Kapitel 2: Graphen

Algorithmen und Datenstrukturen
WS 2022/23

Prof. Dr. Sándor Fekete

Konzentration

2.1 Historie: Ein Mathematiker geht spazieren

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Carl Friedrich Gauß (1777-1855)

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Carl Friedrich Gauß (1777-1855)

$$\begin{array}{rrrrr} 1\ + & 2\ + & 3\ + & \ldots\ + & 100 \\ 100\ + & 99\ + & 98\ + & \ldots\ + & 1 \\ \hline 101\ + & 101\ + & 101\ + & \ldots\ + & 101 \end{array}$$

$= 100 \times 101$

Also:

$1+2+3+\ldots+100 = 5050$

2.1 Historie: Ein Mathematiker geht spazieren

Carl Friedrich Gauß (1777-1855)

1 +	2 +	3 +	… +	100
100 +	99 +	98 +	… +	1
101 +	101 +	101 +	… +	101

= 100 x 101

Also:

1+2+3+…+100 = 5050

Gaußsche Summenformel

Die **Gaußsche Summenformel** (nicht zu verwechseln mit einer Gaußschen Summe), auch **kleiner Gauß** genannt, ist eine Formel für die Summe der ersten n aufeinanderfolgenden natürlichen Zahlen:

$$1 + 2 + 3 + 4 + \cdots + n = \sum_{k=1}^{n} k = \frac{n(n+1)}{2} = \frac{n^2 + n}{2}$$

1 + 2 + 3 + … + 100
100 + 99 + 98 + … + 1

101 + 101 + 101 + … + 101

= 100 x 101

Also:

1+2+3+…+100 = 5050

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Leonhard Euler (1707-1783)

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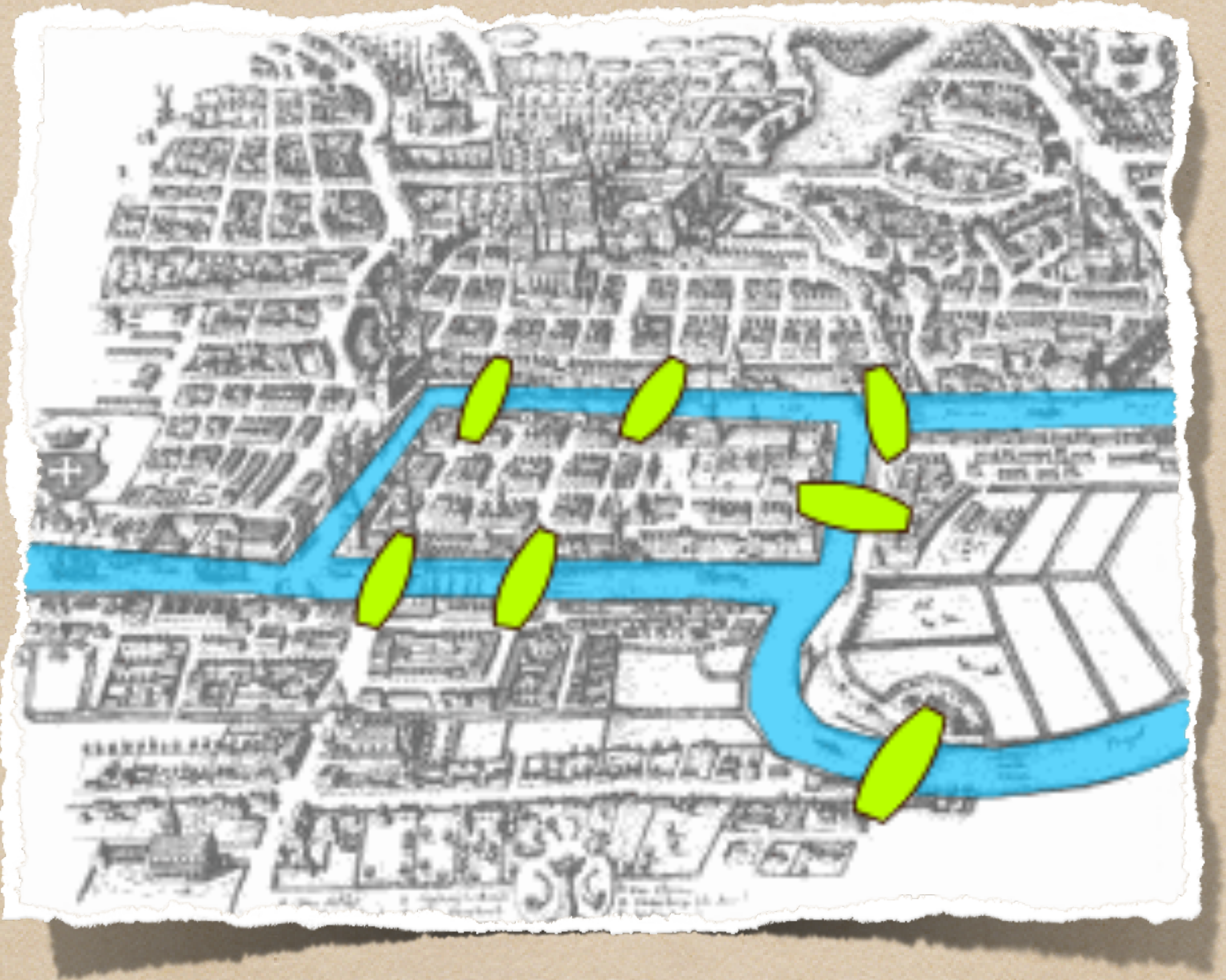

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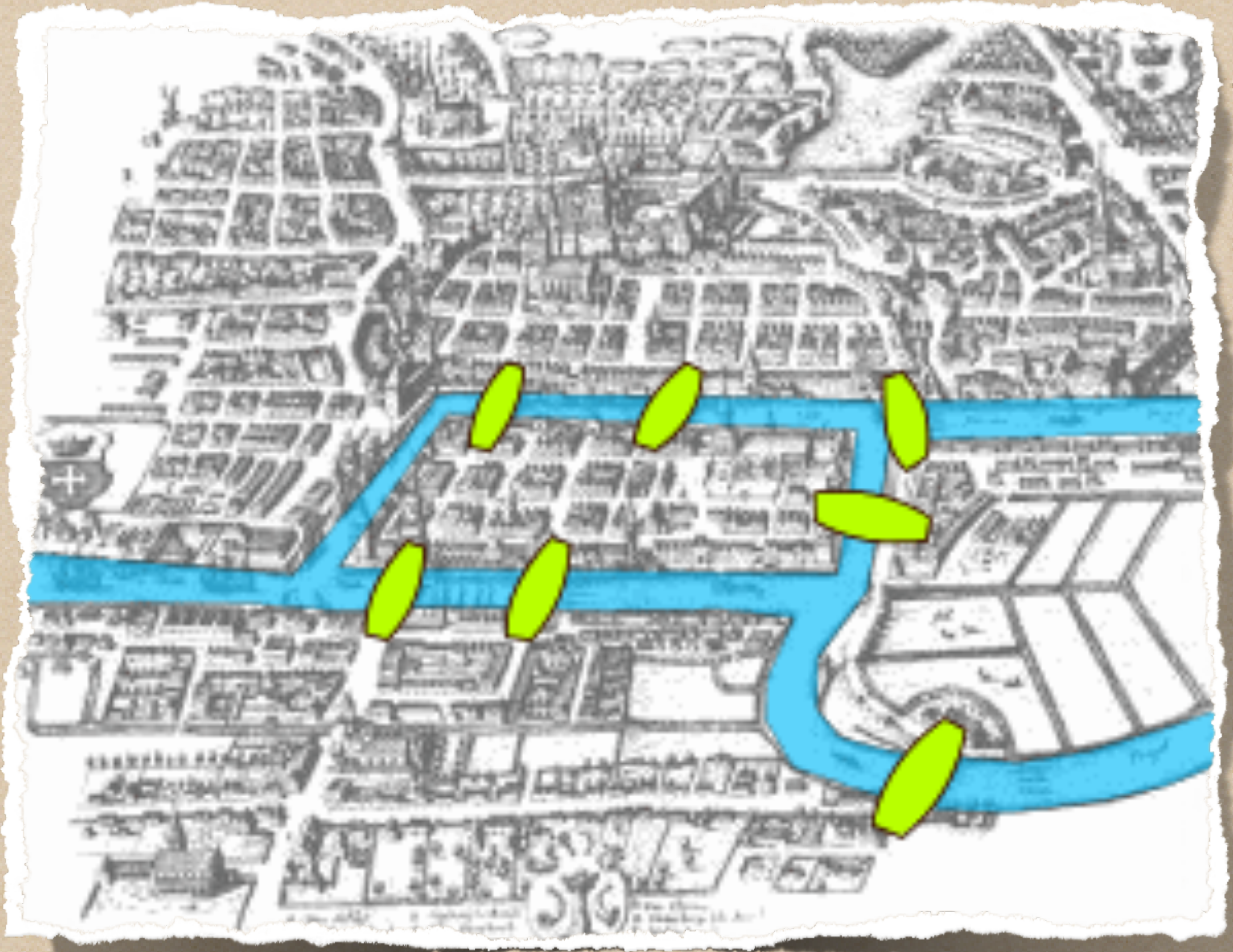

Königsberg und seine 7 Brücken

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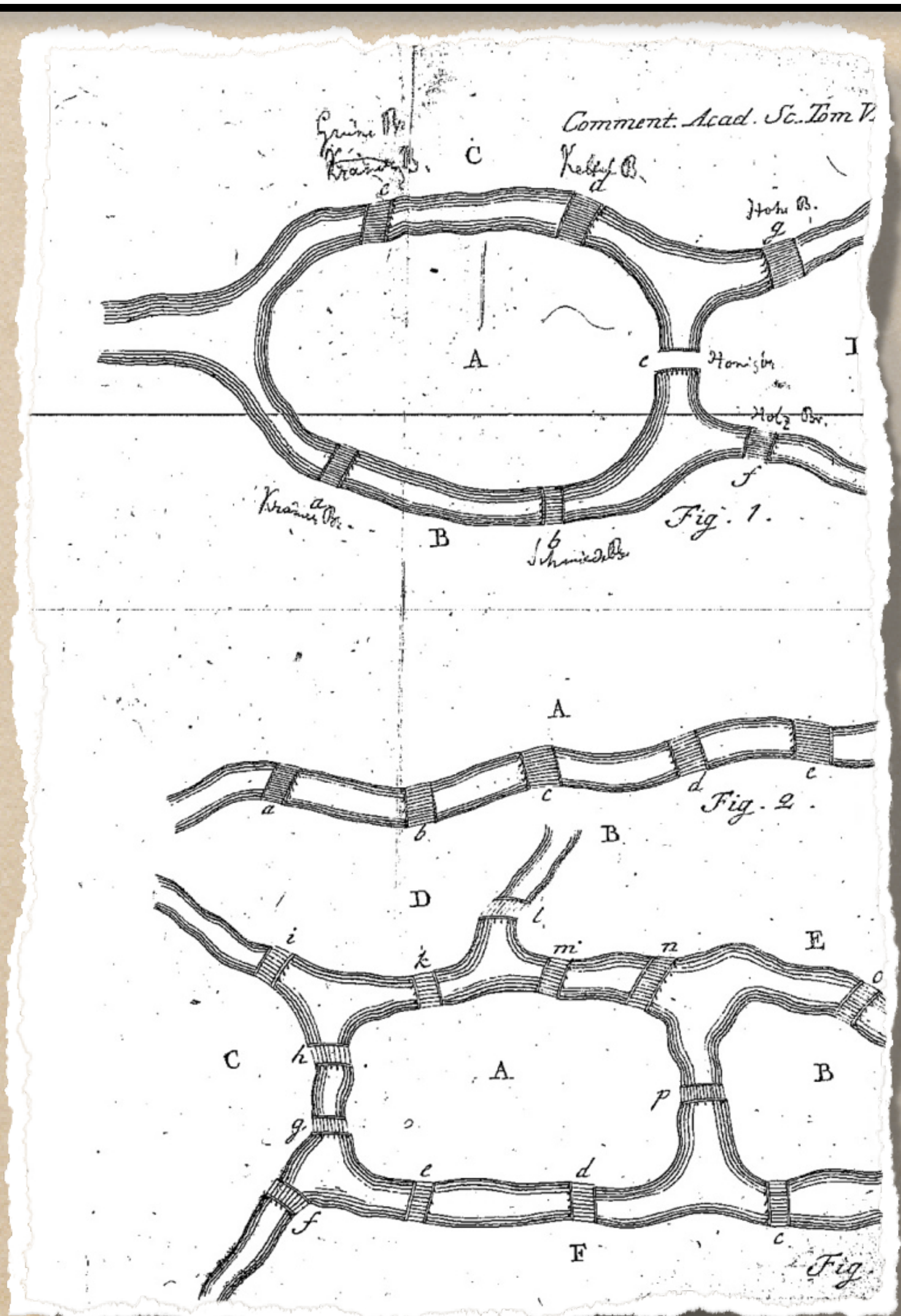

Wie kommt man zur TU?

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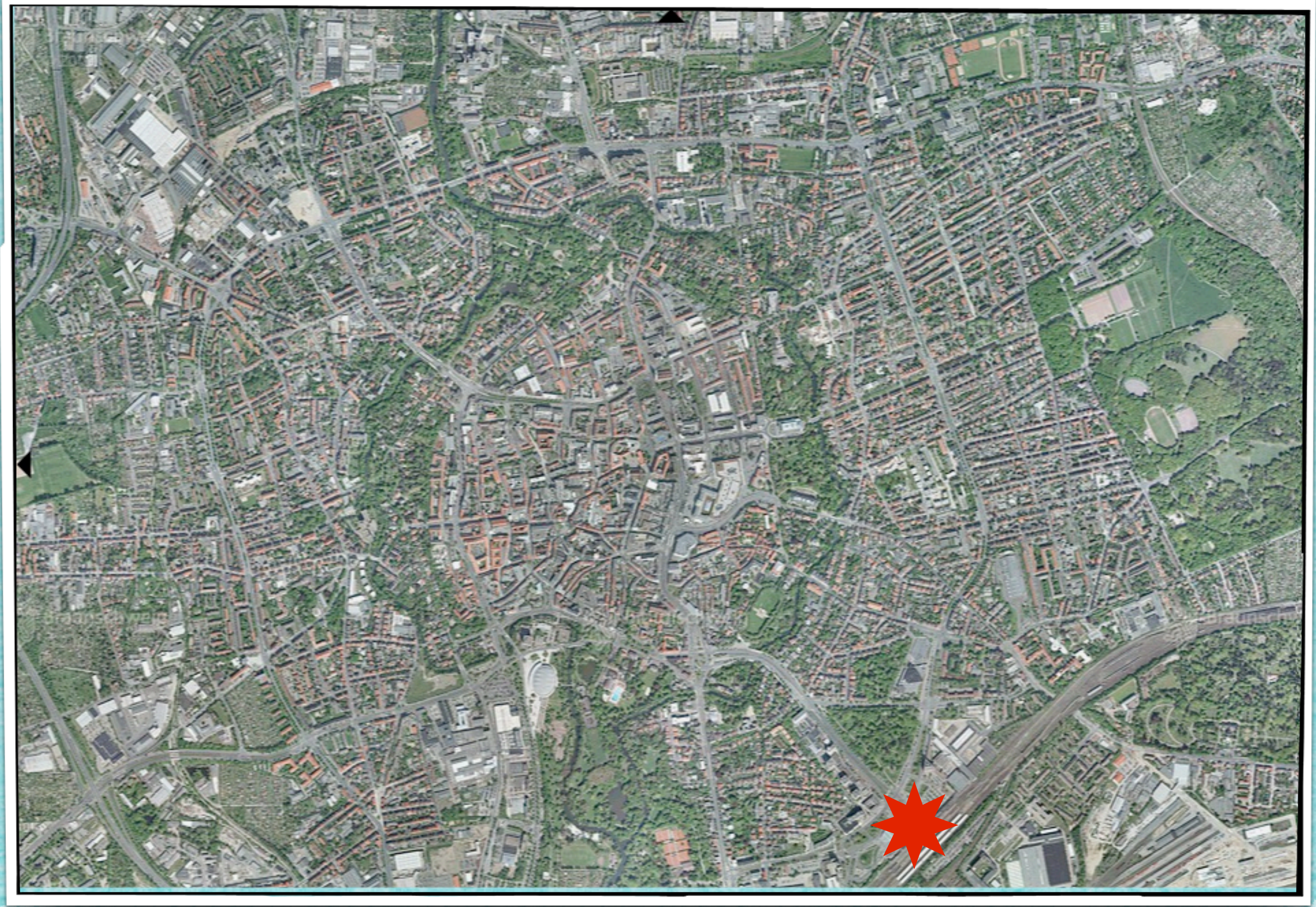

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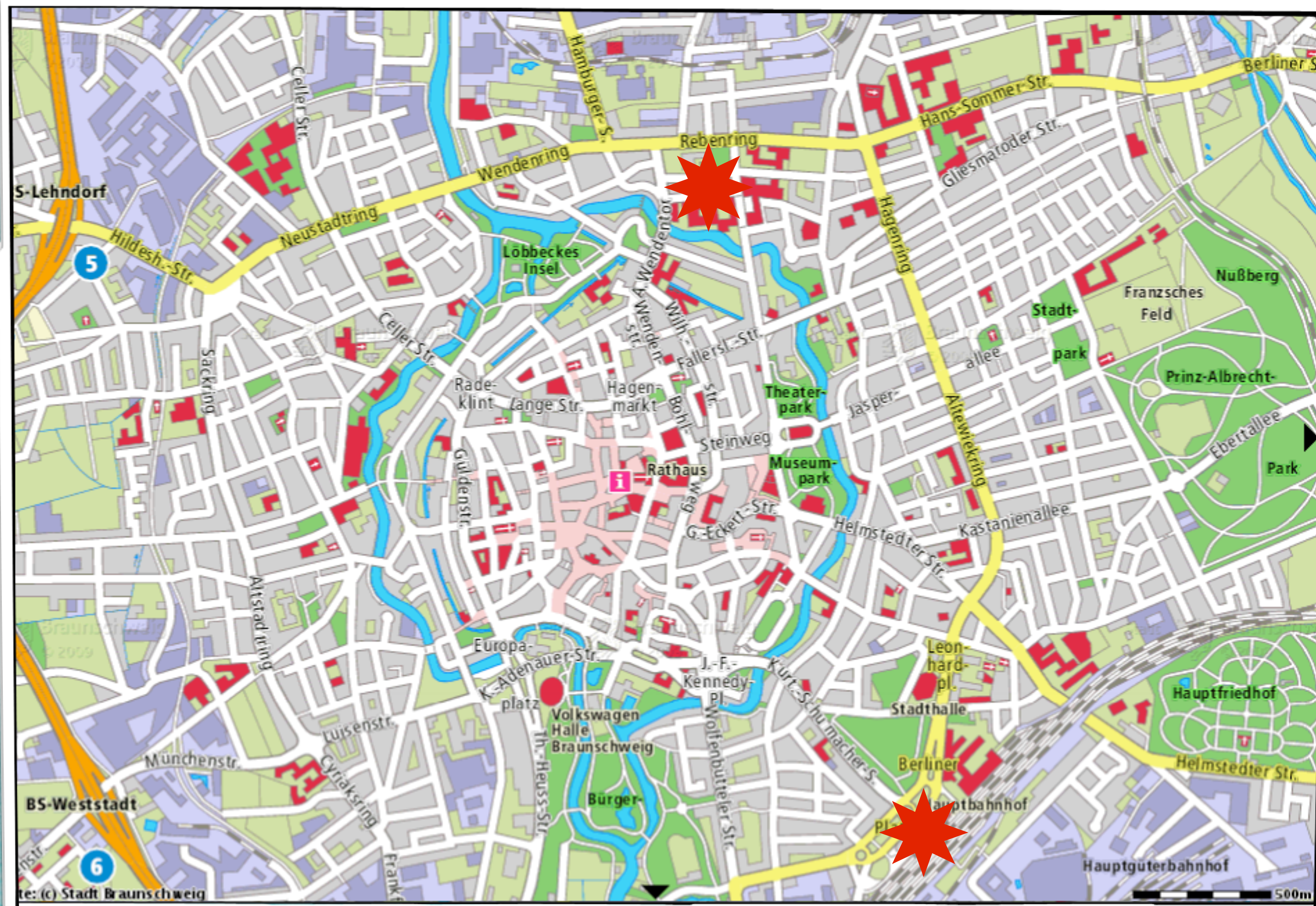

