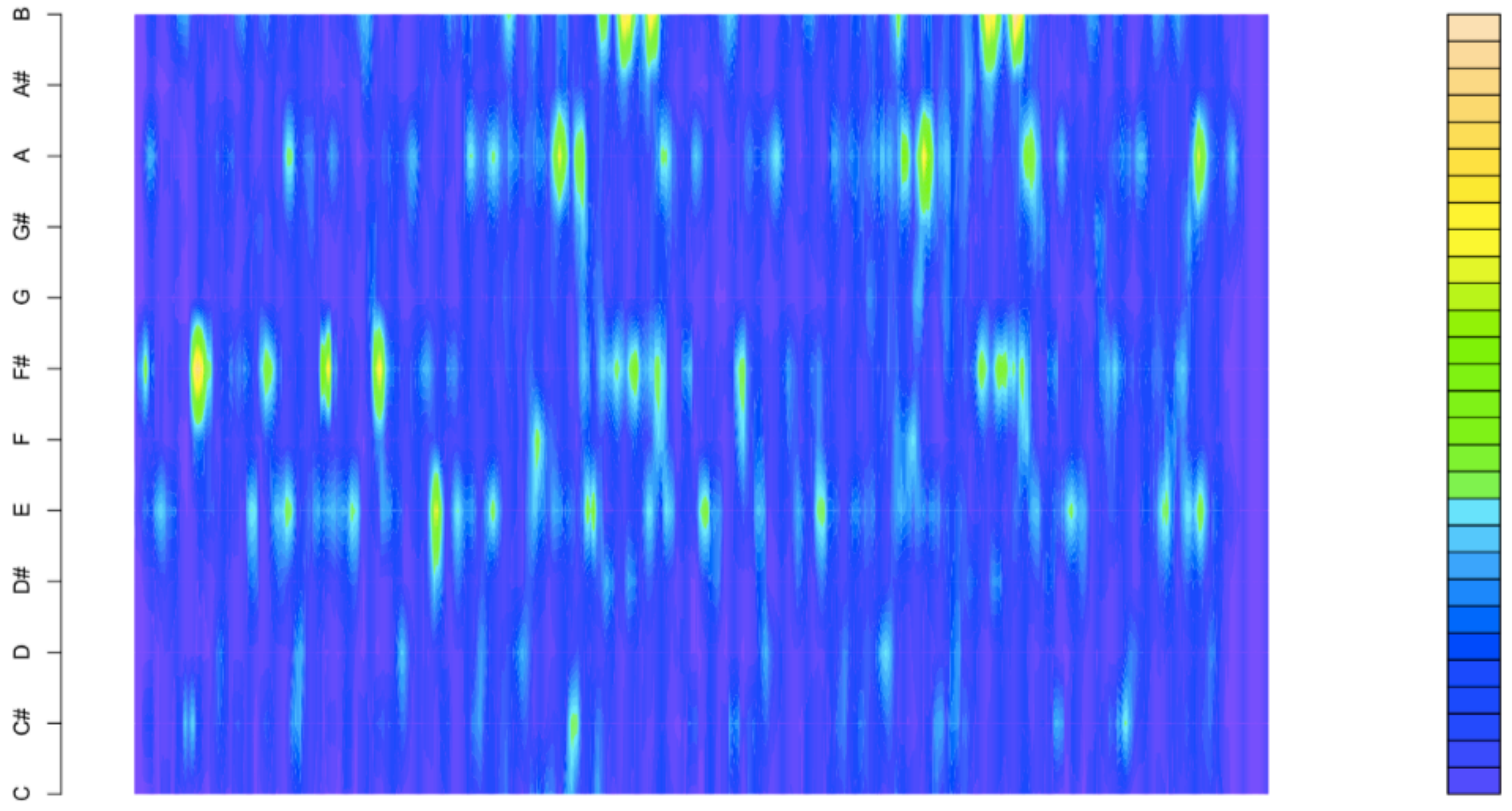


Figure 1.12: Smoothed contour plot of “Oh! Darling”.

Working on my thesis with a manually acquired dataset (2009)

Classification	True Entropy Rate
“Tell Me Why” from *A Hard Day’s Night*	0.2437552
“You’re Going Lose That Girl” from *Help!*	0.1828974
“When I’m 64” from *Sgt. Pepper’s*	0.2822246
“Oh! Darling” from *Abbey Road*	0.3168579
“Two of Us” from *Let It Be*	0.2249230
A Hard Day’s Night	0.3943230
Help!	0.4842243
Sgt. Pepper’s	0.4727886
Abbey Road	0.4709648
Let It Be	0.3357670
First mvmt. of Beethoven	0.3933457
Second mvmt. of Beethoven	0.2513897
Third mvmt. of Beethoven	0.3841676
All of Beethoven	0.4578376

Christopher Harte’s rich Beatles datasets (2010): http://isophonics.net/

Reference Annotations: The Beatles

Note: Please be sure to read the page describing these annotations before use. In particular, the level of confidence we have in the individual annotations is described there, as well as the original CD issue numbers from which we worked.