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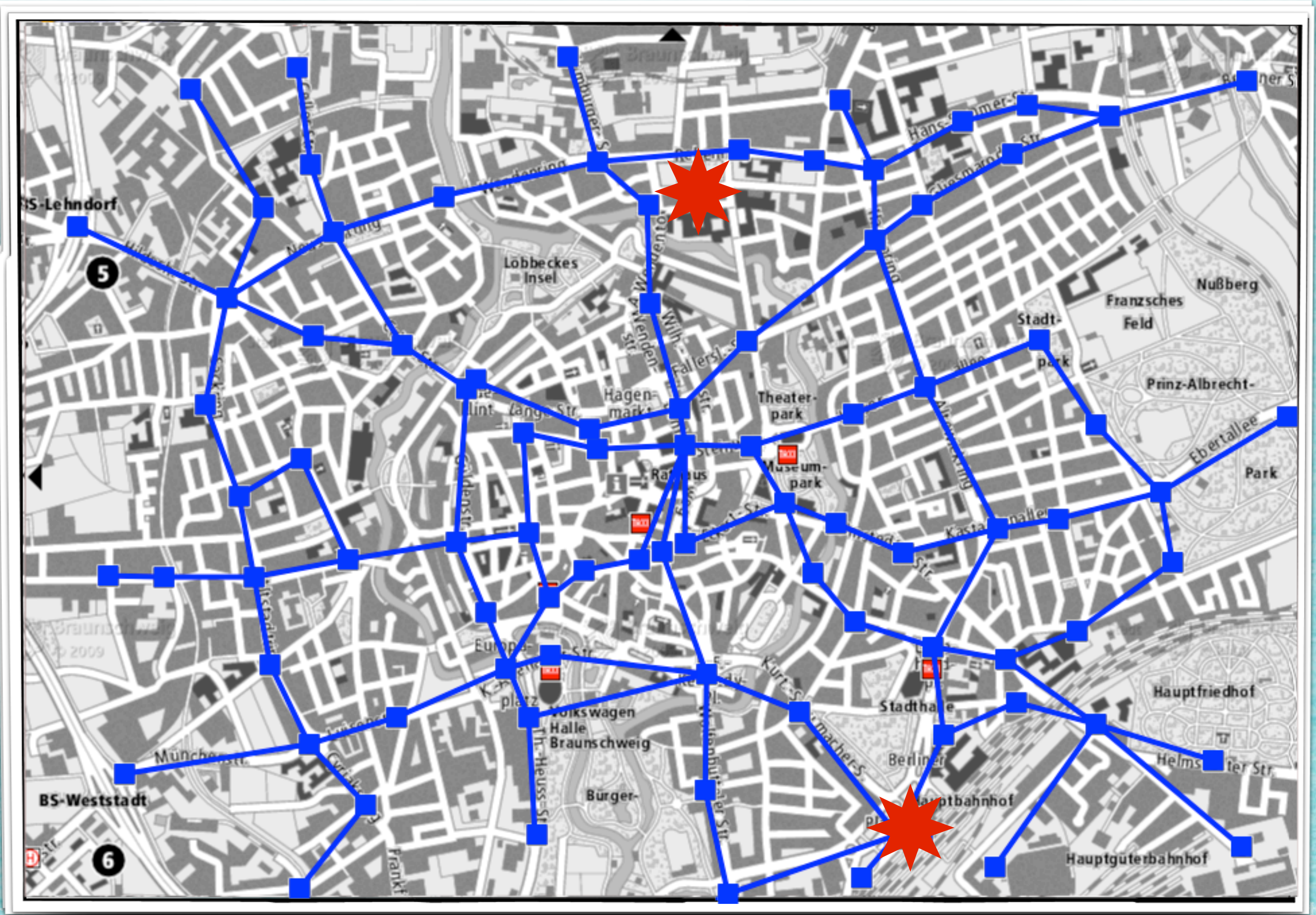

Gestatten, Graph!

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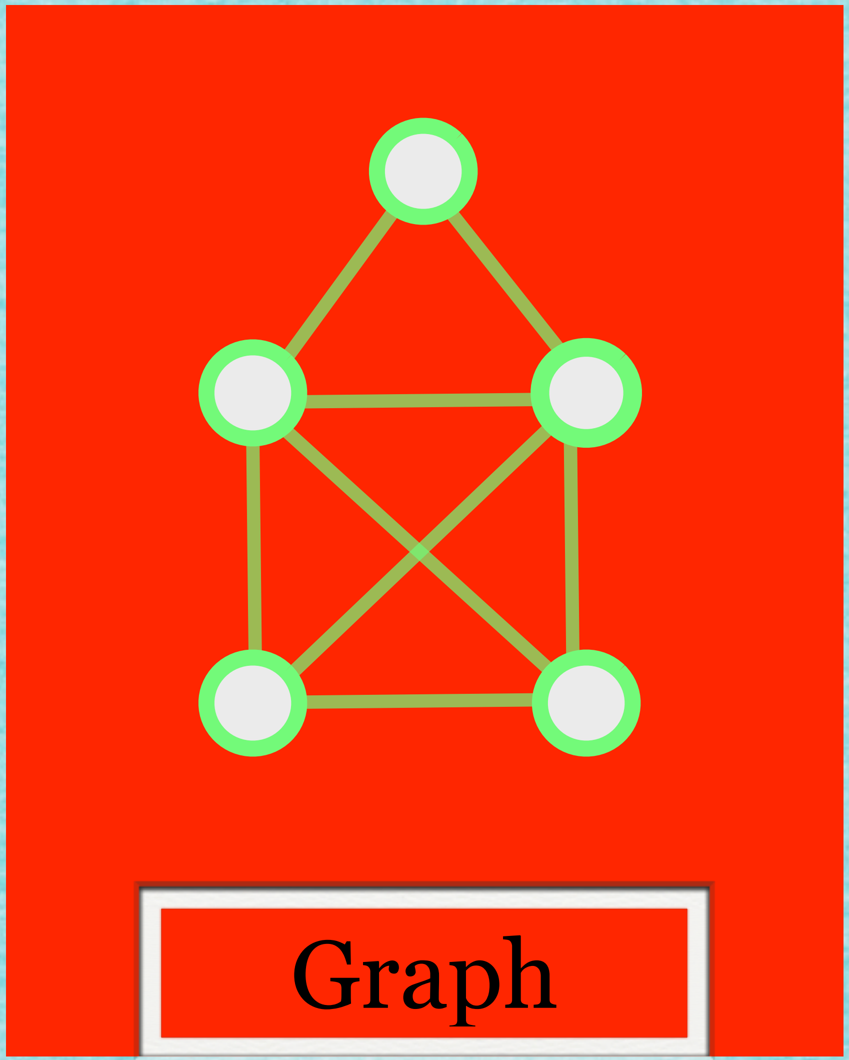

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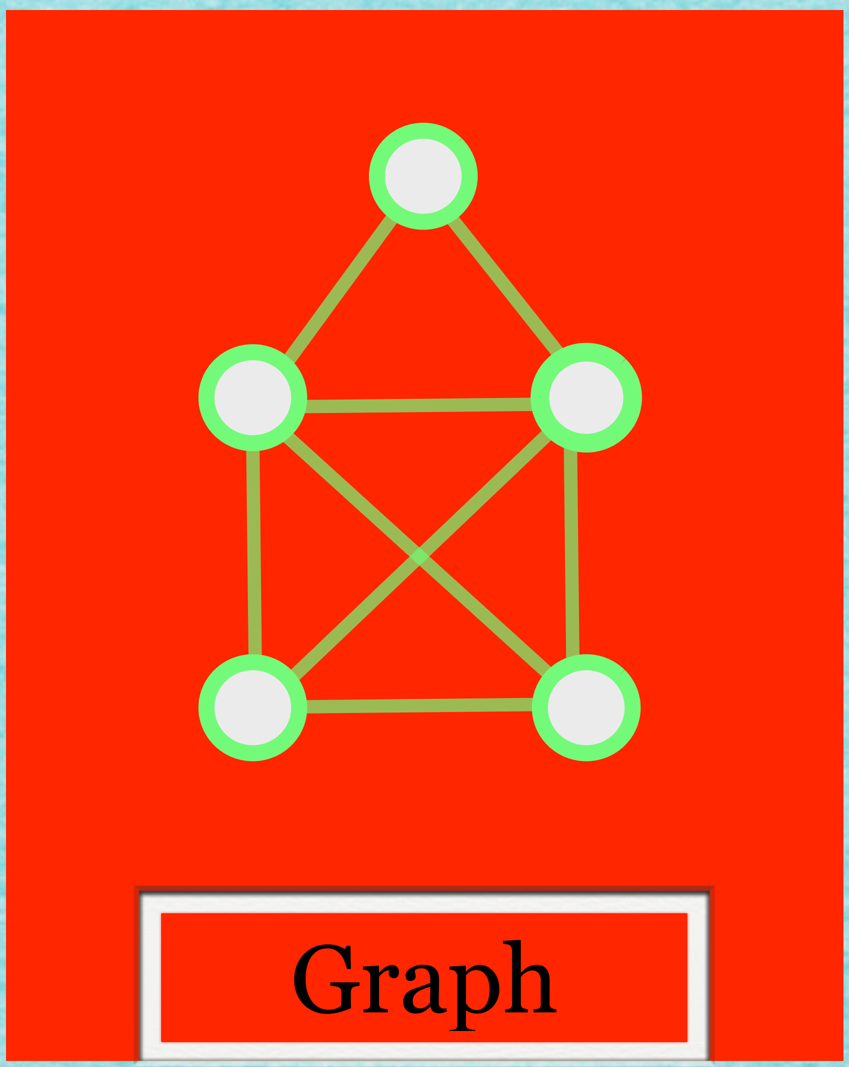
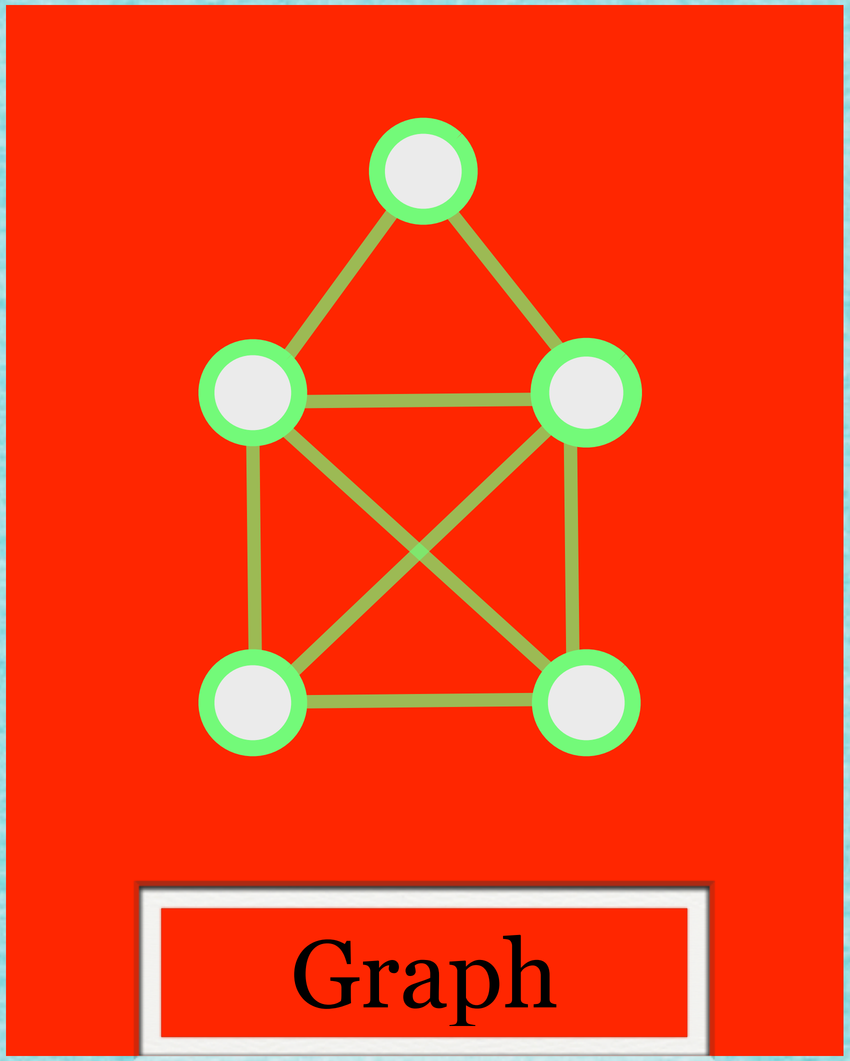


Graph: Ein Gebilde aus Knoten (Haltestellen)

Gestatten, Graph!



Graph: Ein Gebilde aus Knoten (Haltestellen) und Kanten (Verbindungen)

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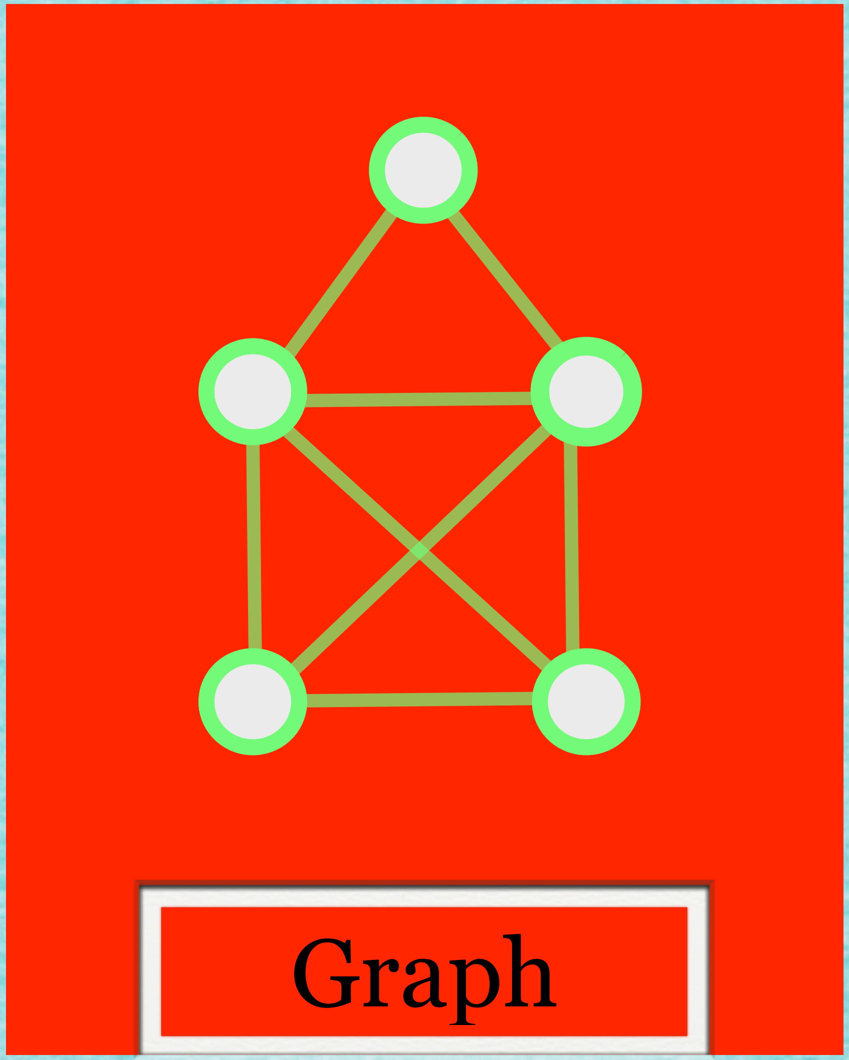
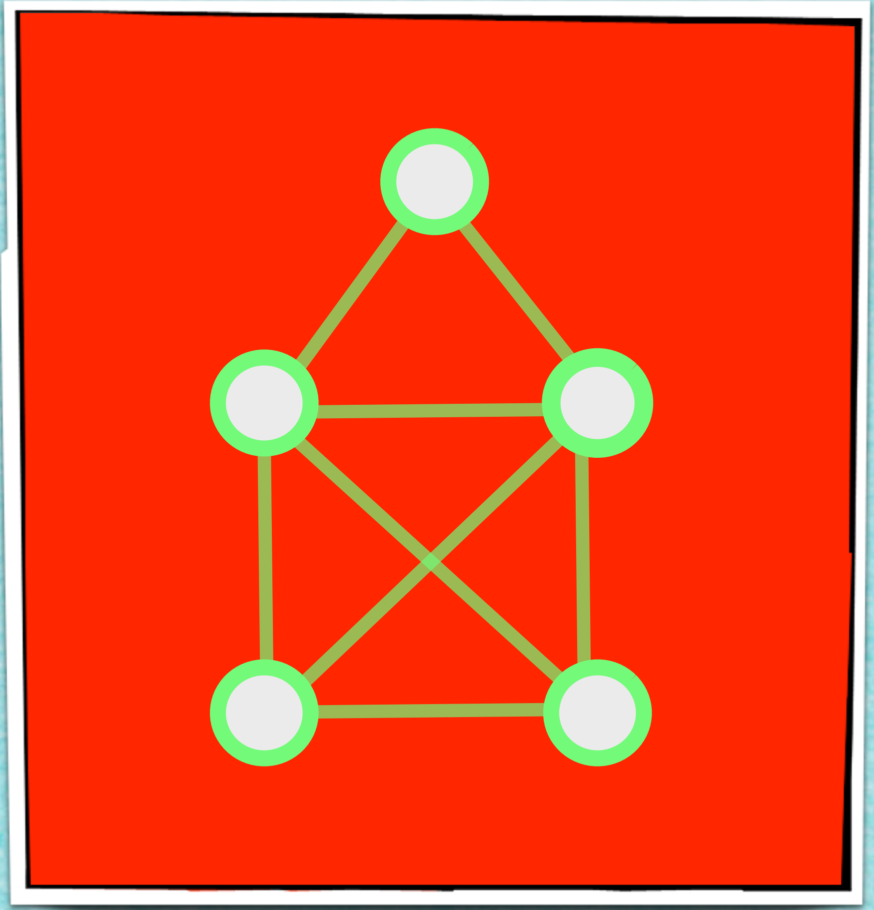


Graph: Ein Gebilde aus Knoten (Haltestellen) und Kanten (Verbindungen)

Das Haus des Nikolaus



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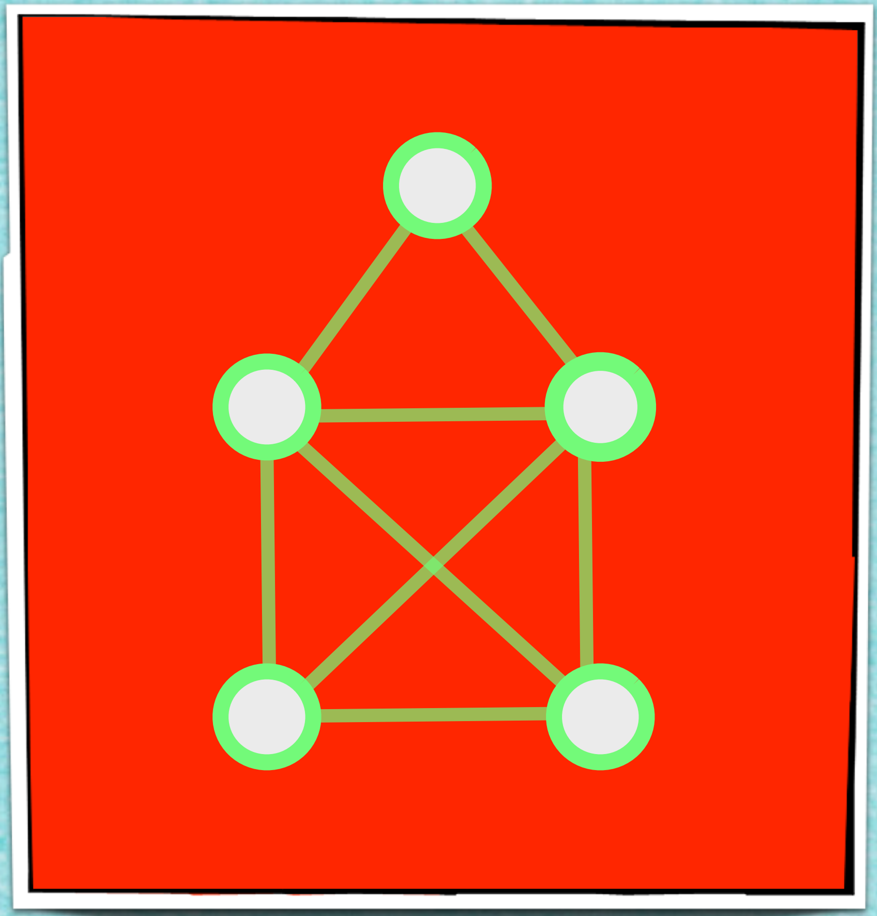

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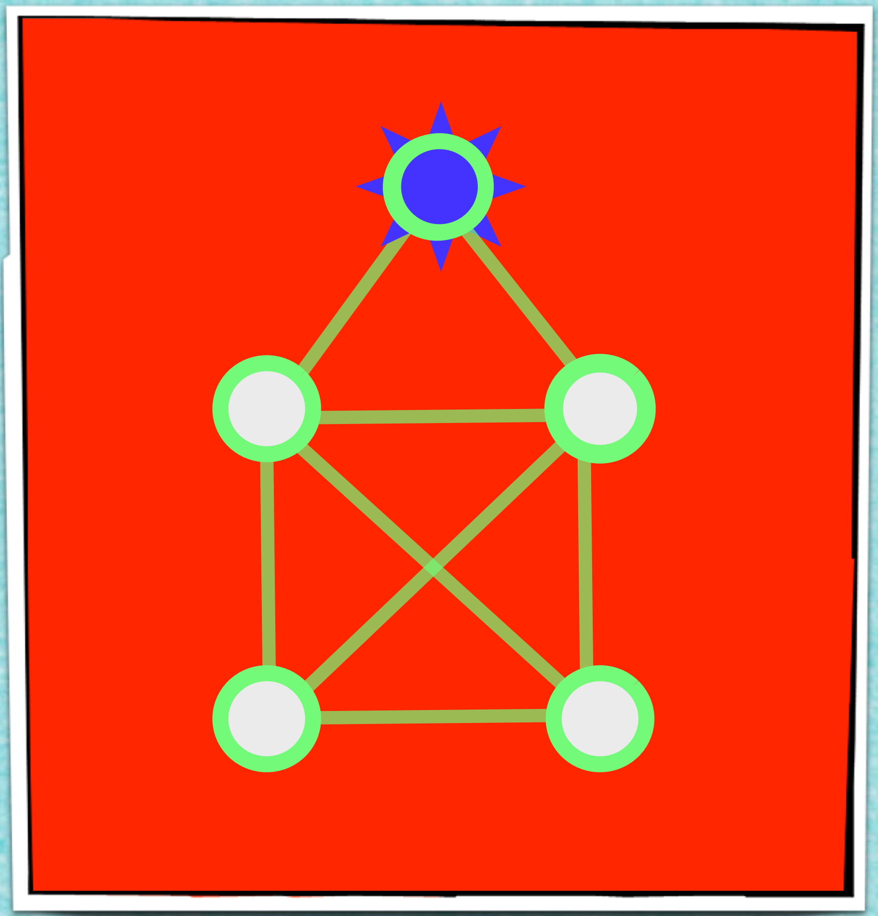

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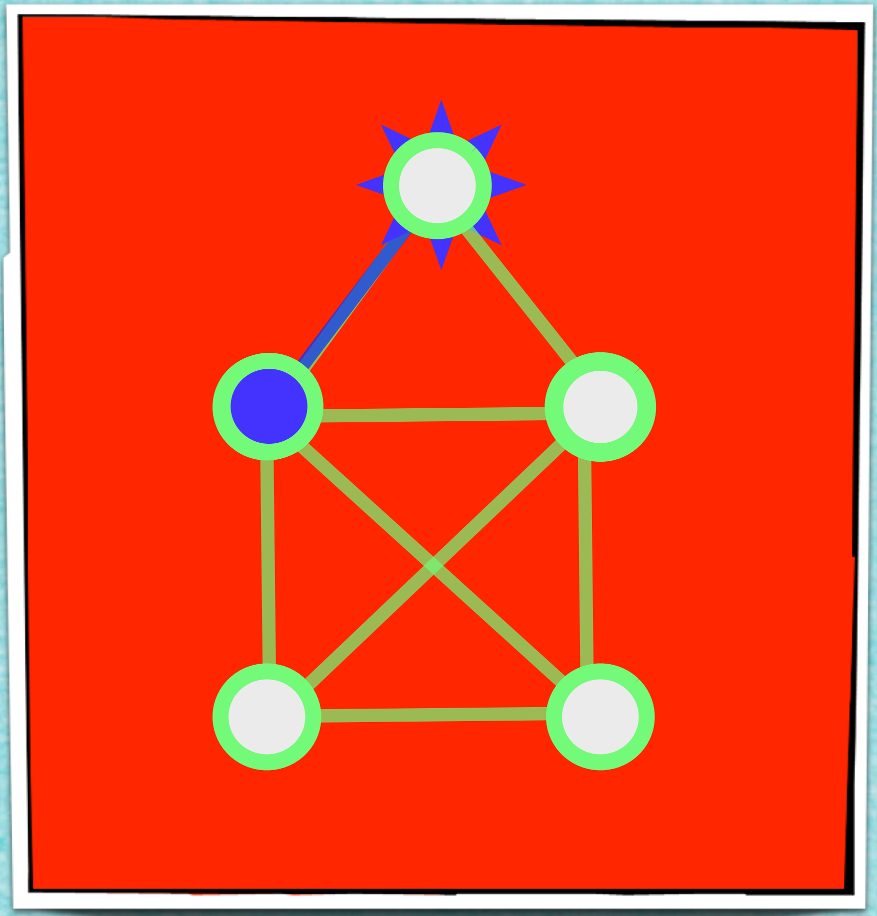

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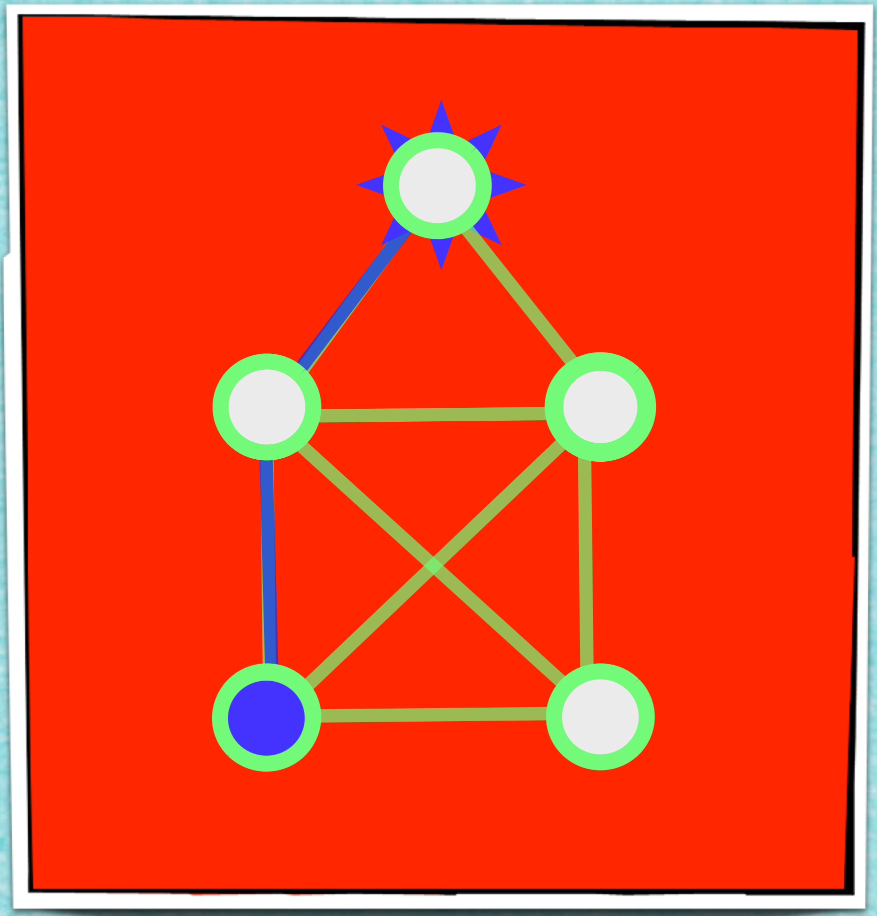

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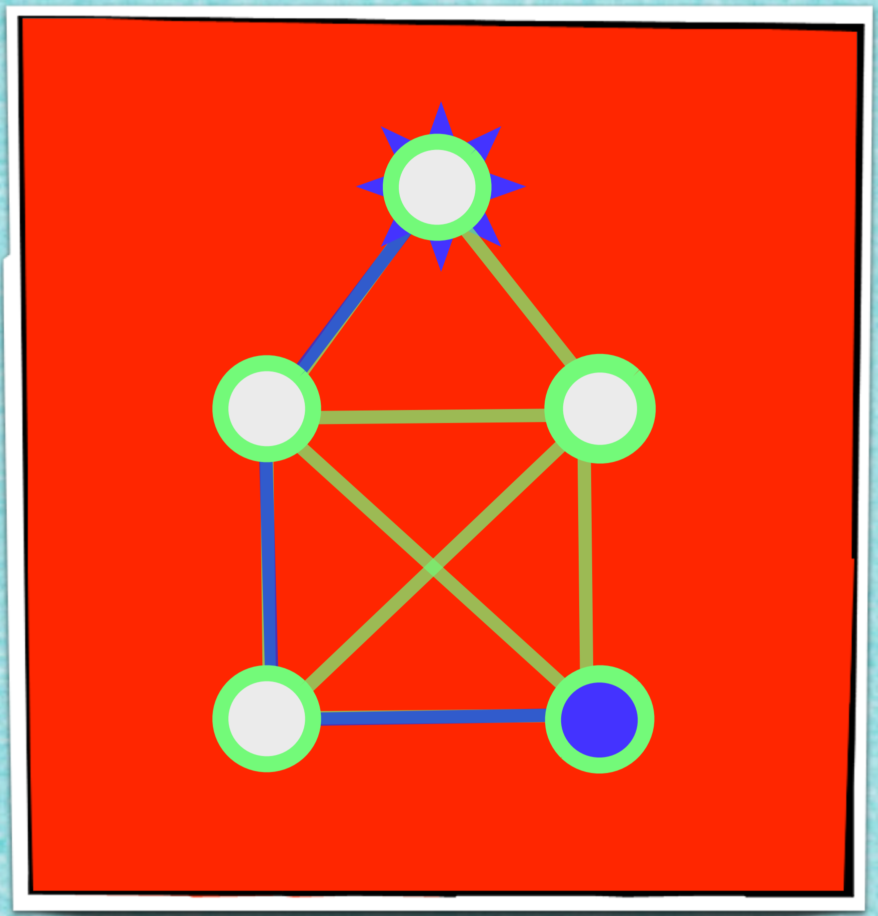

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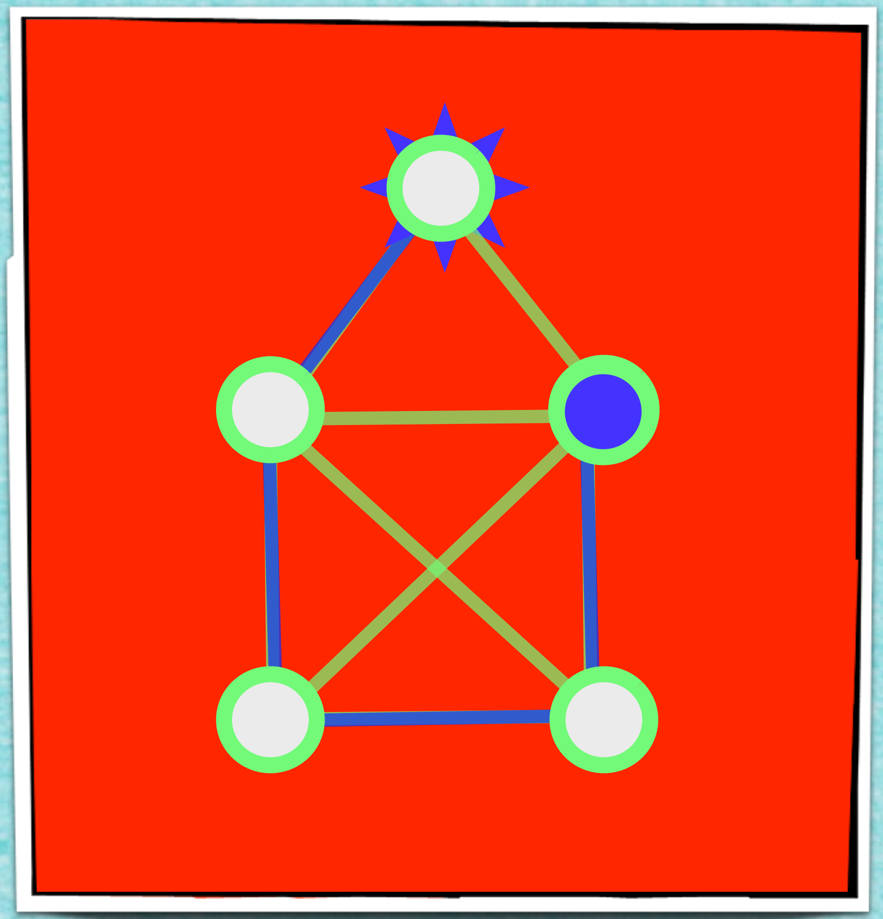

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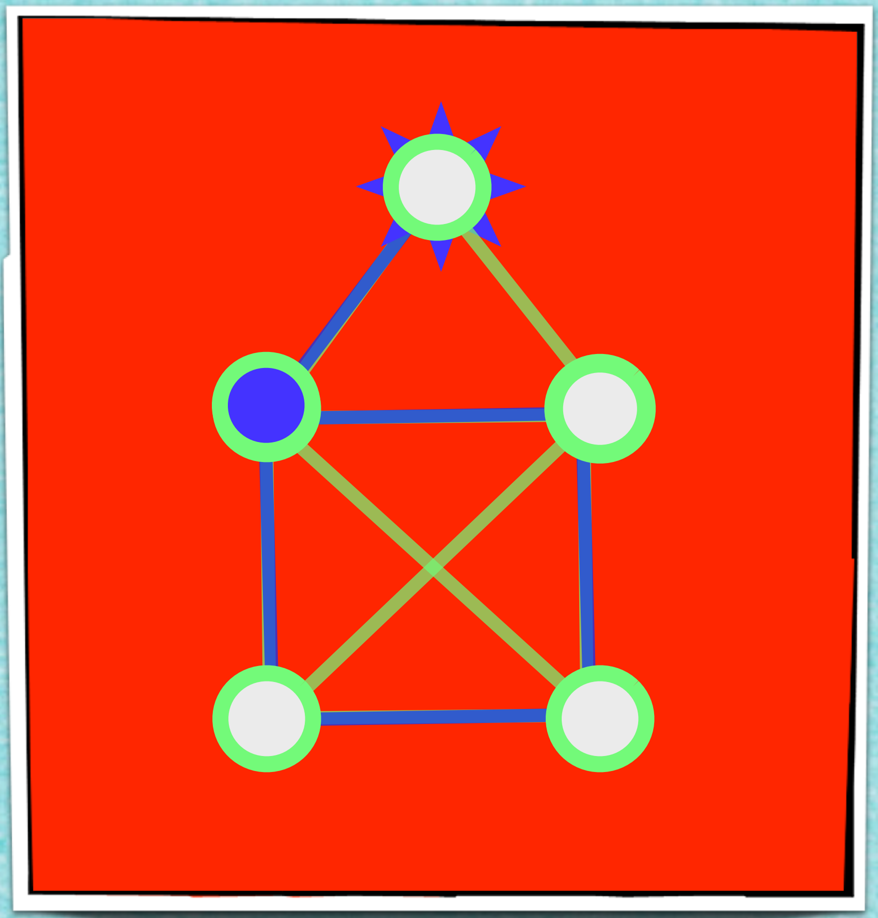

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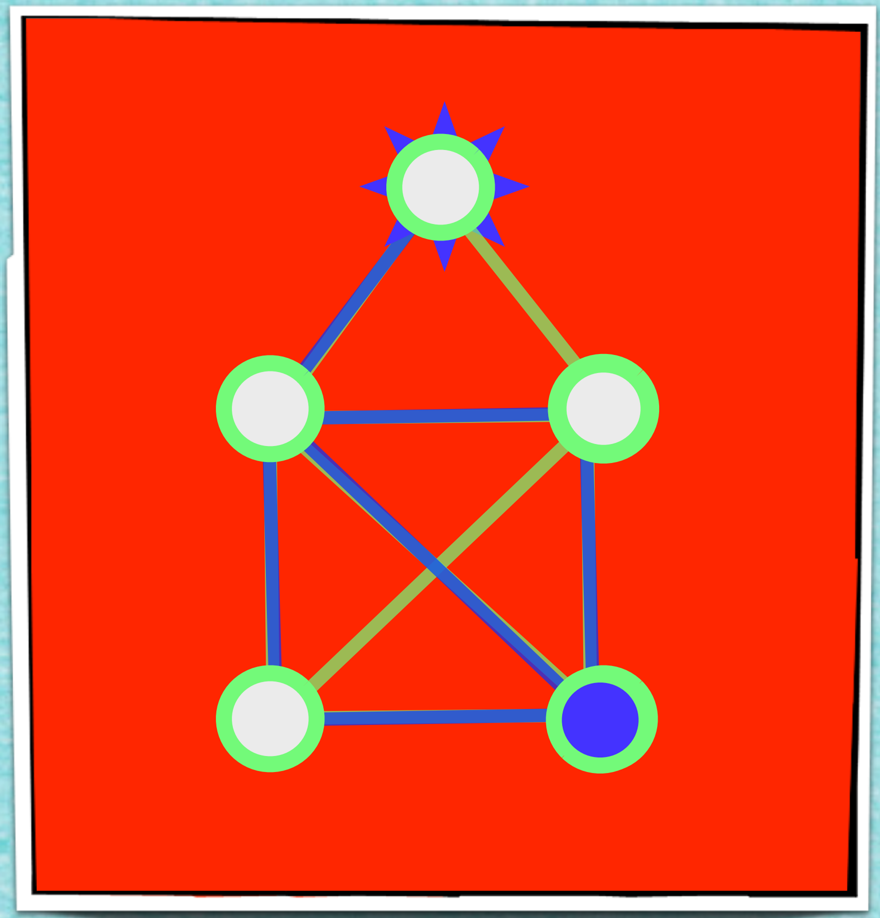

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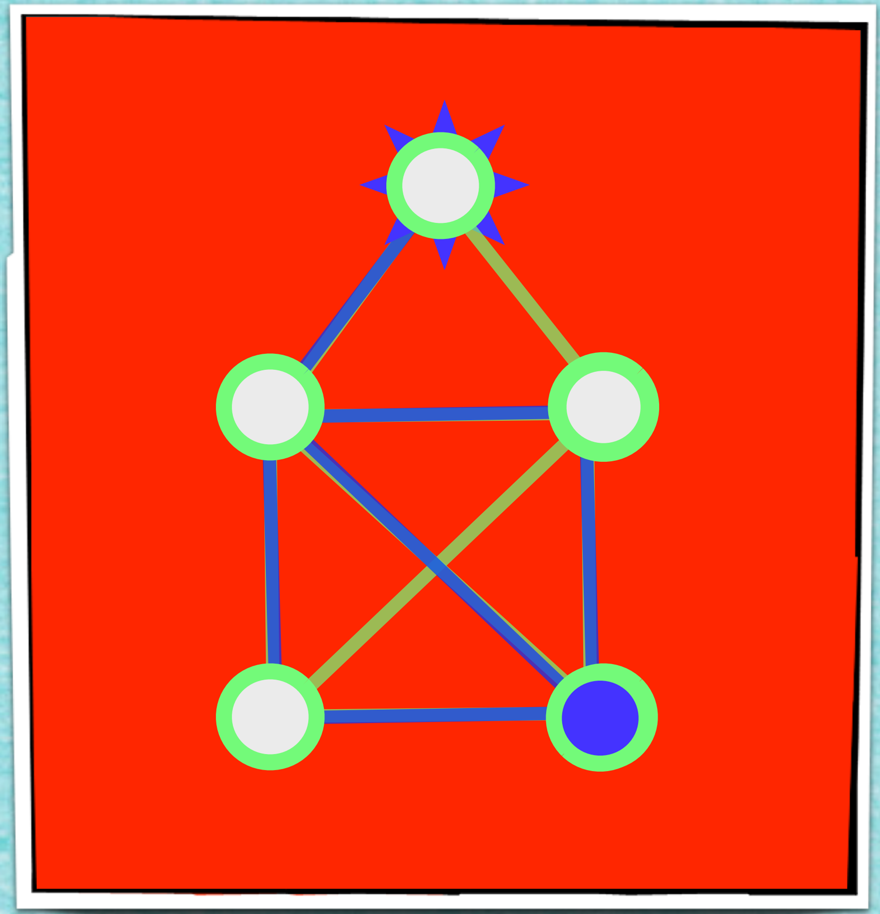

Klappt so nicht...