Chris Harte's PhD thesis (2010) which describes the chord syntax, transcription process and verification process for the Beatles collection can be downloaded here.

The chord transcription files currently available on this page are version 1.2. of the collection.

All Beatles annotations in a single tar.gz file

Please Please Me

1. I Saw Her Standing There
   - Structural segmentation: csv rdf
   - Key changes: csv rdf
   - Chords: csv rdf svl
   - Beats: csv rdf
   - All of the above: rdf
2. Misery
   - Structural segmentation: csv rdf
   - Key changes: csv rdf
   - Chords: csv rdf svl
   - Beats: csv rdf
   - All of the above: rdf
3. Anna (Go To Him)

A quick introduction to

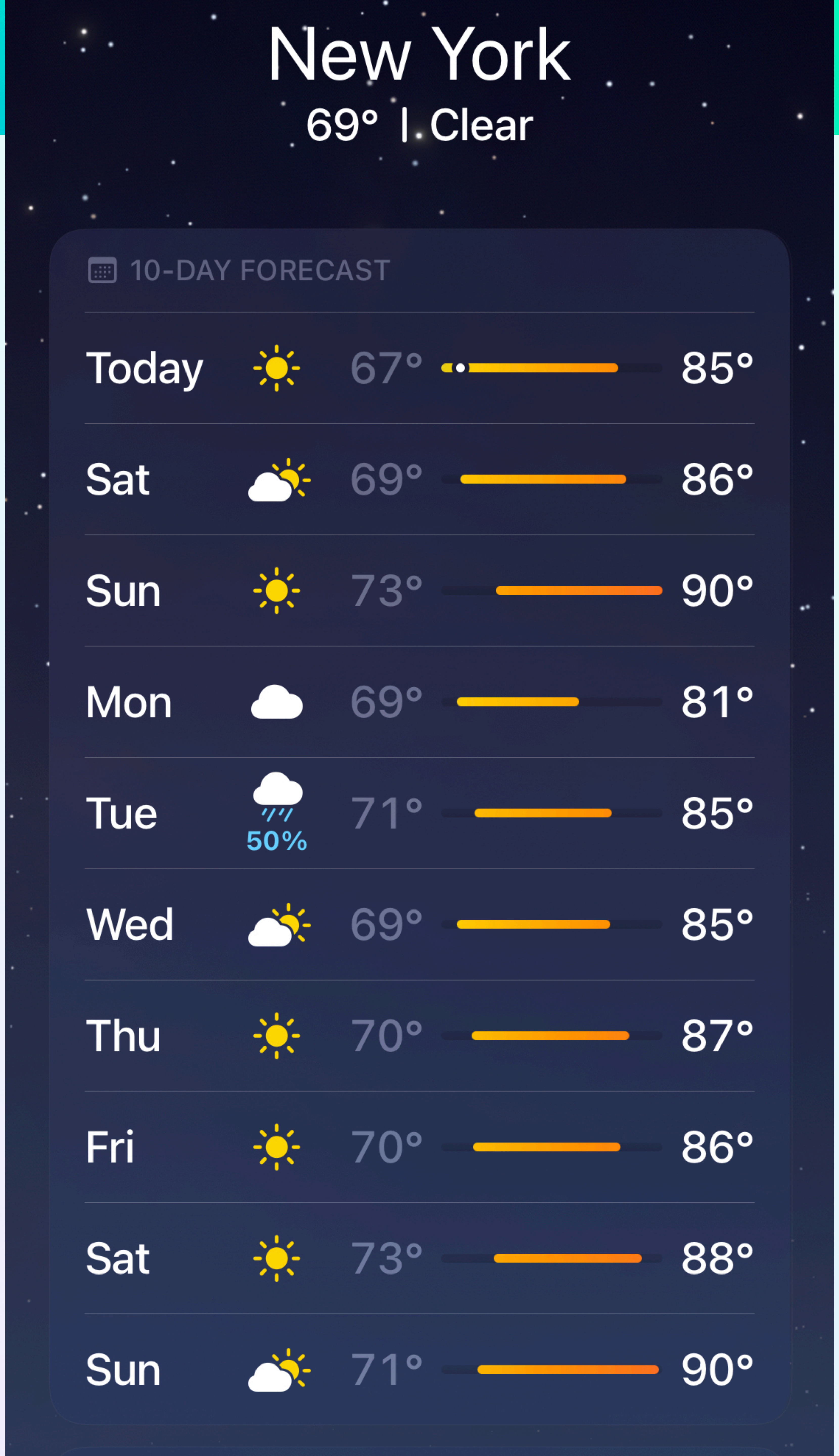
MARKOV CHAINS

WHAT IS A MARKOV PROCESS?