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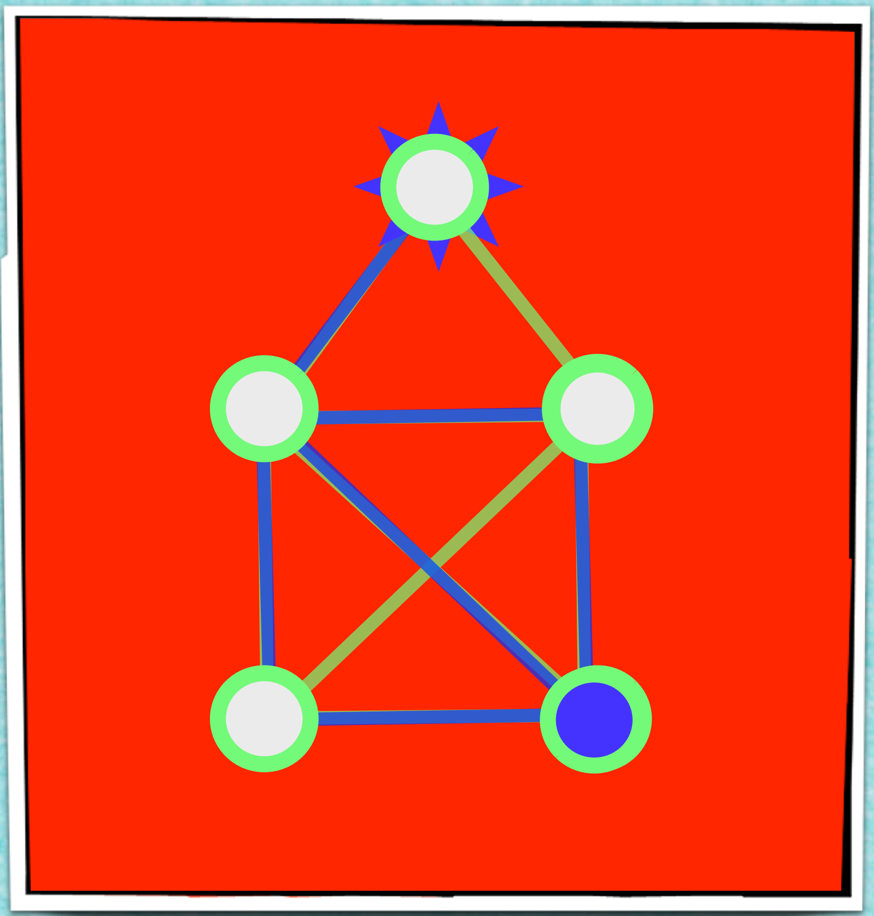
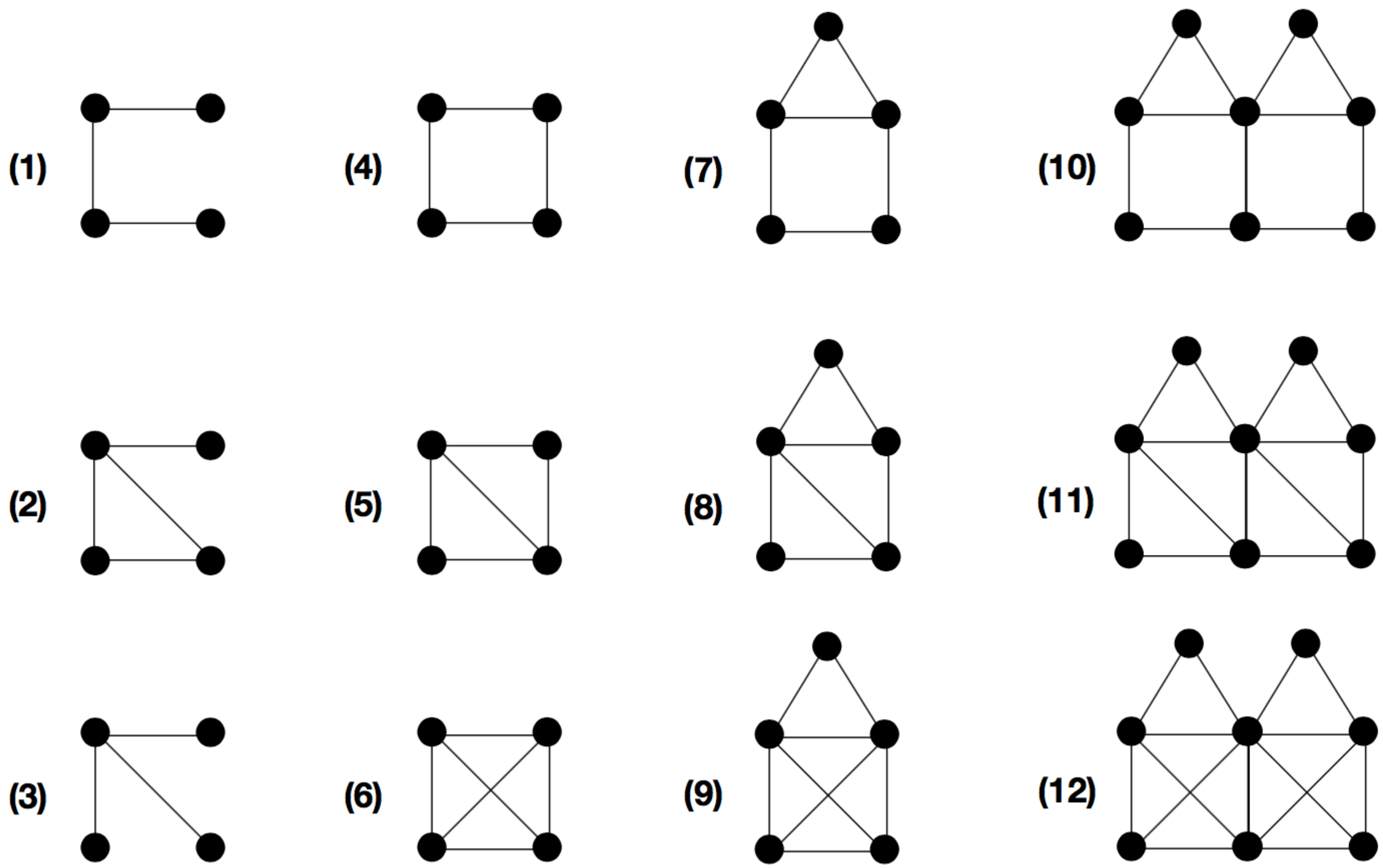


Herausforderung !

Welche Graphen kannst Du in einem Zug nachzeichnen, ohne den Stift abzusetzen?
(Wenn ja, wo kann man anfangen oder aufhören?)



Herausforderung !

App Store Vorschau

One touch Drawing 4+

Ecapyc Inc.

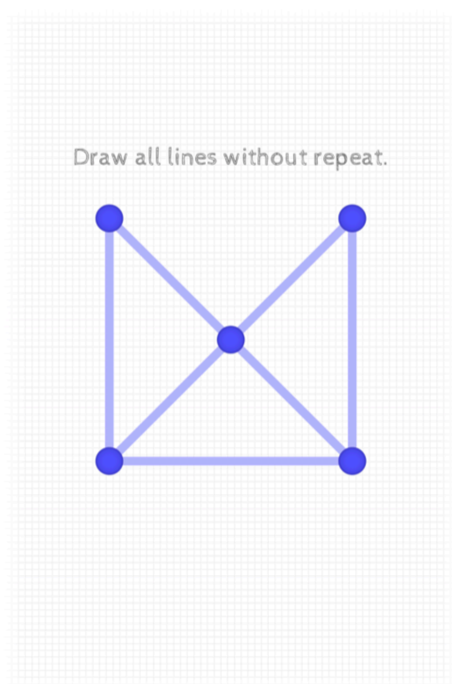
★★★★★ 4,5 • 50 Bewertungen

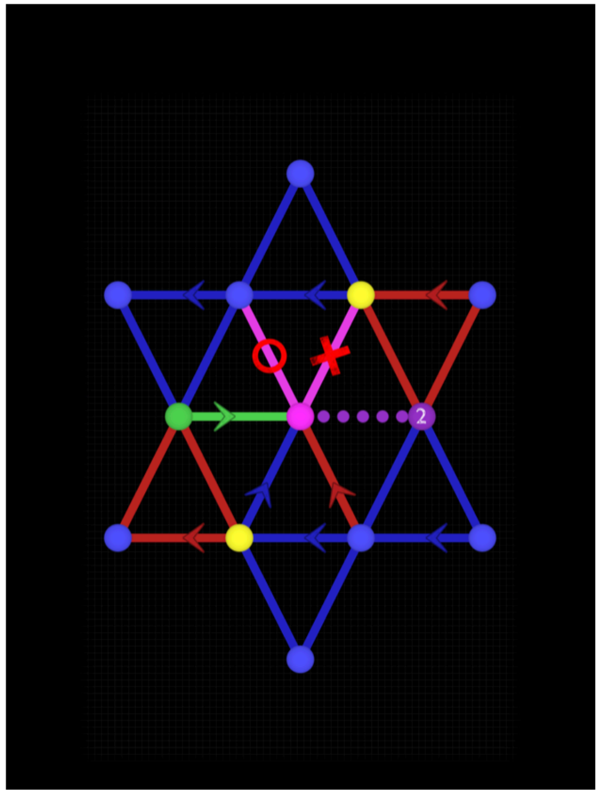
Gratis · In-App-Käufe möglich

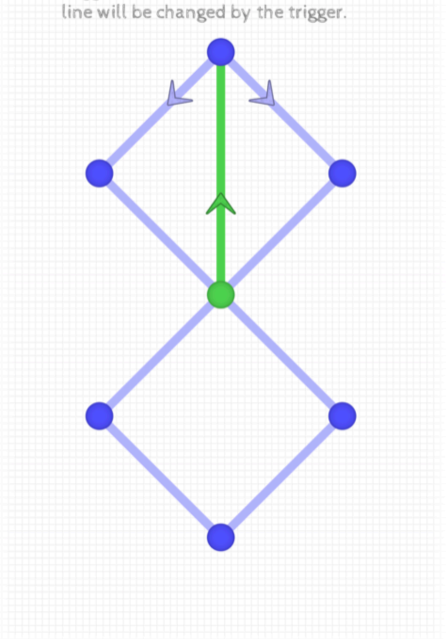
Anzeigen in: Mac App Store ↗

Screenshots

iPad iPhone







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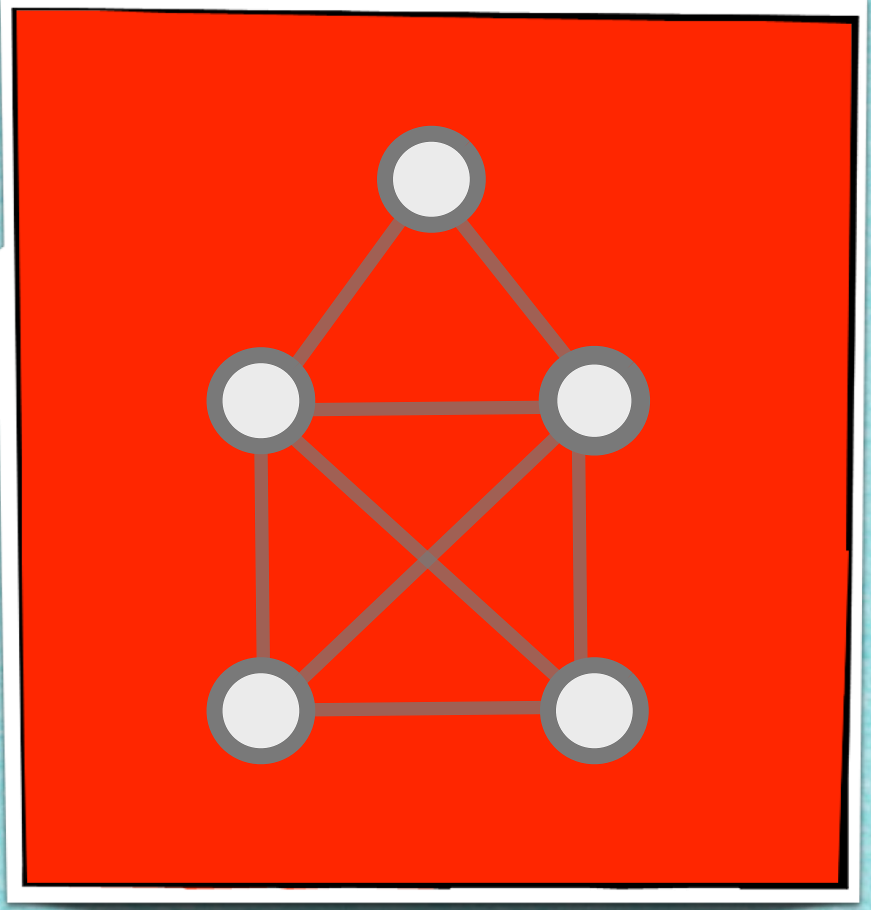

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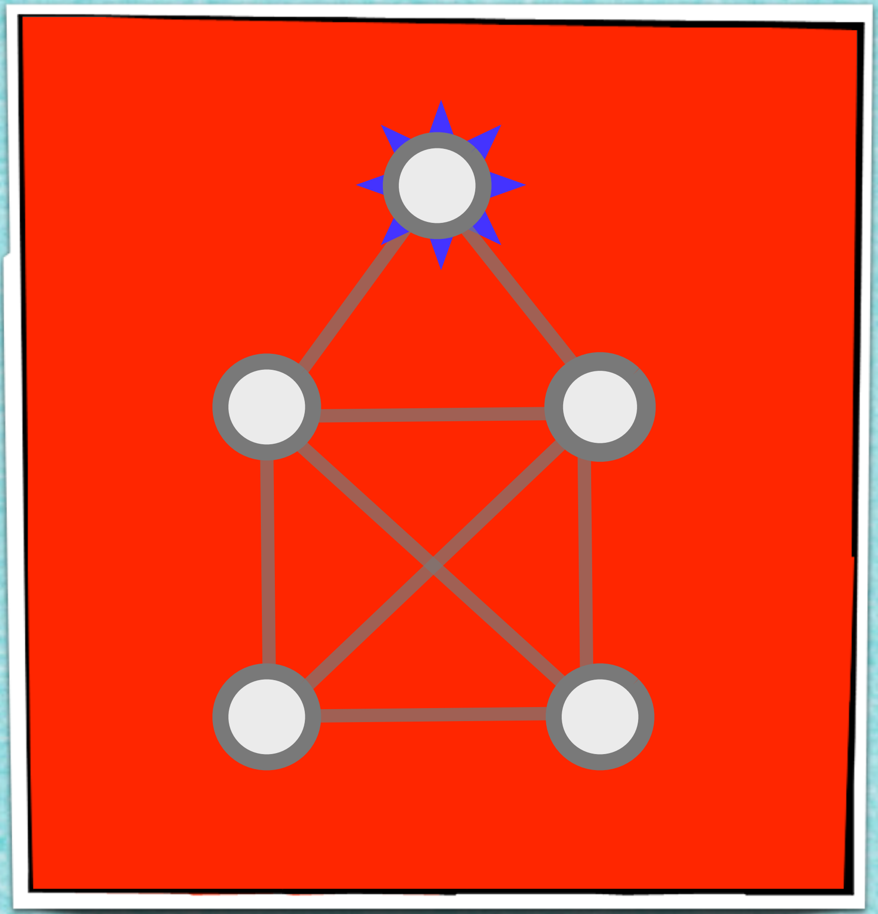

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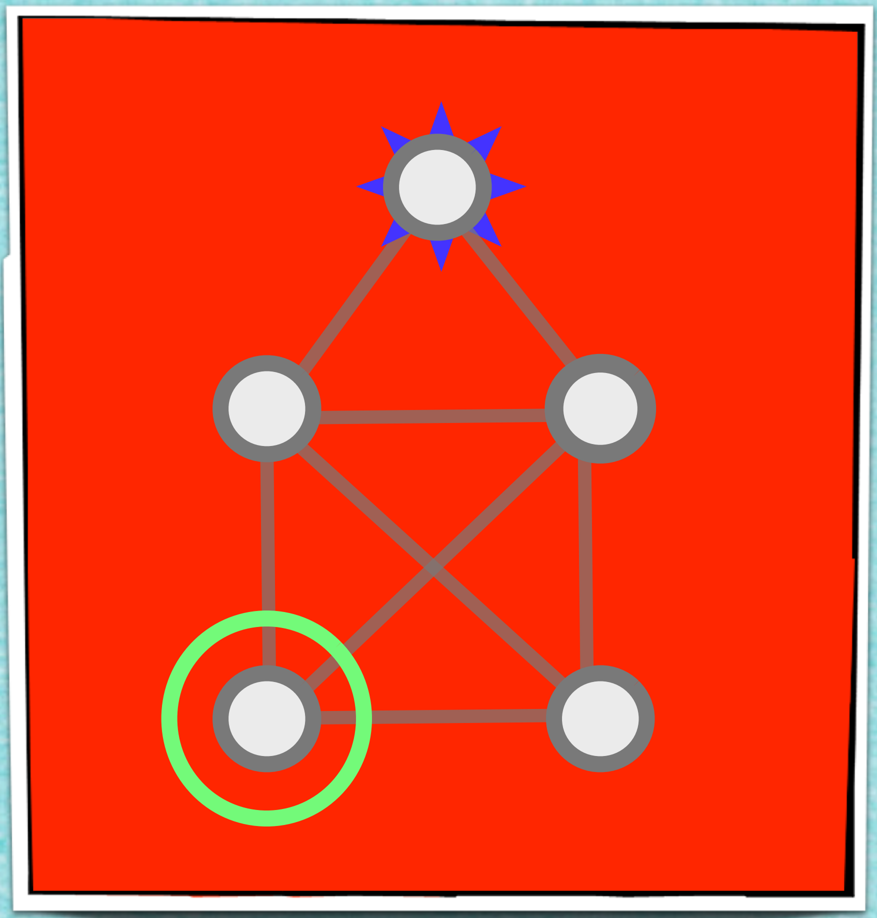

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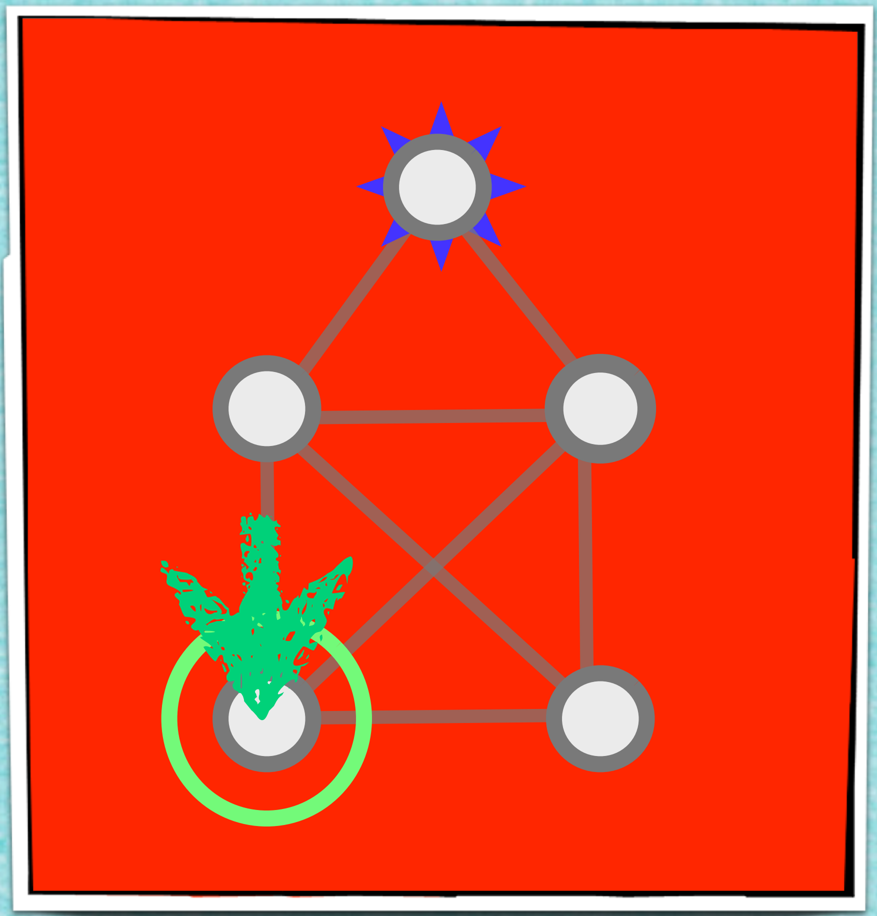

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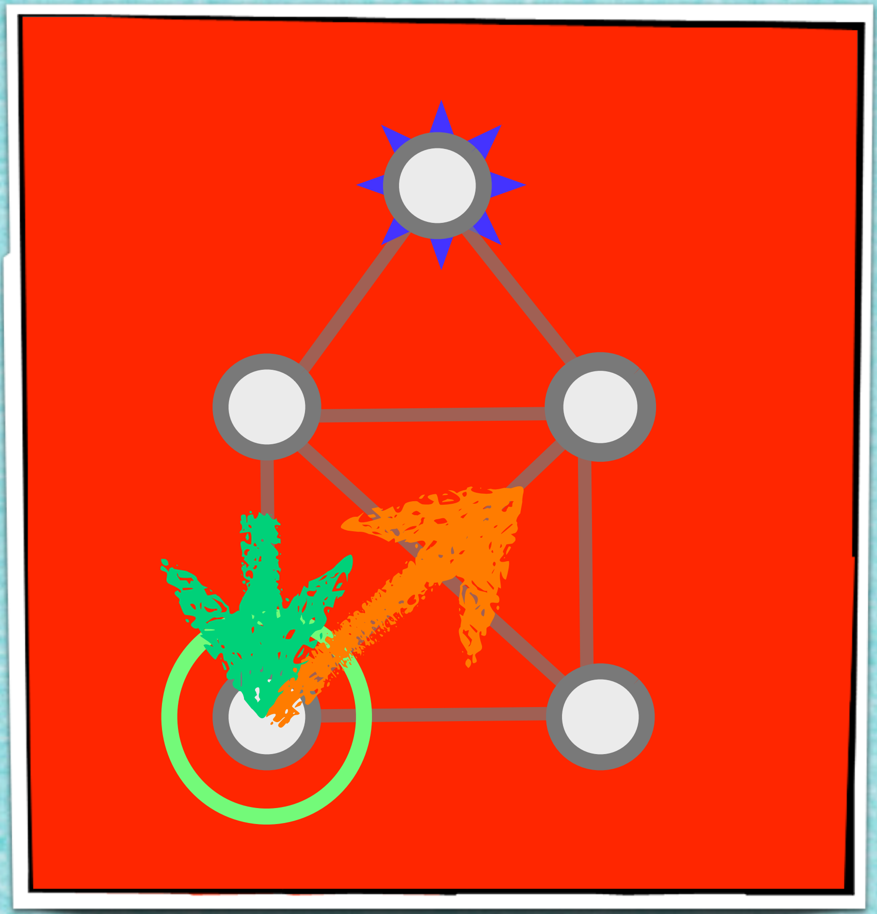