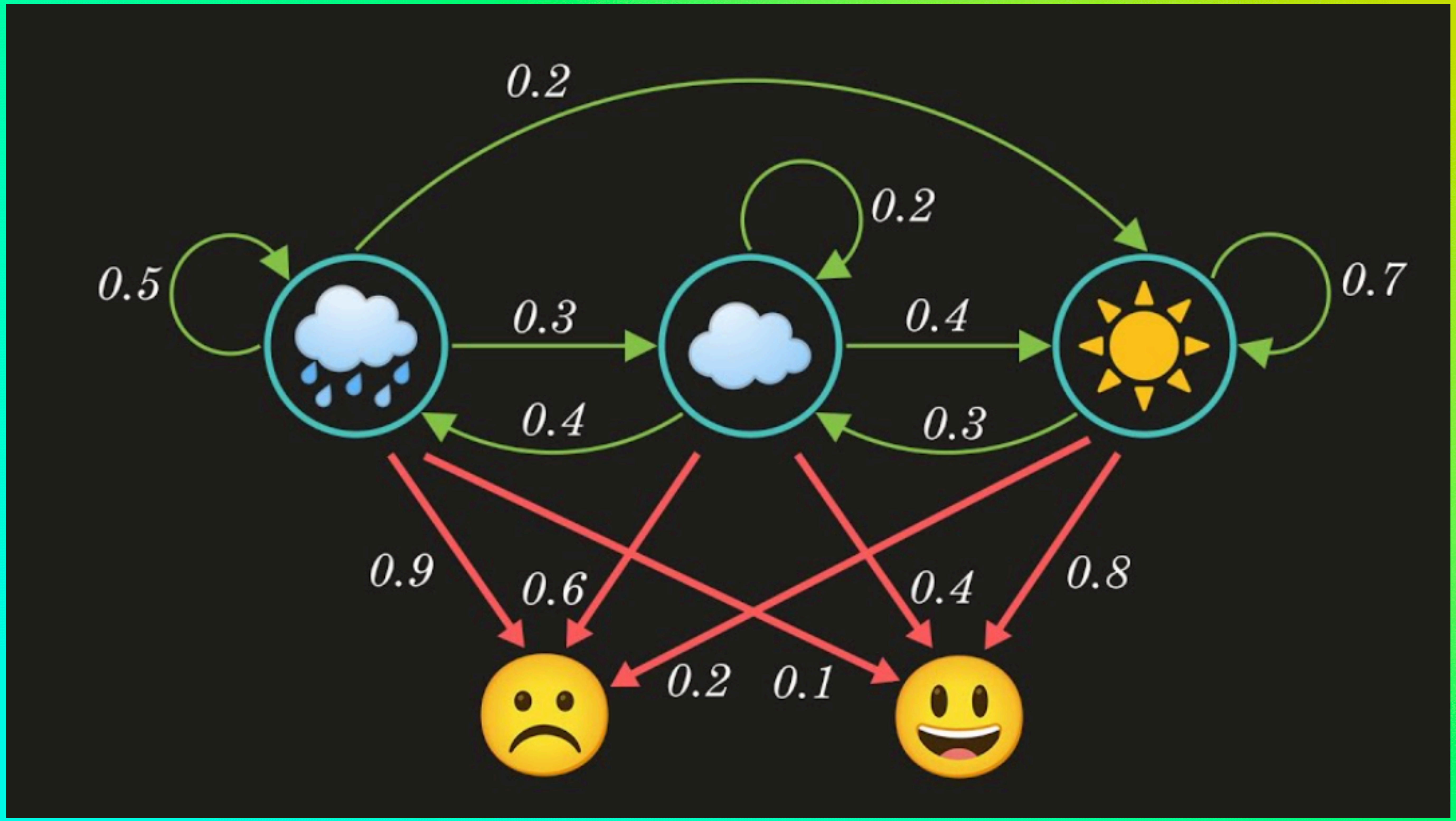
A.K.A., A MARKOV CHAIN

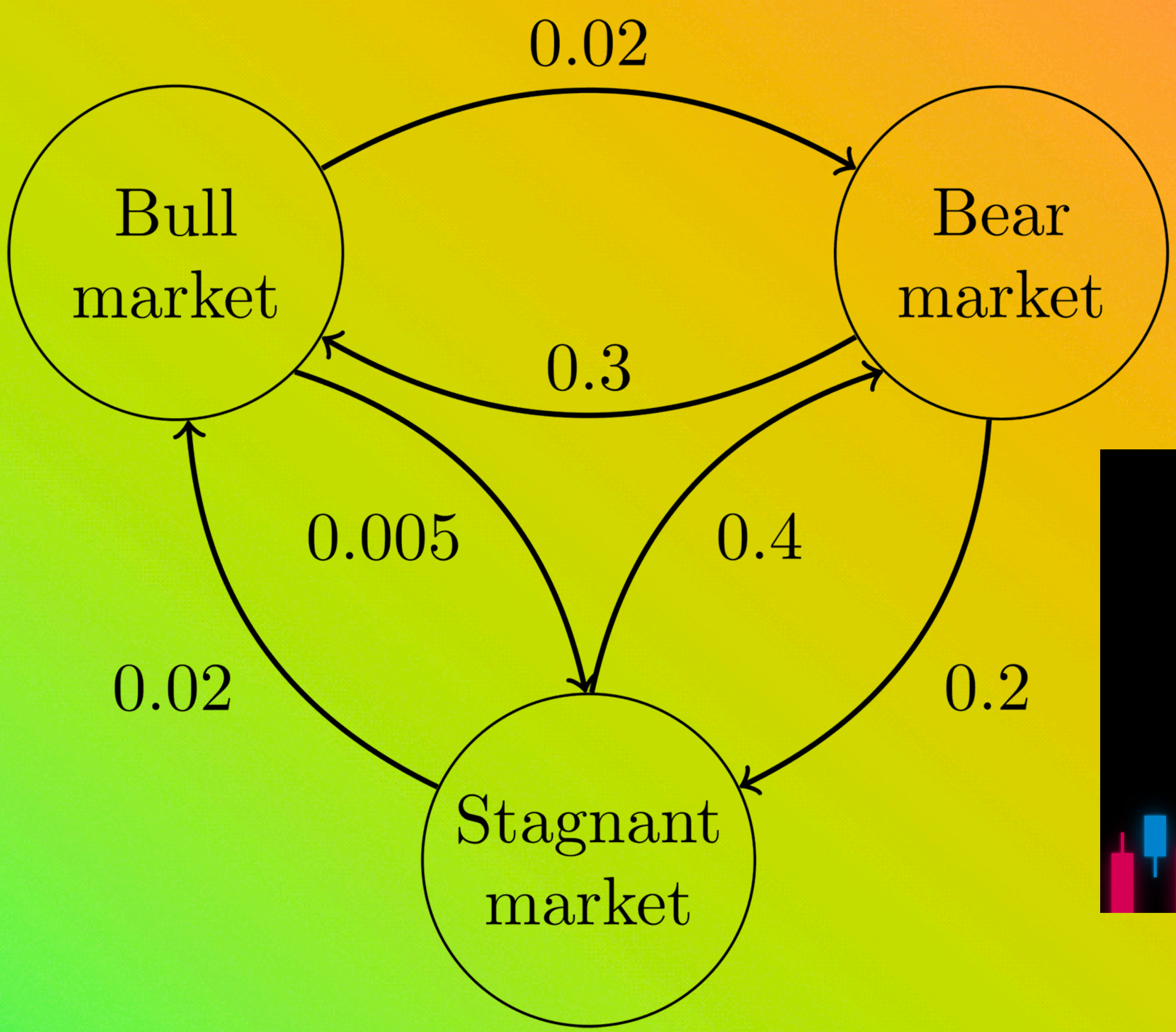
- **A system in which the probability of each "state" depends *only* on the previous state**
- **When a state changes, it's said to "transition"**
- **Characterized by a square NxN matrix of "transition probabilities" where N is the size of the state space:**

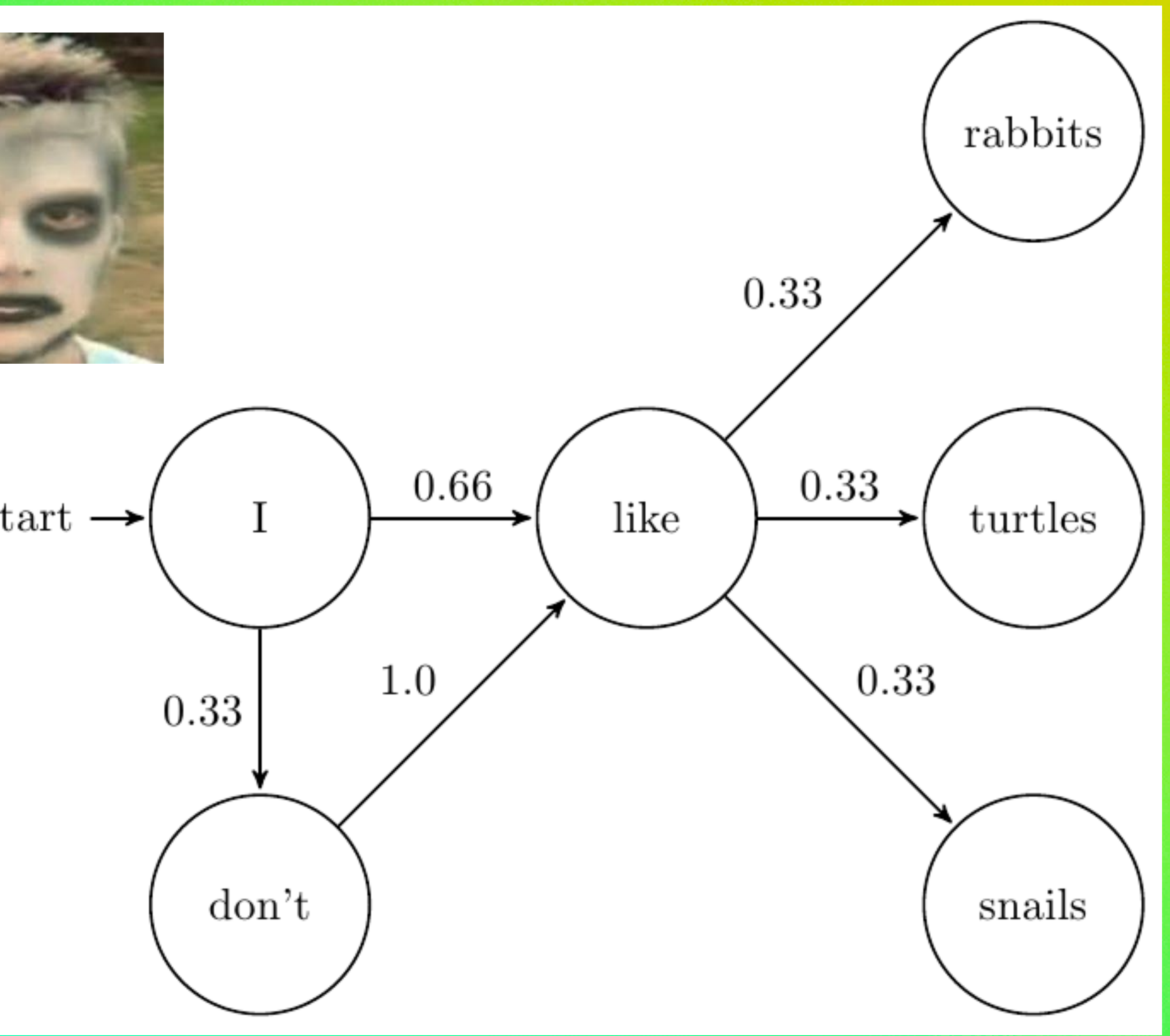
$$p_{ij} = Pr(X_{n+1} = j \mid X_n = i)$$

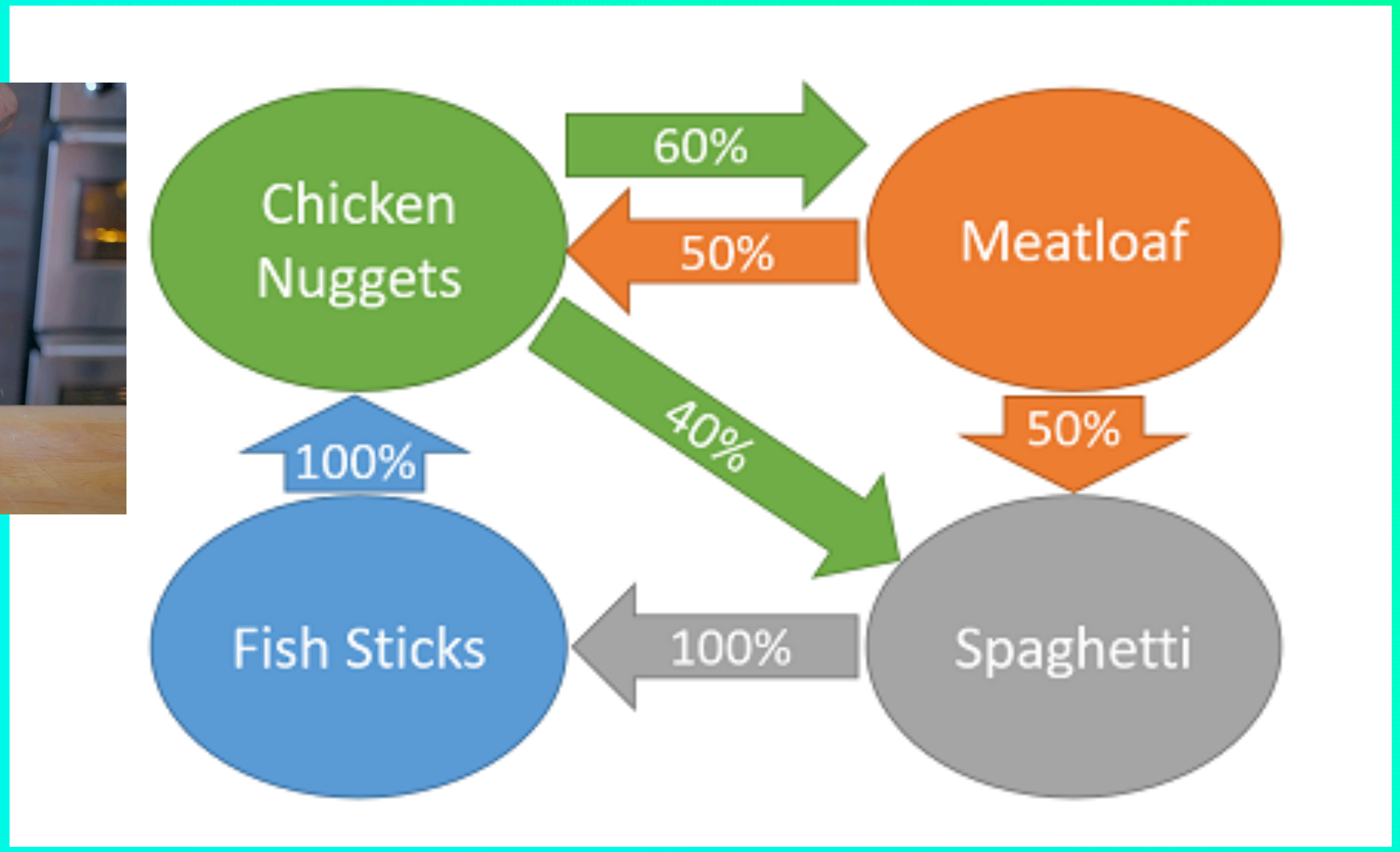



NO DICE

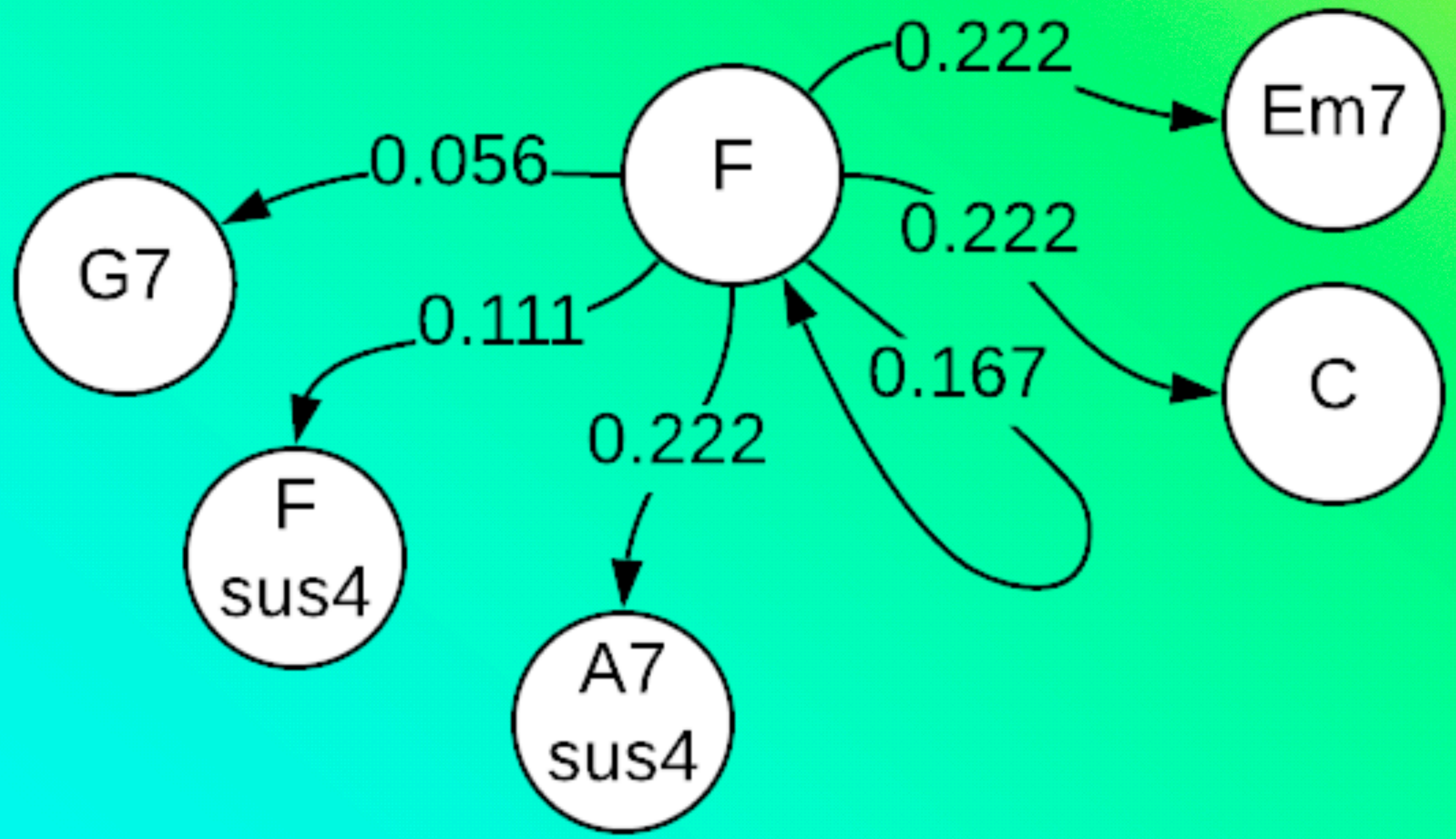

0.2
0.5
0.2
0.7
0.3
0.4
0.4
0.3
0.9
0.6
0.4
0.8
0.2
0.1


0.02
Bull market
Bear market
0.3
0.005
0.4
0.02
0.2
Stagnant market


rabbits
0.33
start
I
0.66
like
0.33
turtles
0.33
1.0
0.33
don't
snails


60%
Chicken Nuggets
50%