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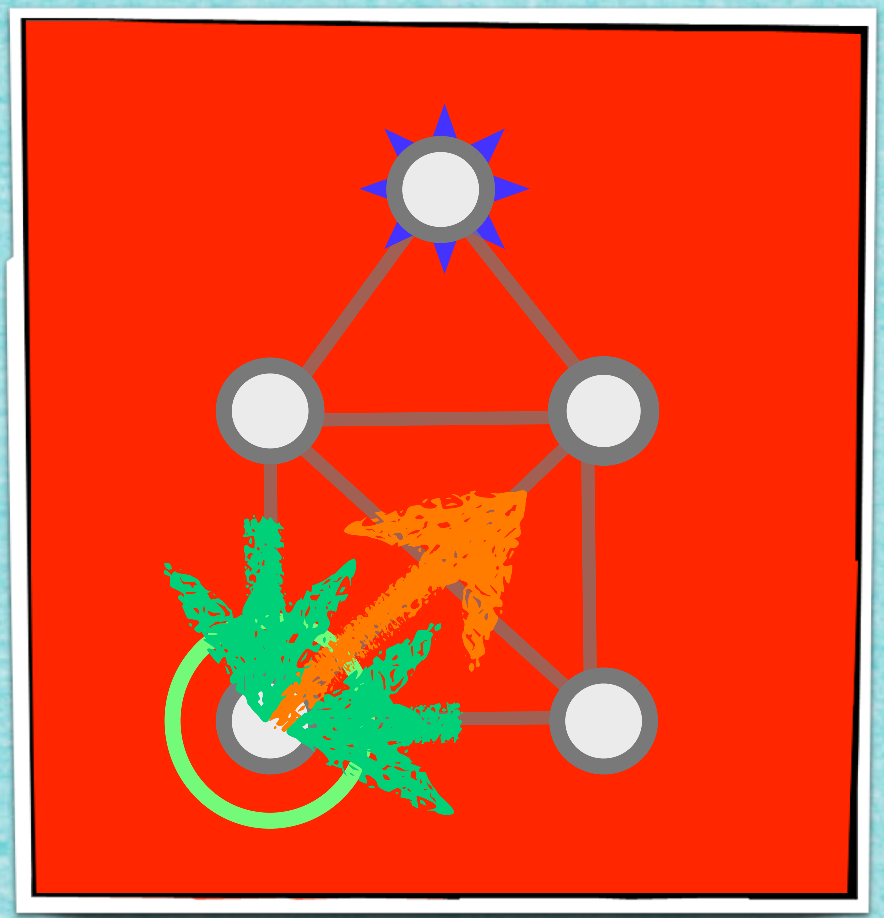

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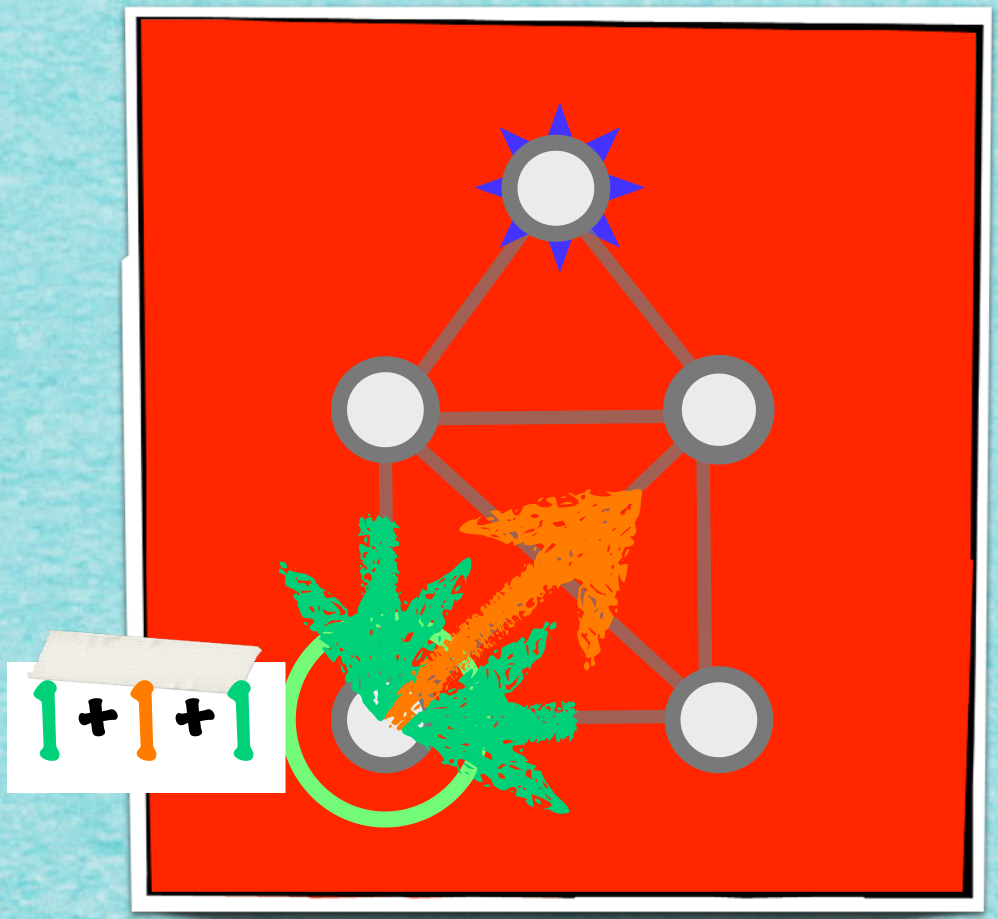

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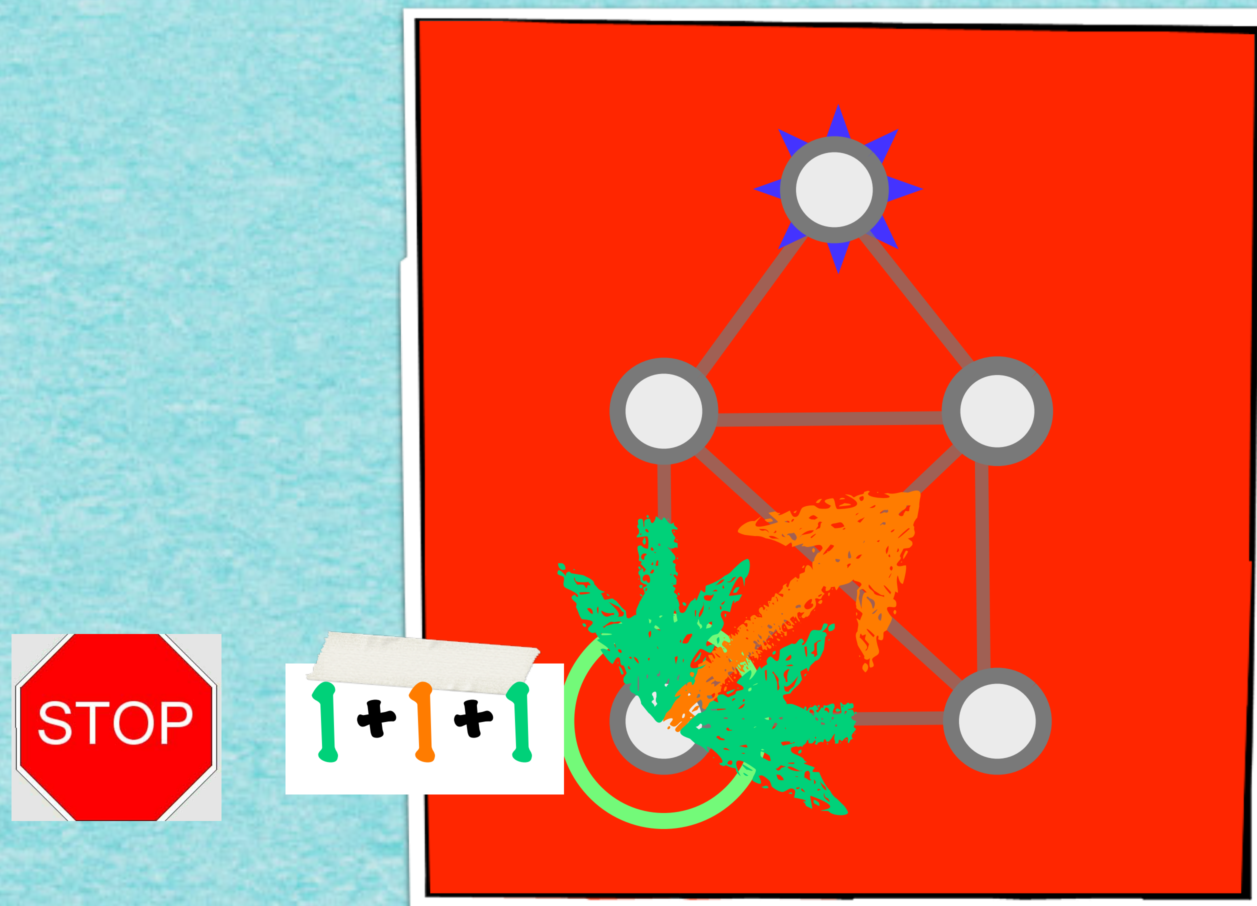

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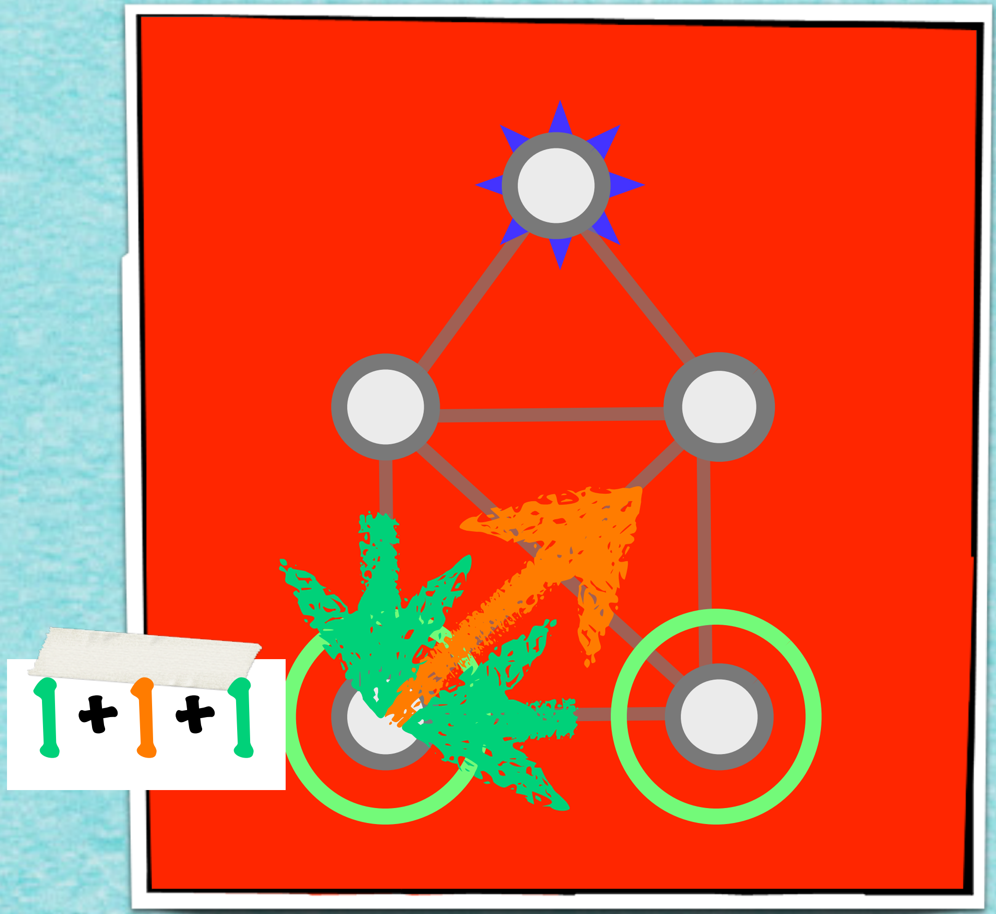

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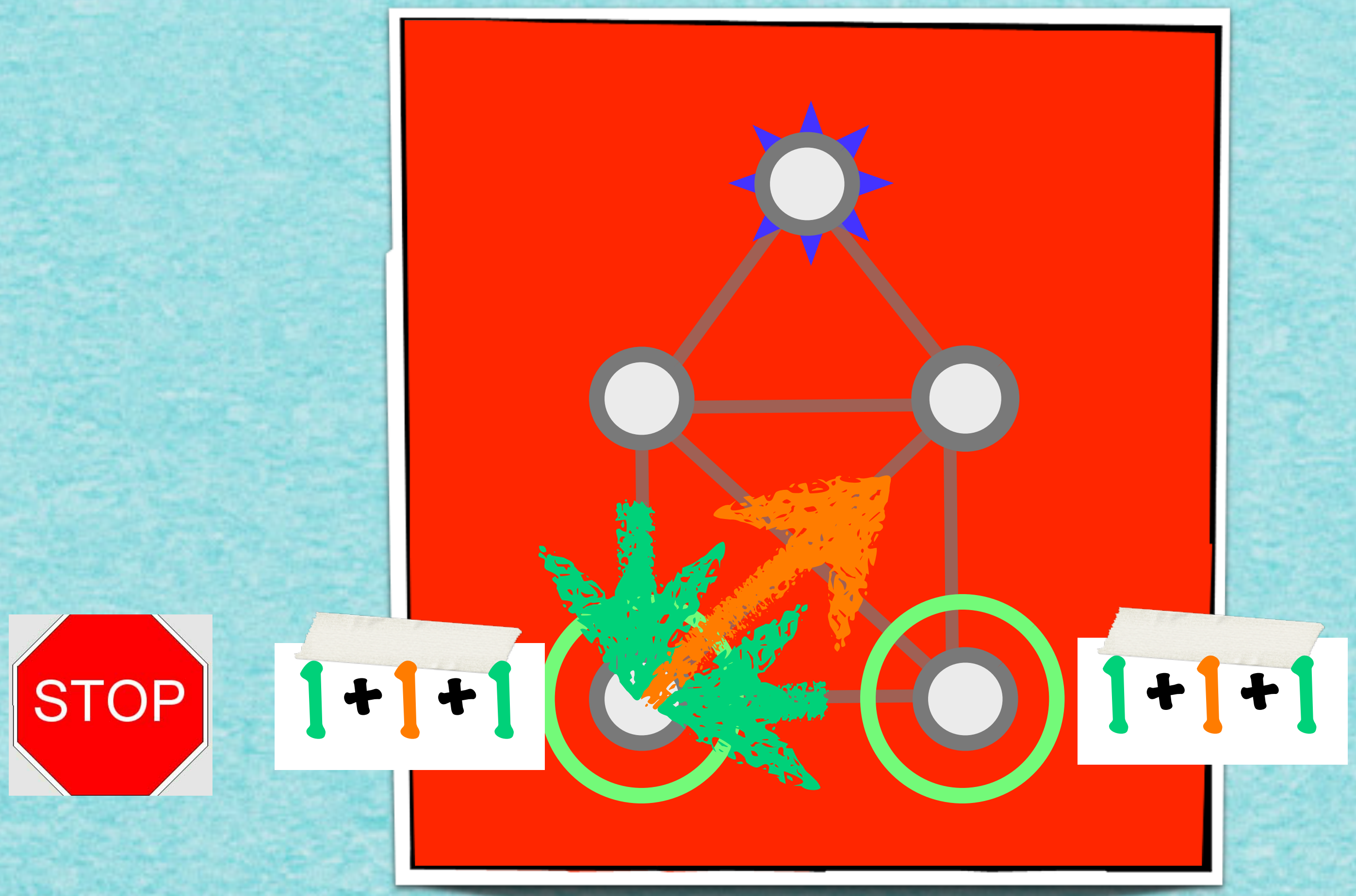

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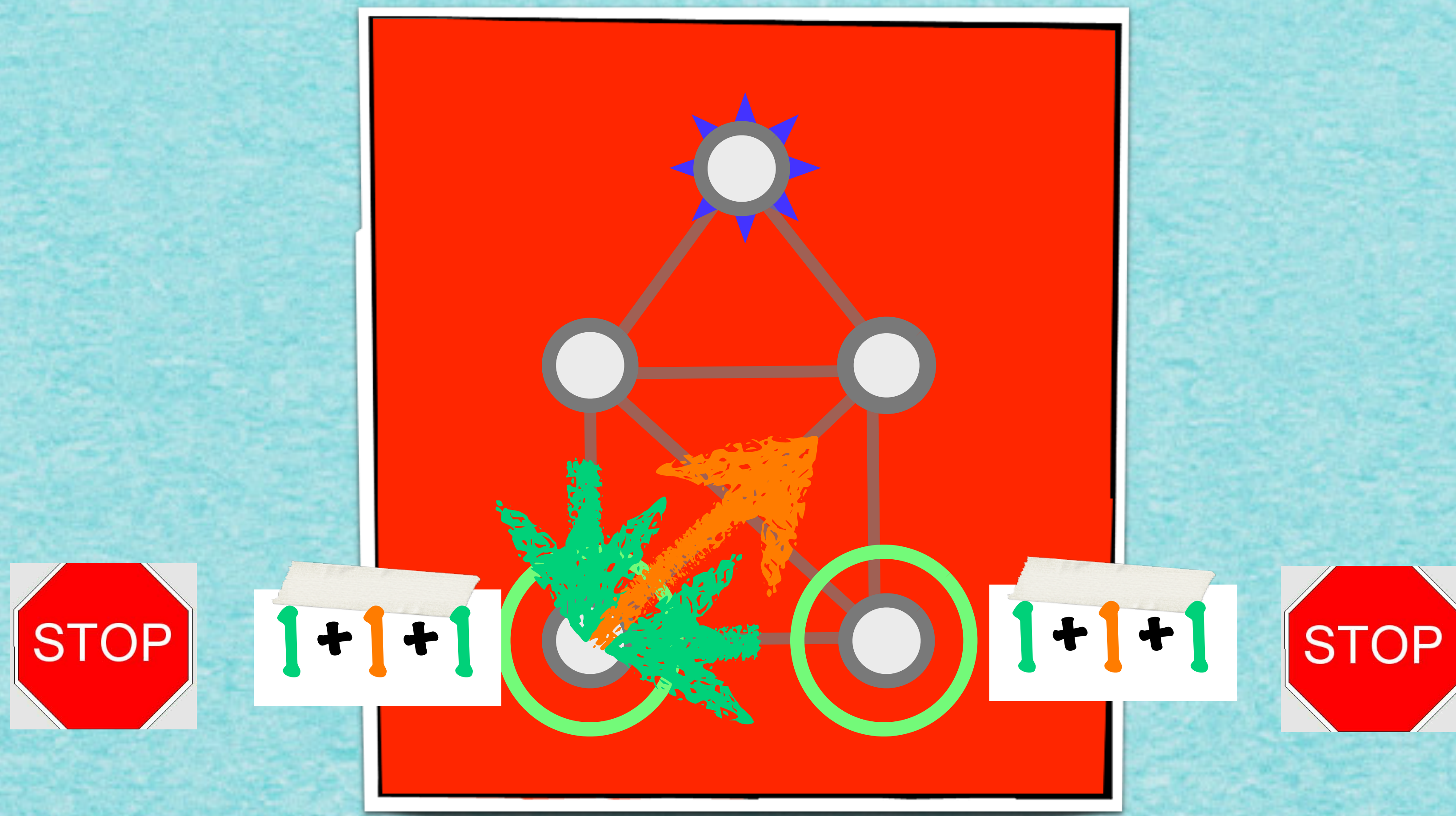

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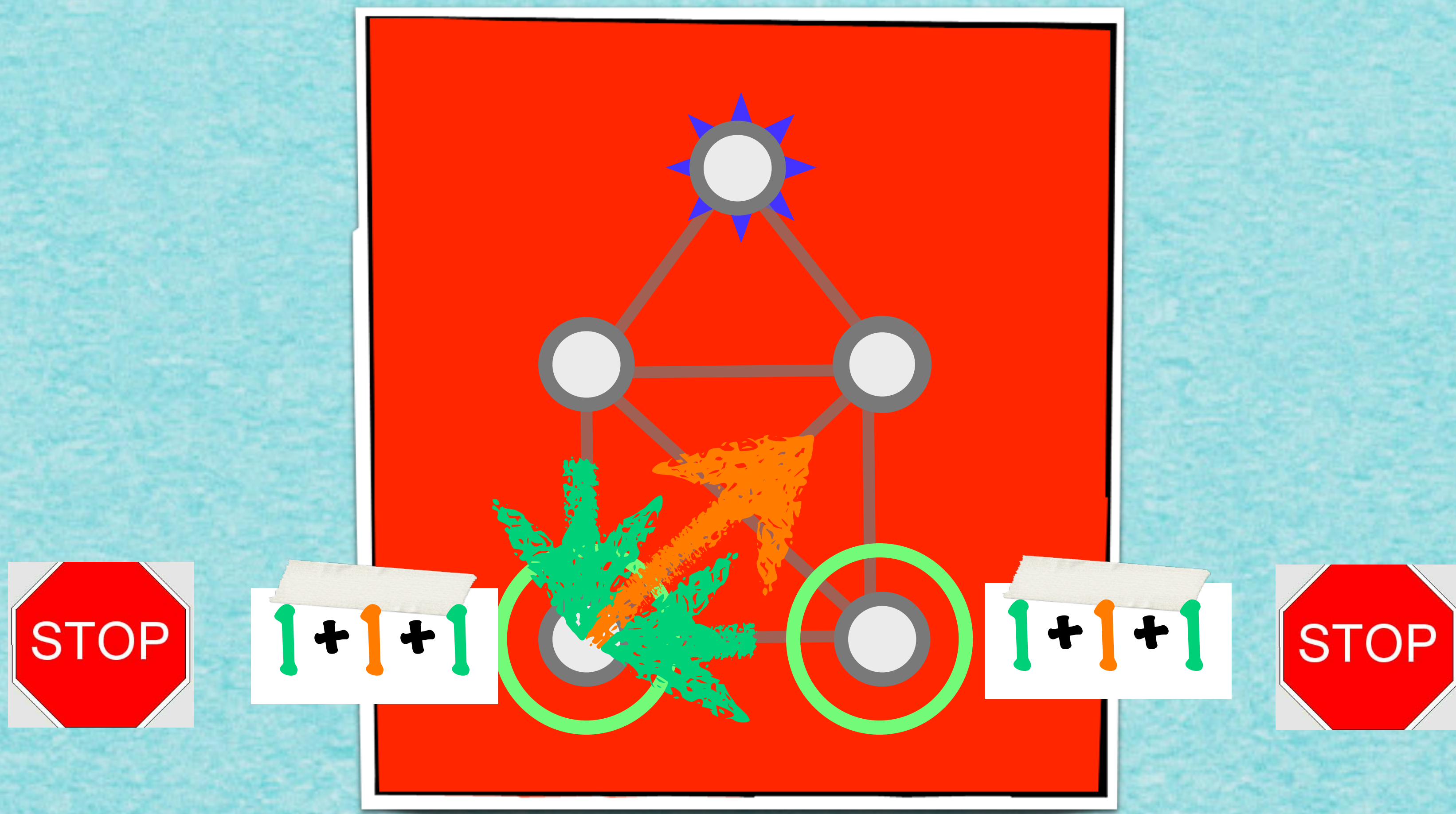

Hmmmmm...