Meatloaf
40%
50%
100%
Fish Sticks
100%
Spaghetti

THE TRANSITION MATRIX



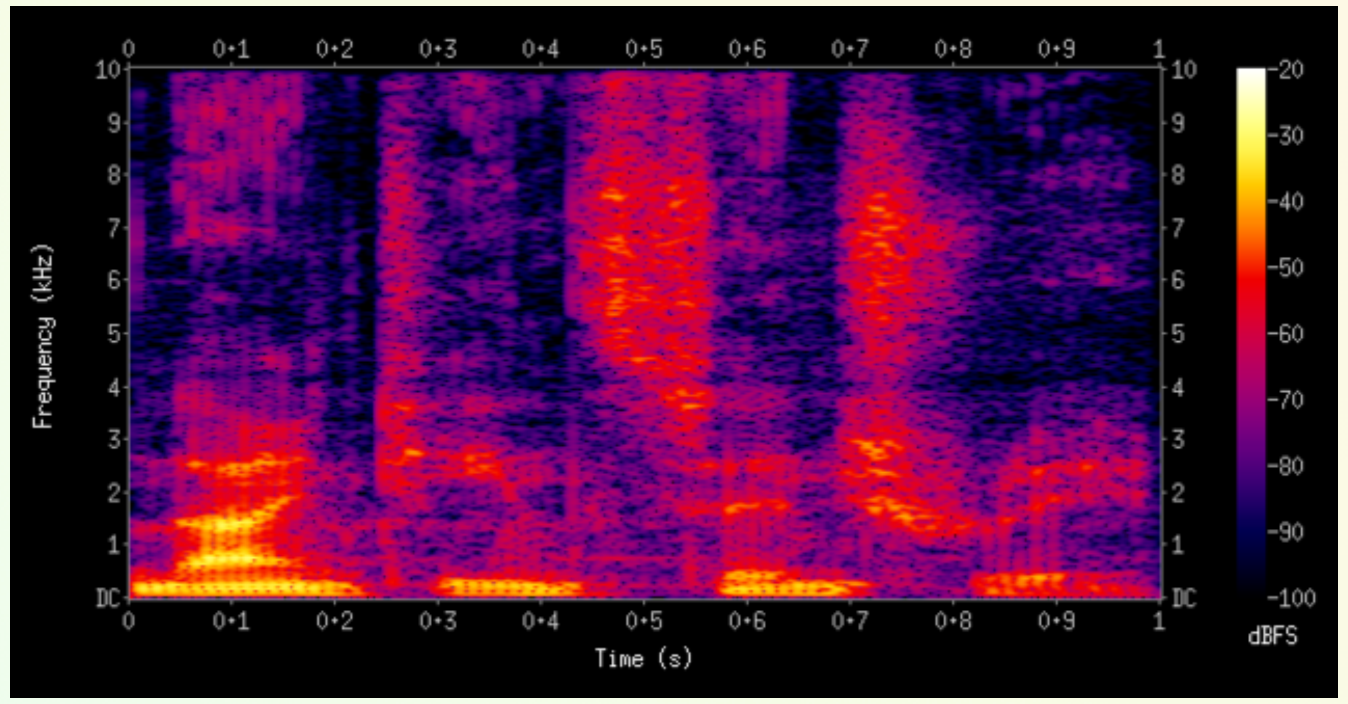
	F	Em7	C	A7sus 4	Fsus4	G7
F	0.167	0.222	0.222	0.222	0.111	0.056
Em7	0.0	0.0	0.5	0.5	0.0	0.0
C	0.3	0.1	0.0	0.1	0.1	0.4
A7su s4	0.0	0.667	0.0	0.0	0.0	0.333
Fsus4	0.1	0.0	0.4	0.0	0.0	0.5
G7	0.3	0.0	0.4	0.0	0.2	0.0

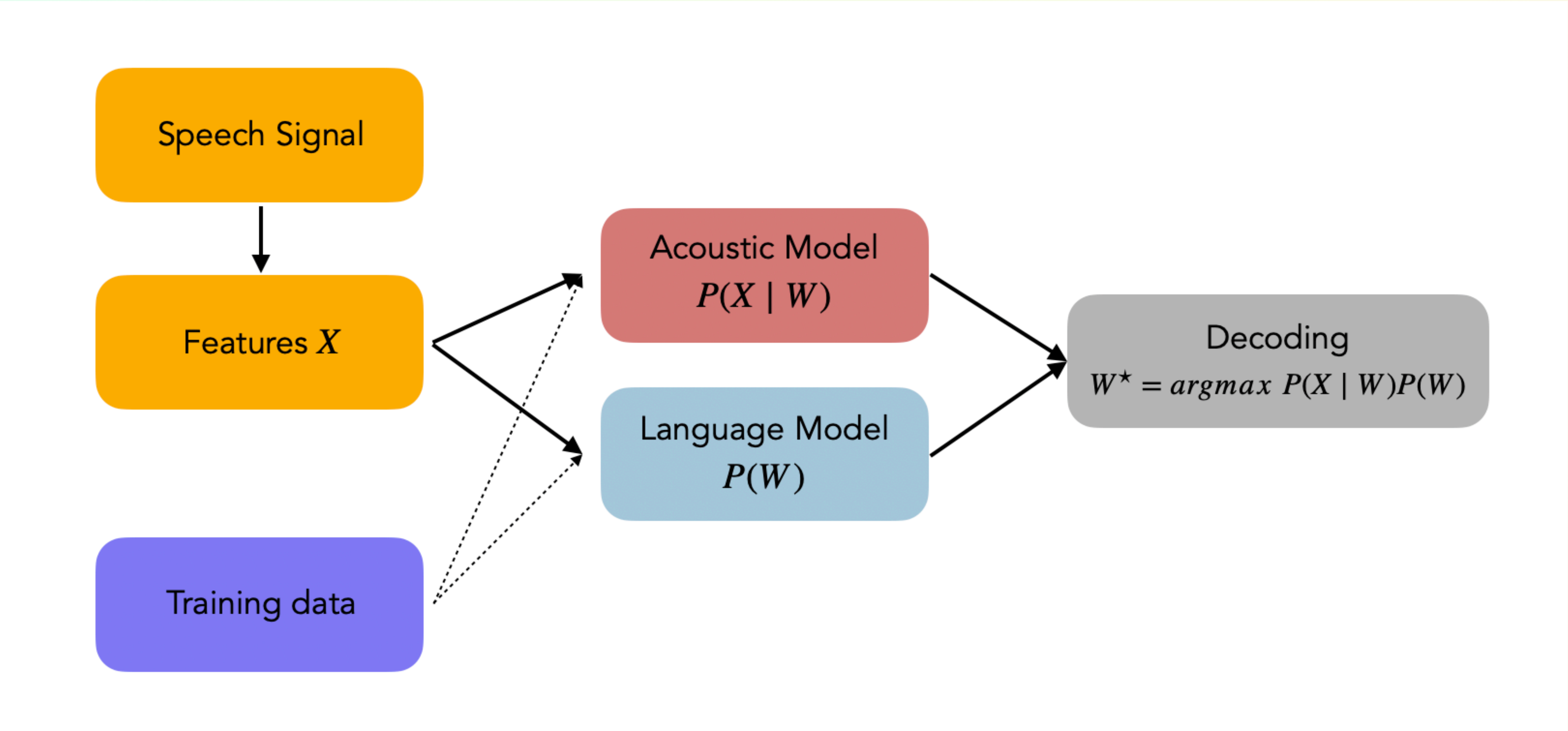
Source: "Markov Chain for music generation", Alexander Osipenko: https://towardsdatascience.com/markov-chain-for-music-generation-932ea8a88305

SPEECH RECOGNITION WITH MARKOV MODELS

- Until about 2010, the acoustic model might use a Hidden Markov Model (HMM) to predict the sequence of phonemes in speech

- Recently these were replaced with other machine learning models such as a Long Short Term Memory (LSTM) model





MUSIC IS A LANGUAGE

I AM PRETTY SURE

GRAPHEMES <=> NOTES

PHONEMES <=> TIMBRE, PITCH

MORPHEMES <=> HARMONY

MEANING <=> MEANING

BACH DOS AND DON'TS

Keep most of the harmony simple by starting from stage I and only make harmonic changes that complement the bassline

Ib and VI are the best approach chords to IIb7 in the run up to a cadence

All other things being equal, it is a good idea to be in root position I on the first strong beat of a chorale or its upbeat

Root progressions using falling thirds (e.g. VI to IV and I to VI) are much better than those using rising thirds

If you use the same chord twice in a row, make sure that one is in root position and the next is in first inversion

Don't use second inversions other than in IC - V - I

Avoid progressions using II other than as an approach chord to V. Chord IIb can also be used as an approach to IC at a cadence.

Don't use II in root position in minor keys

Don't use iii other than as an approach to vi and avoid in minor keys altogether

Avoid progressions between IV and V unless the melody is going in the opposite direction to the root progression of the two chords

Only use VI in root position

Don't use viio other than as viibo resolving either to I or Ib

Don't repeat the bass note (except from the upbeat to the first beat of a phrase)

TRITONE ALERT!!

DEVIL MUSIC

DEMONSTRATION

PLEASE STAND BY

FUTURE WORK

COOL IDEAS I DIDN'T HAVE TIME TO DO YET SO ACTUALLY UNSURE HOW COOL THEY ARE BUT WHATEVER

- MIDI data, Guitar tabs (chords) -> Markov model
- Increase or decrease randomness of output
- Introduce rules about repetition or specific beats
- Whole album models
- Songwriter models

THANK U :)