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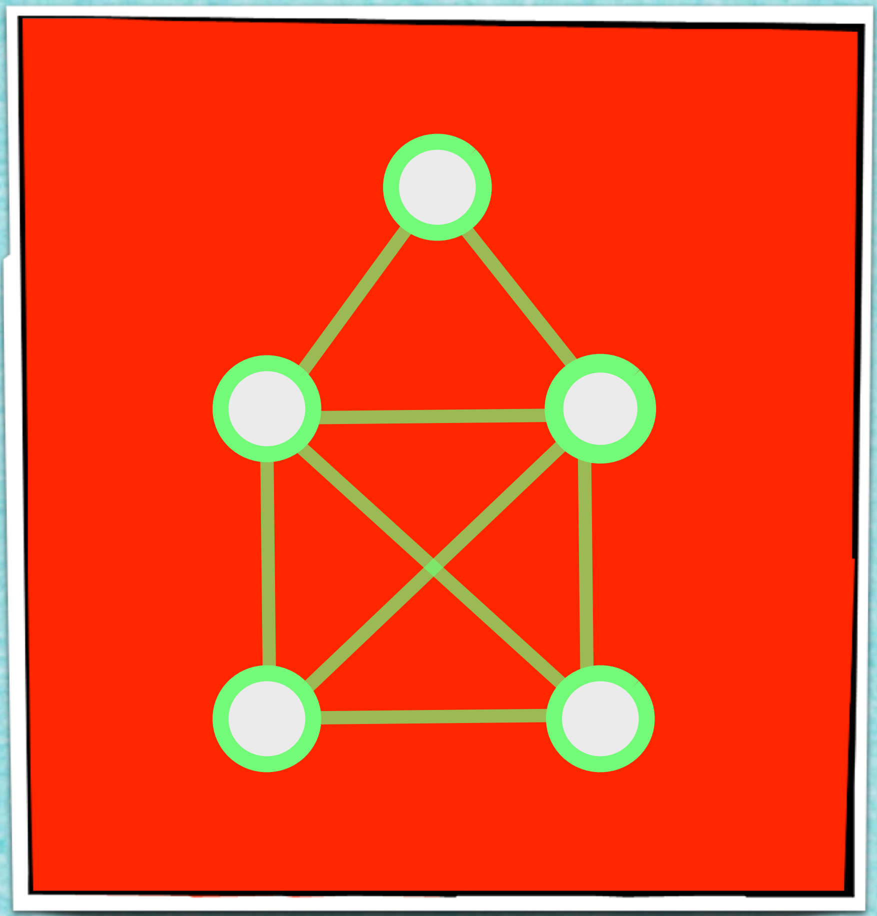

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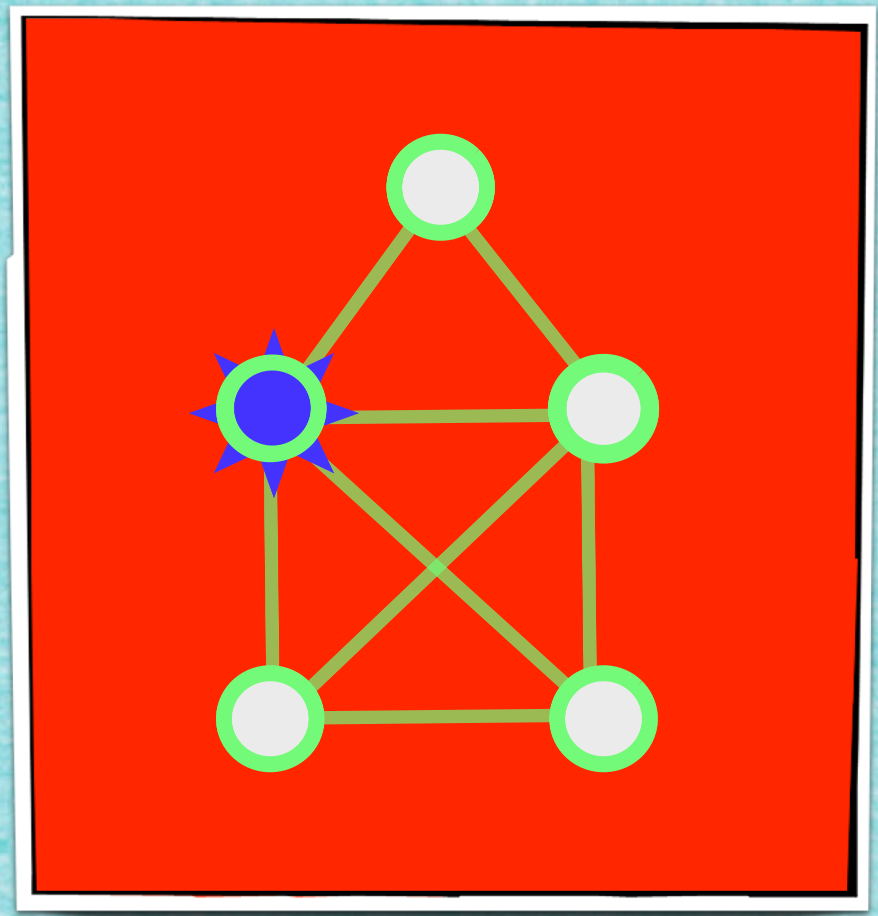

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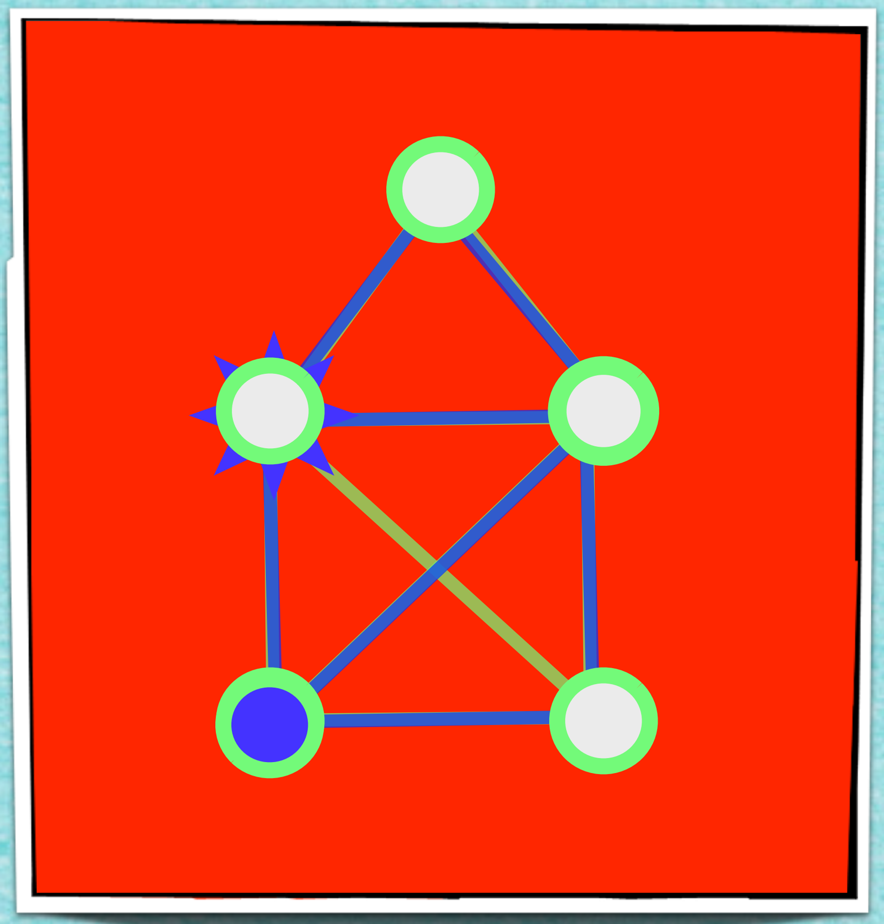

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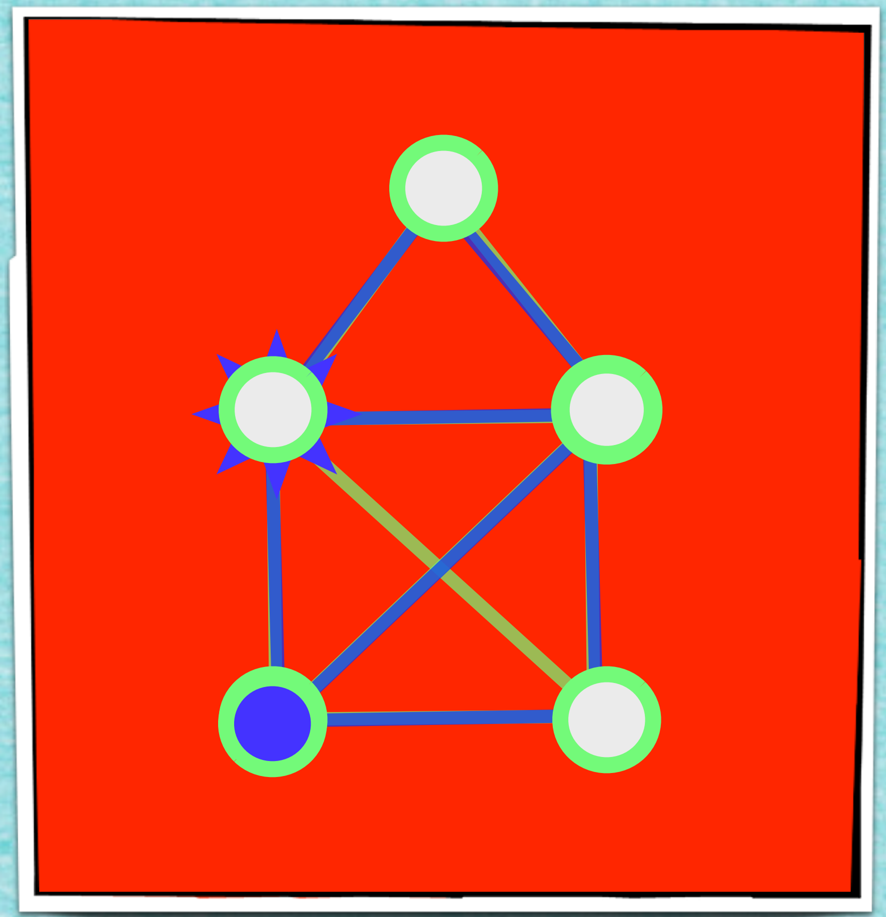

Oooooooooch...

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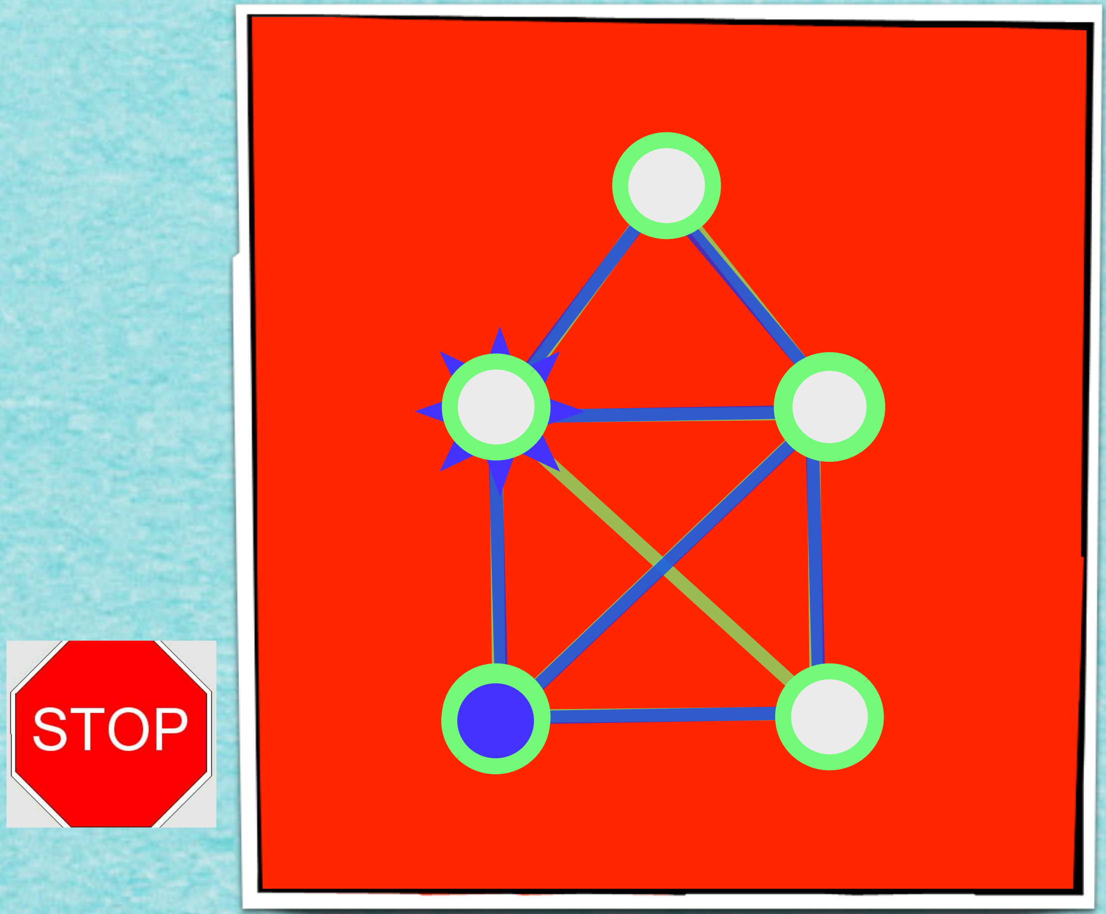

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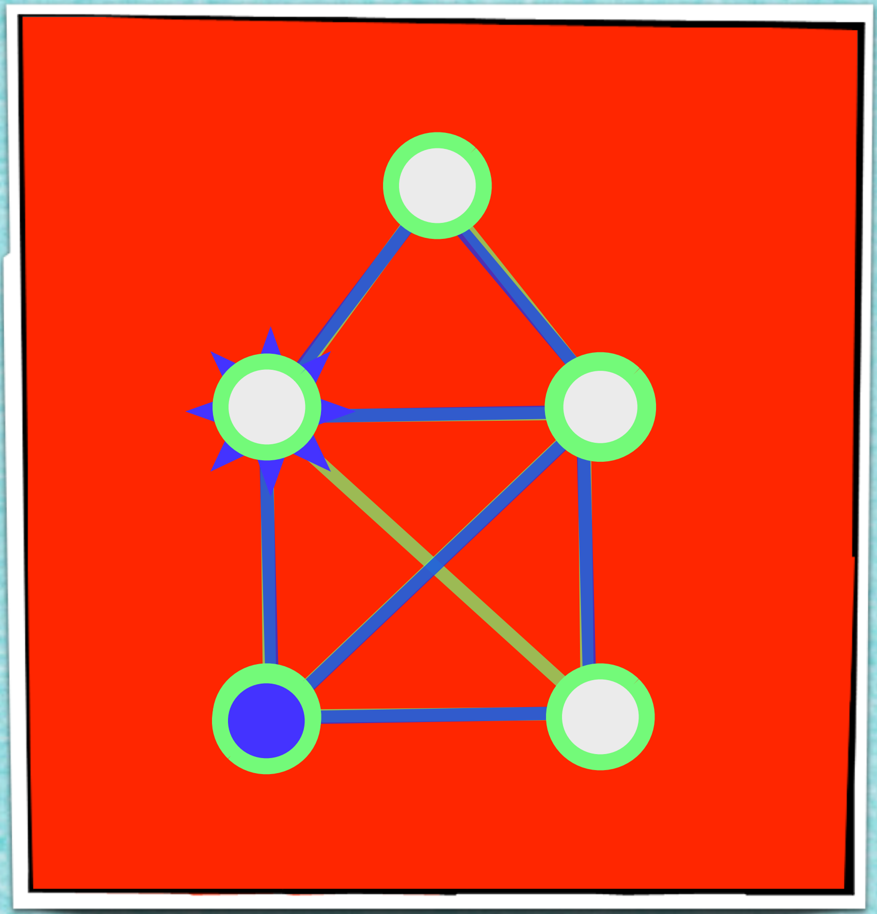

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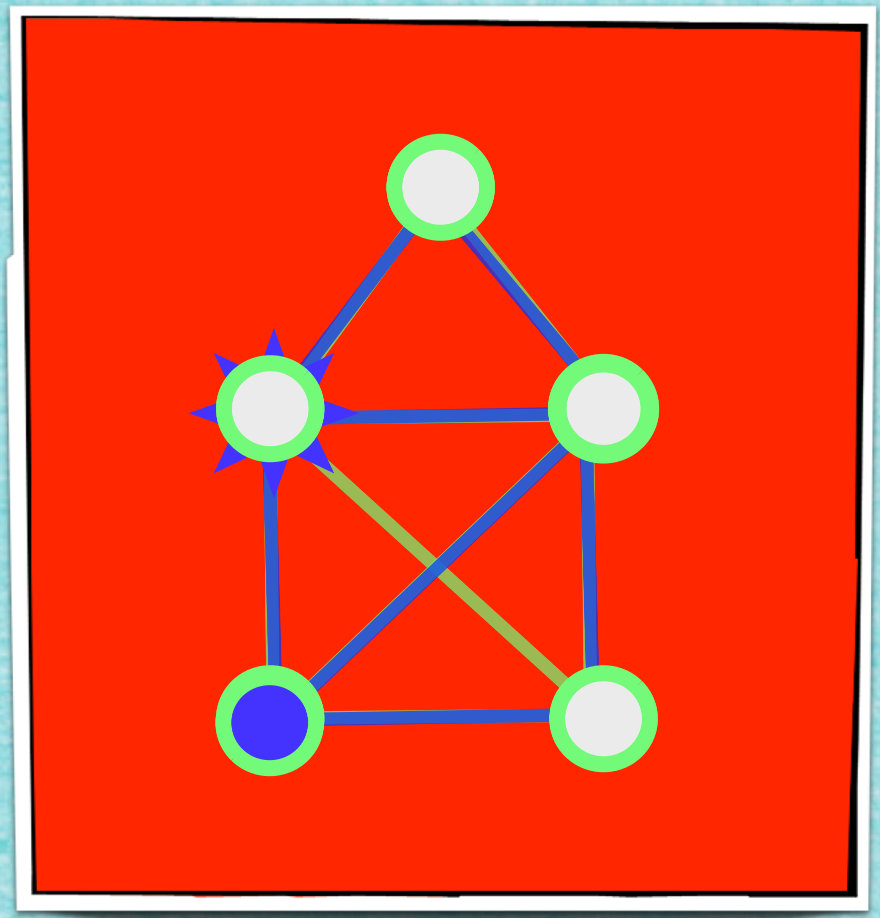

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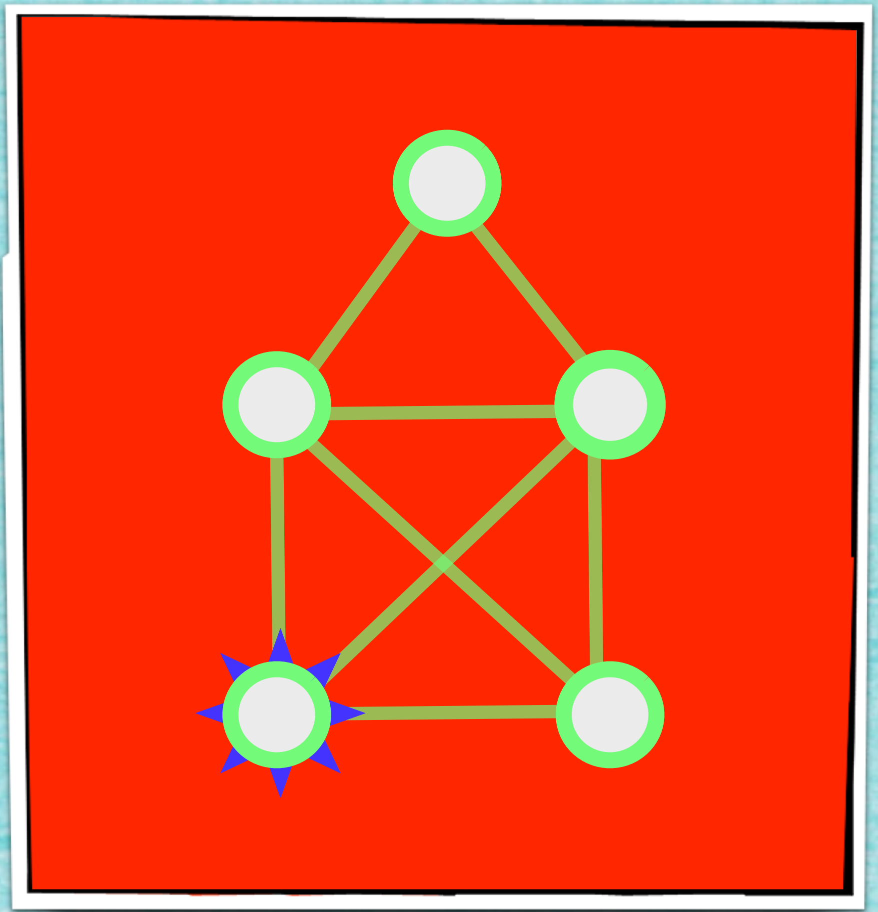

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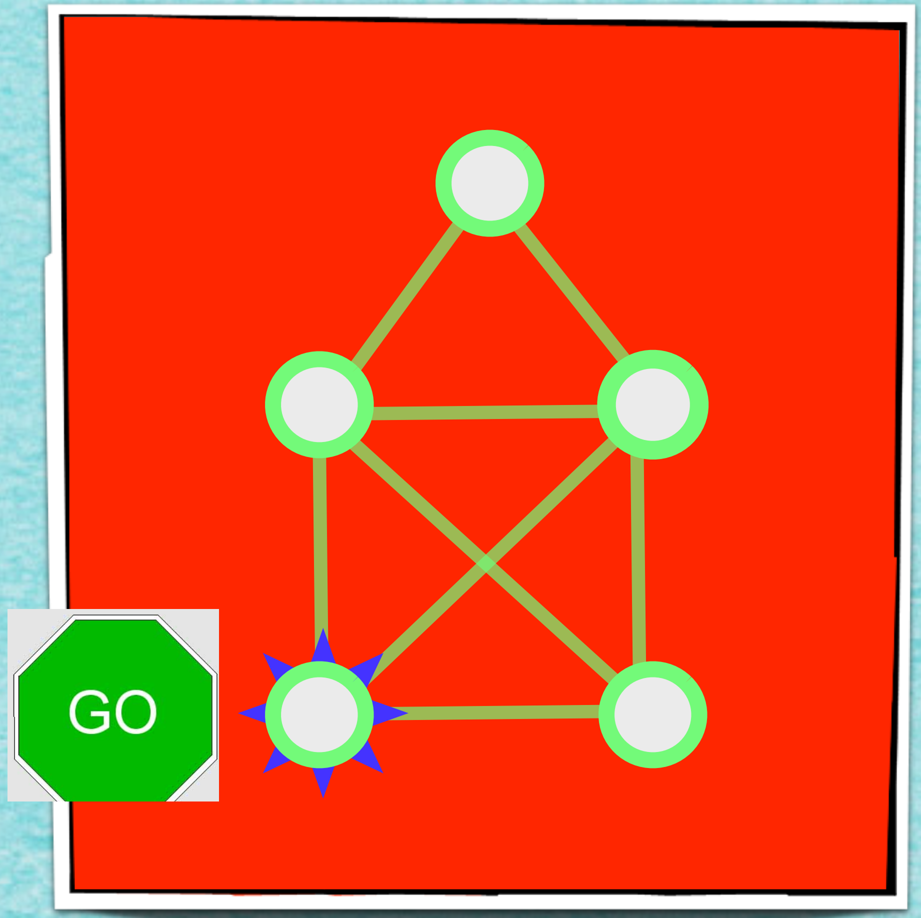

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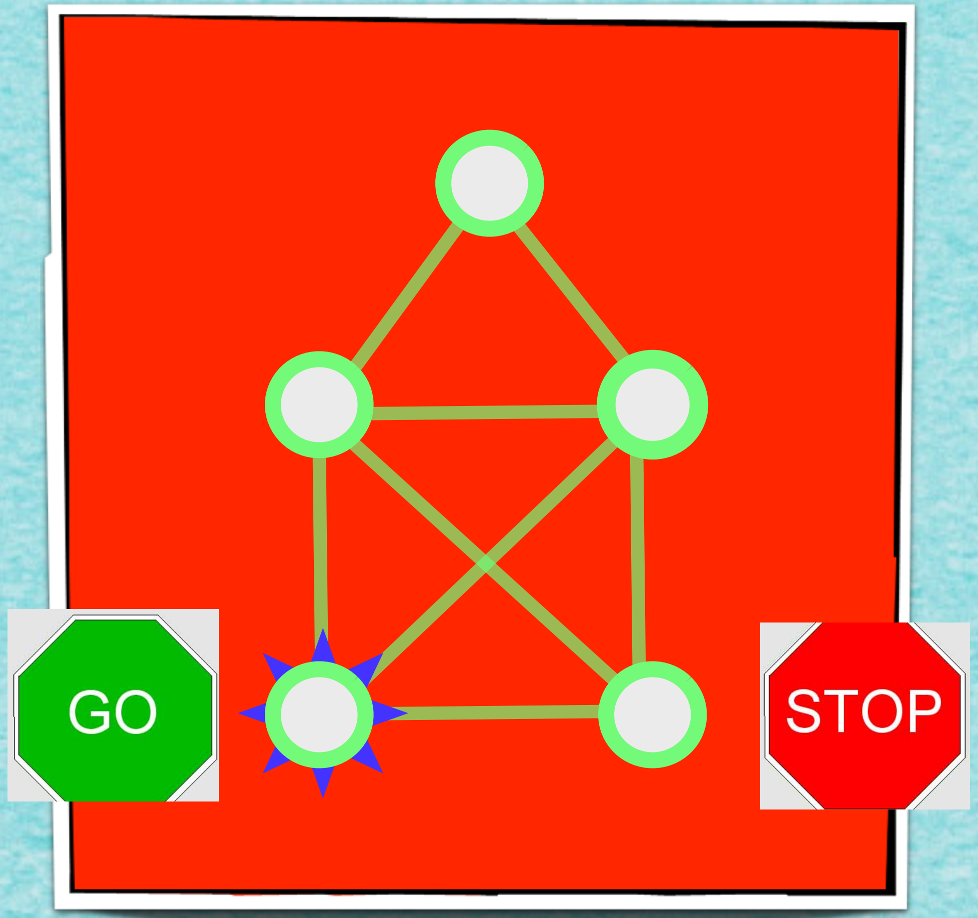

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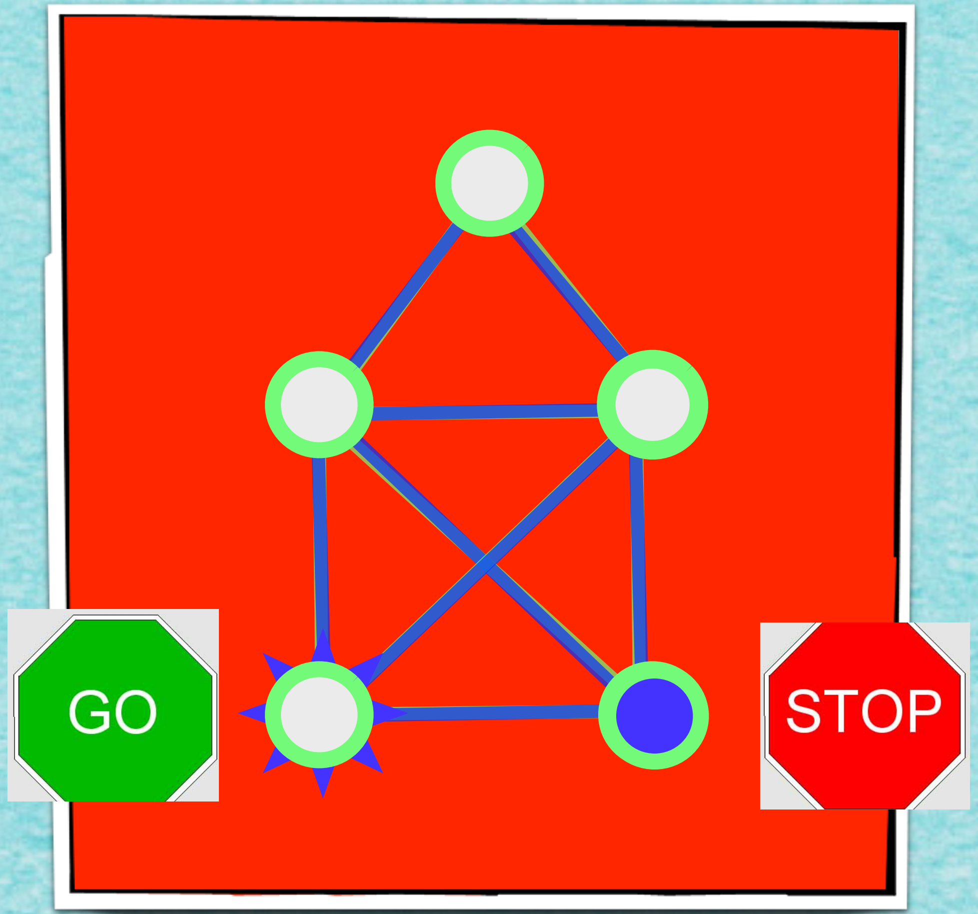

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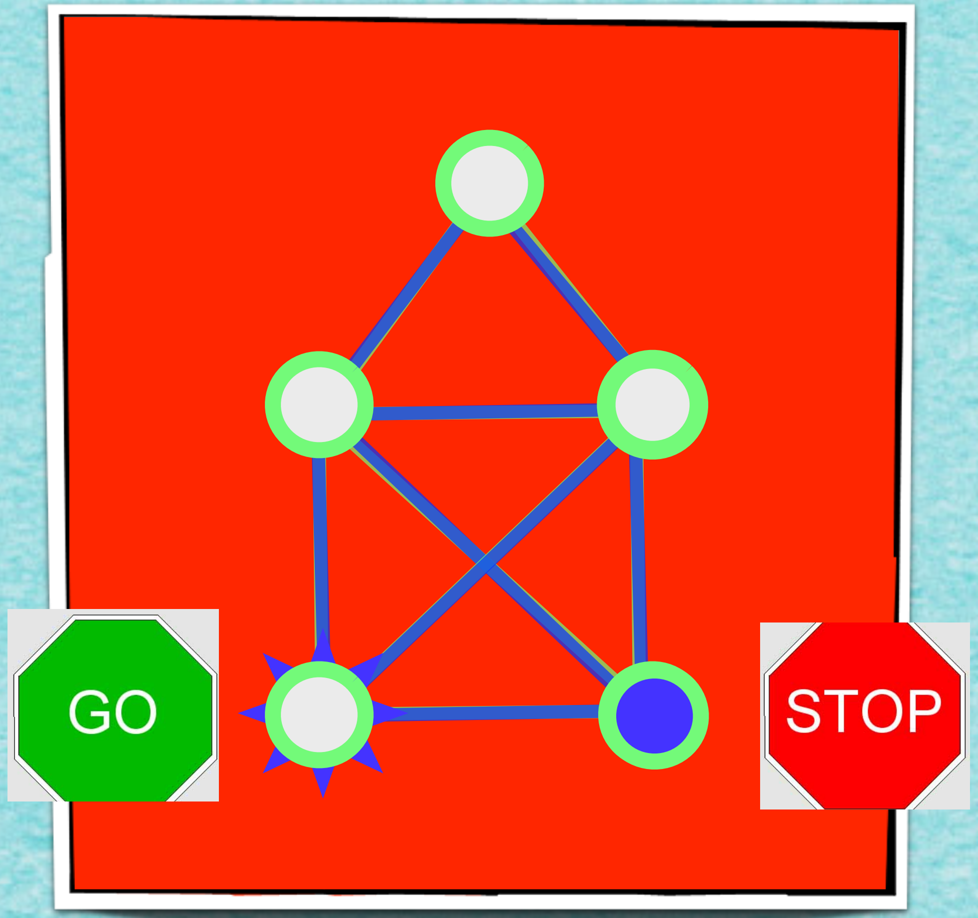
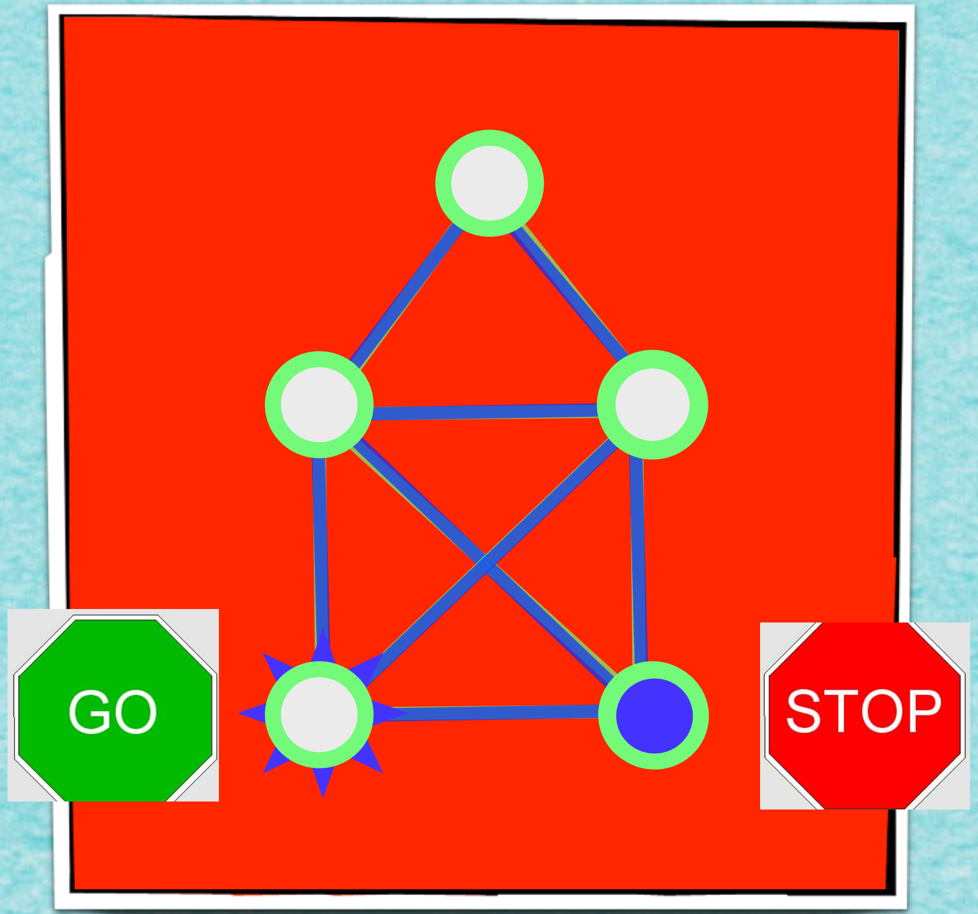


Ahhhhhhh!

Das Haus des Nikolaus



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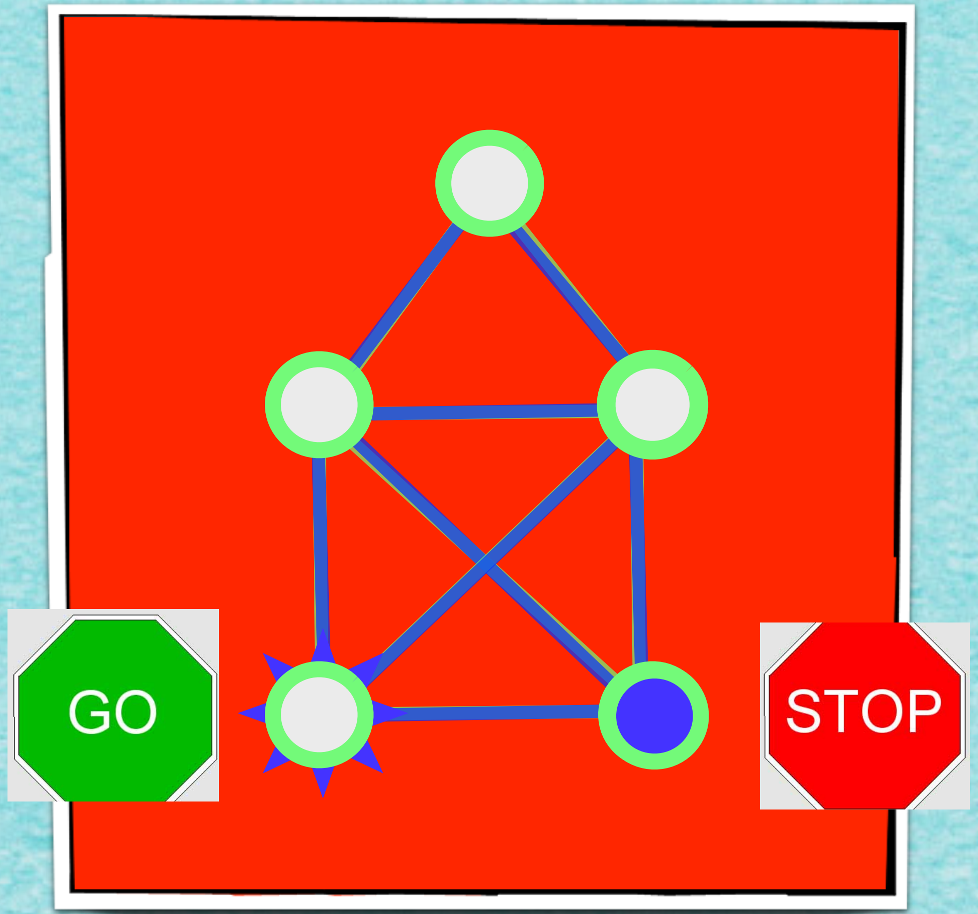

Wichtig: An einem der Knoten mit drei Kanten anfangen, weil man sonst irgendwann dort nicht mehr weg kommt!

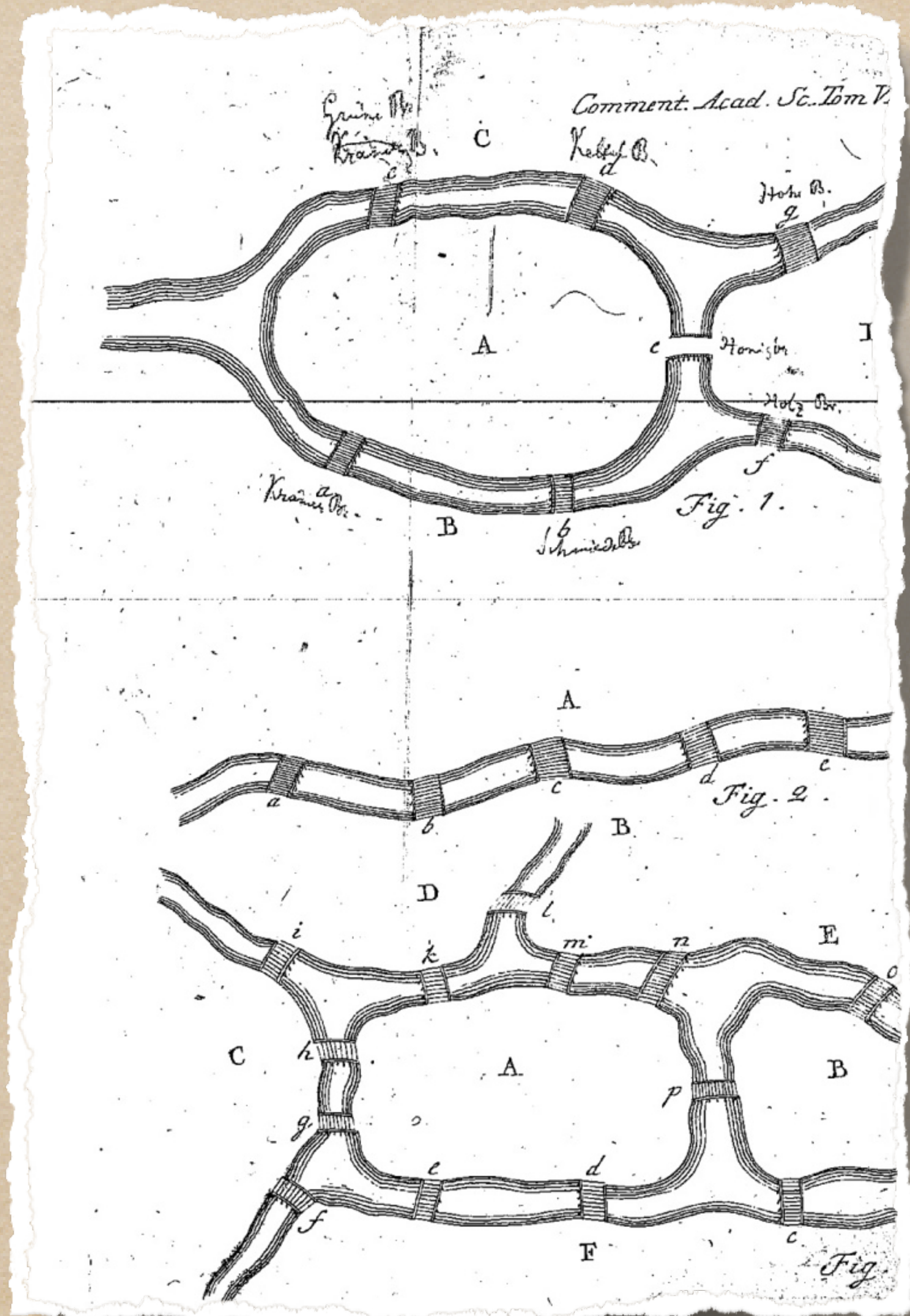
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Fig. 1.
Fig. 2.
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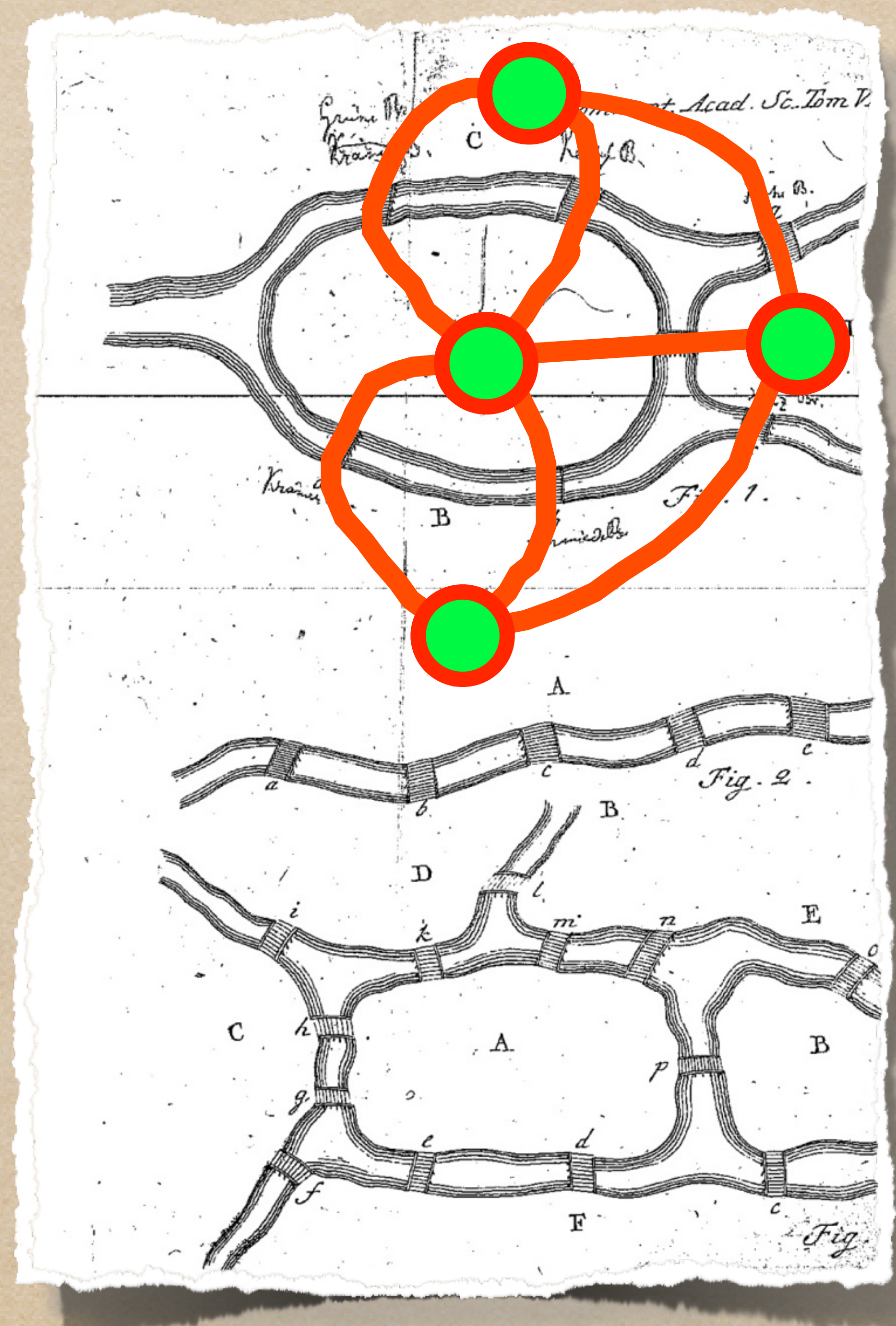
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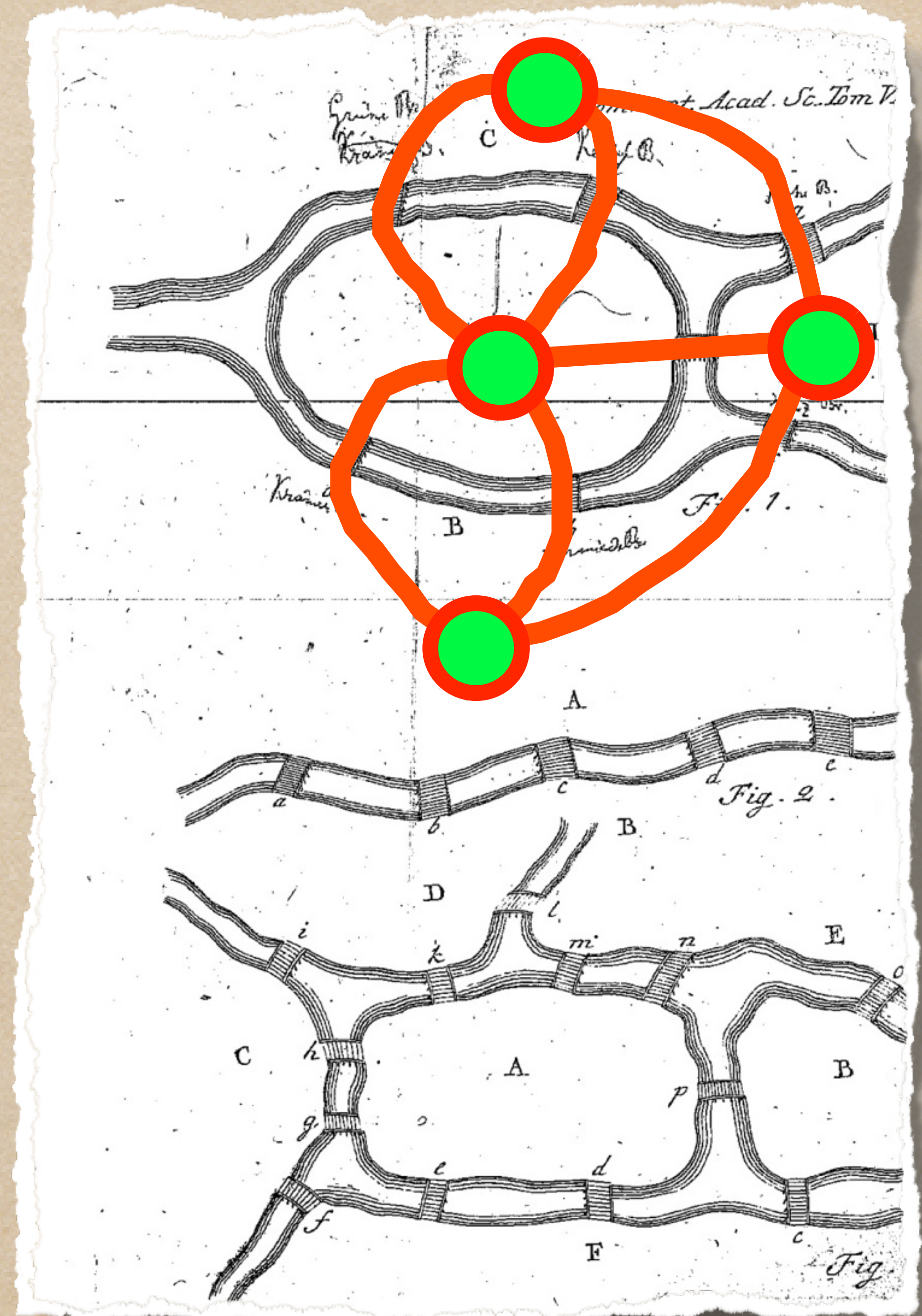
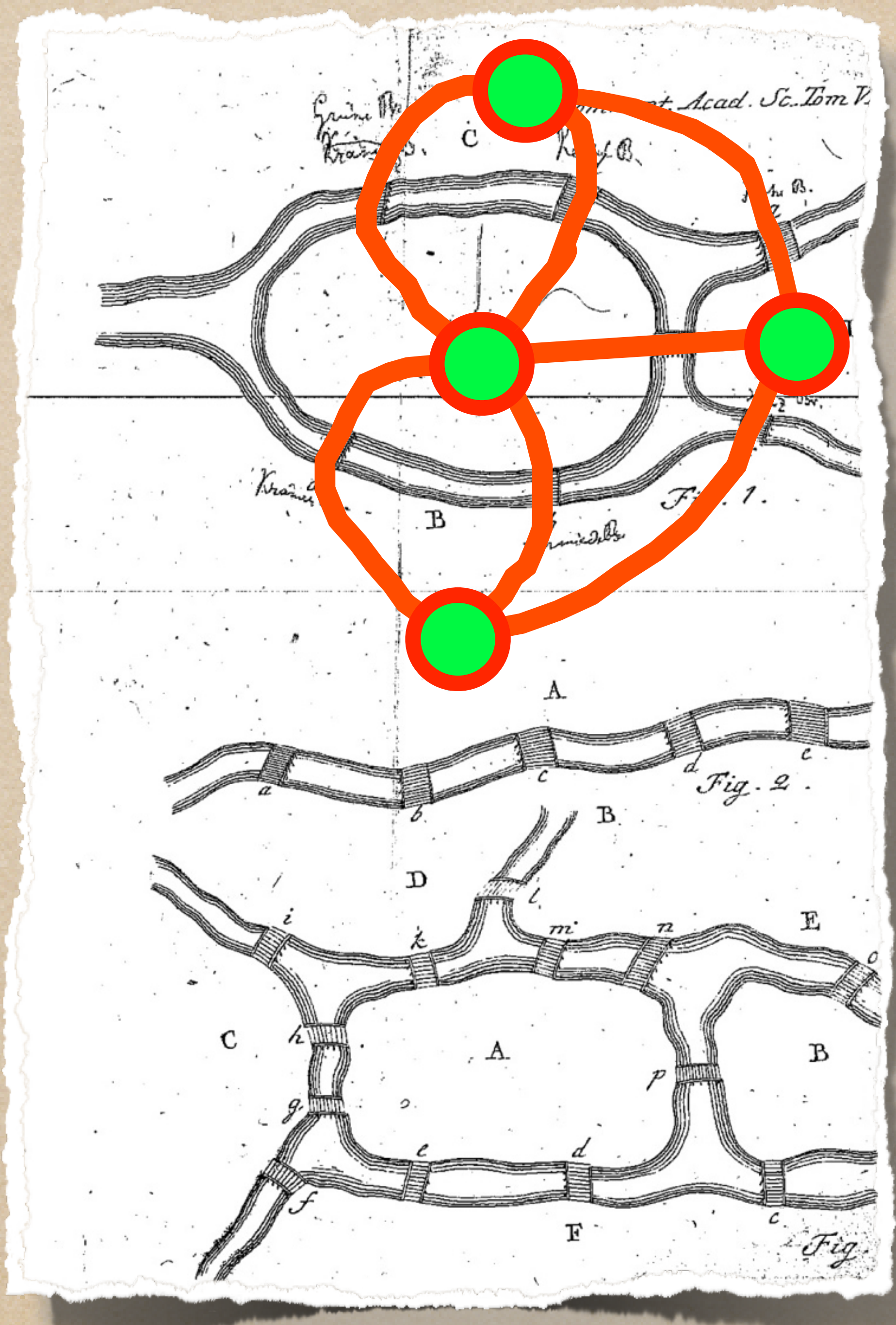
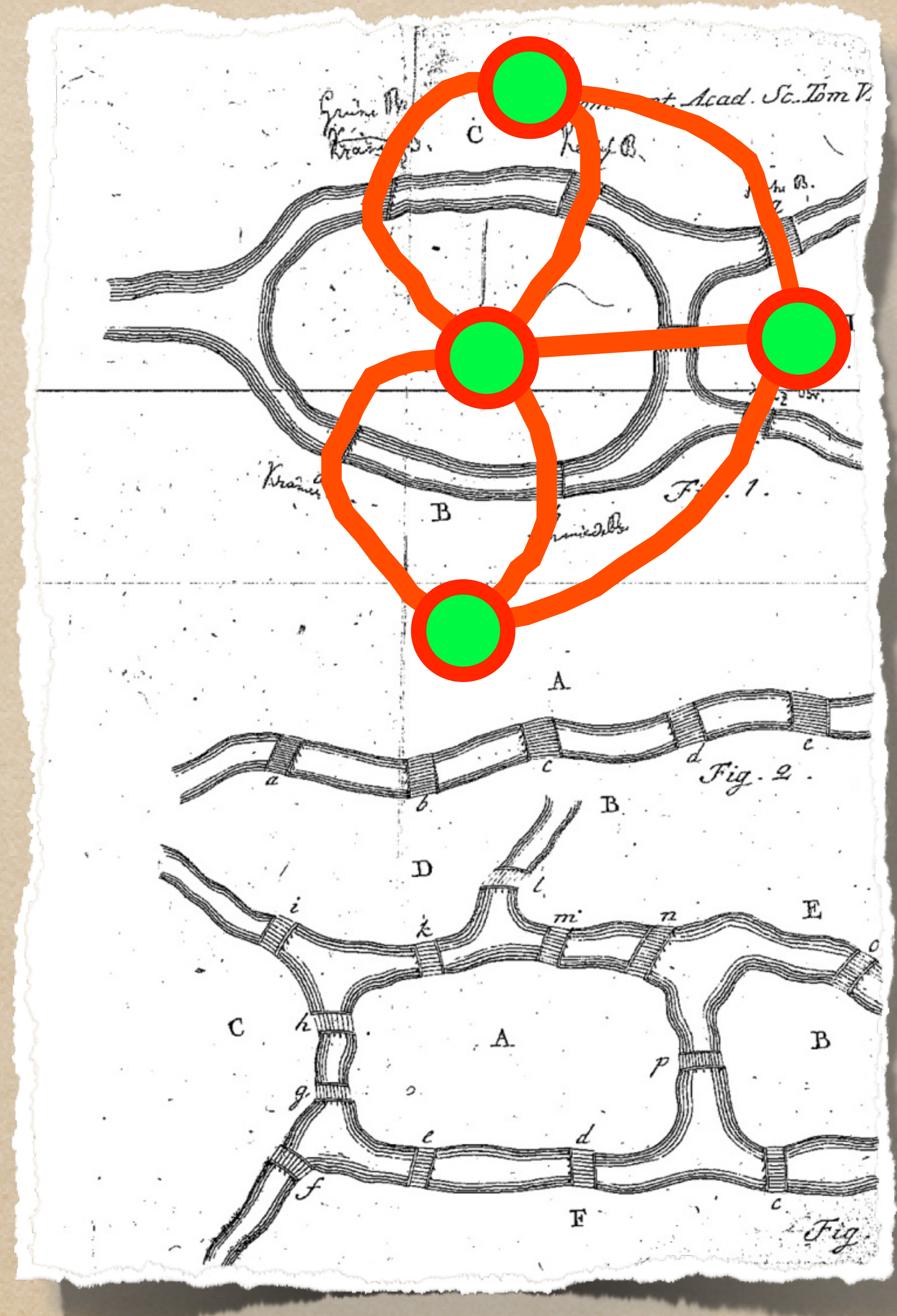


- Alle Knoten sind ungerade?!



- Alle Knoten sind ungerade?!
- Man müsste an allen anfangen oder aufhören!



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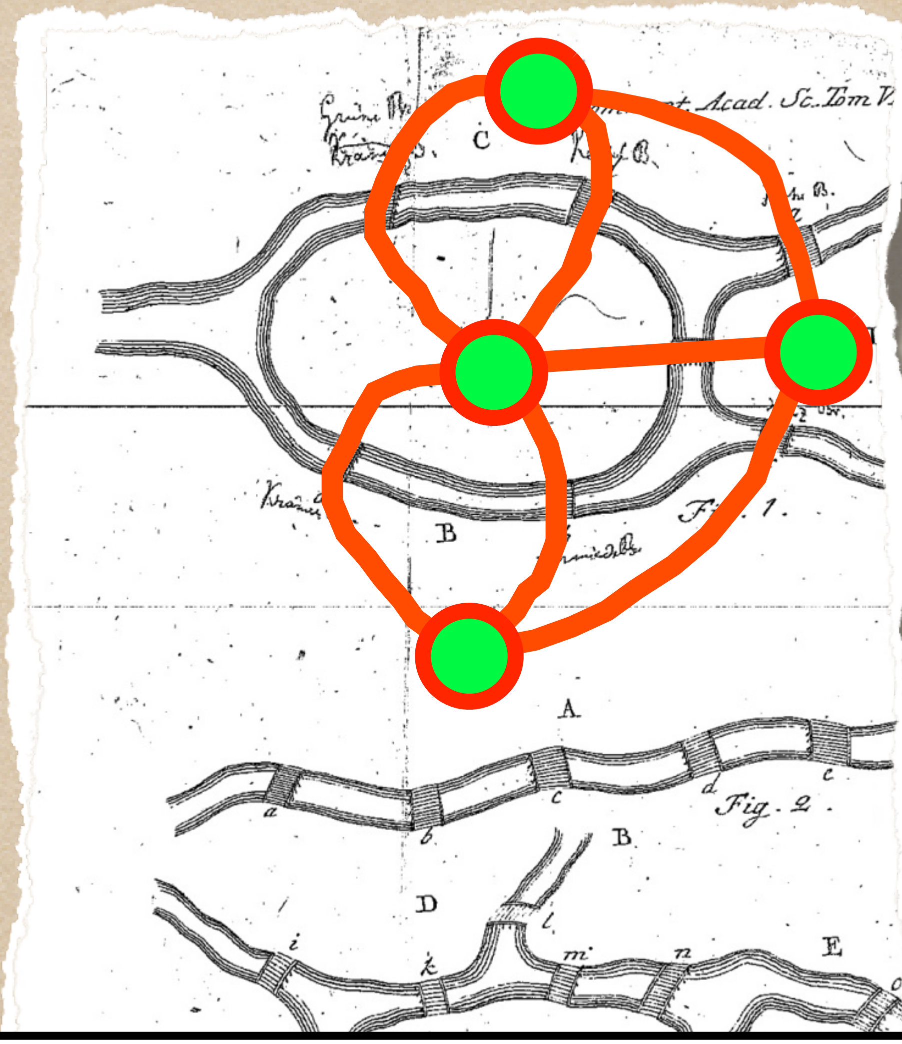
- Das geht nicht an einem Stück!



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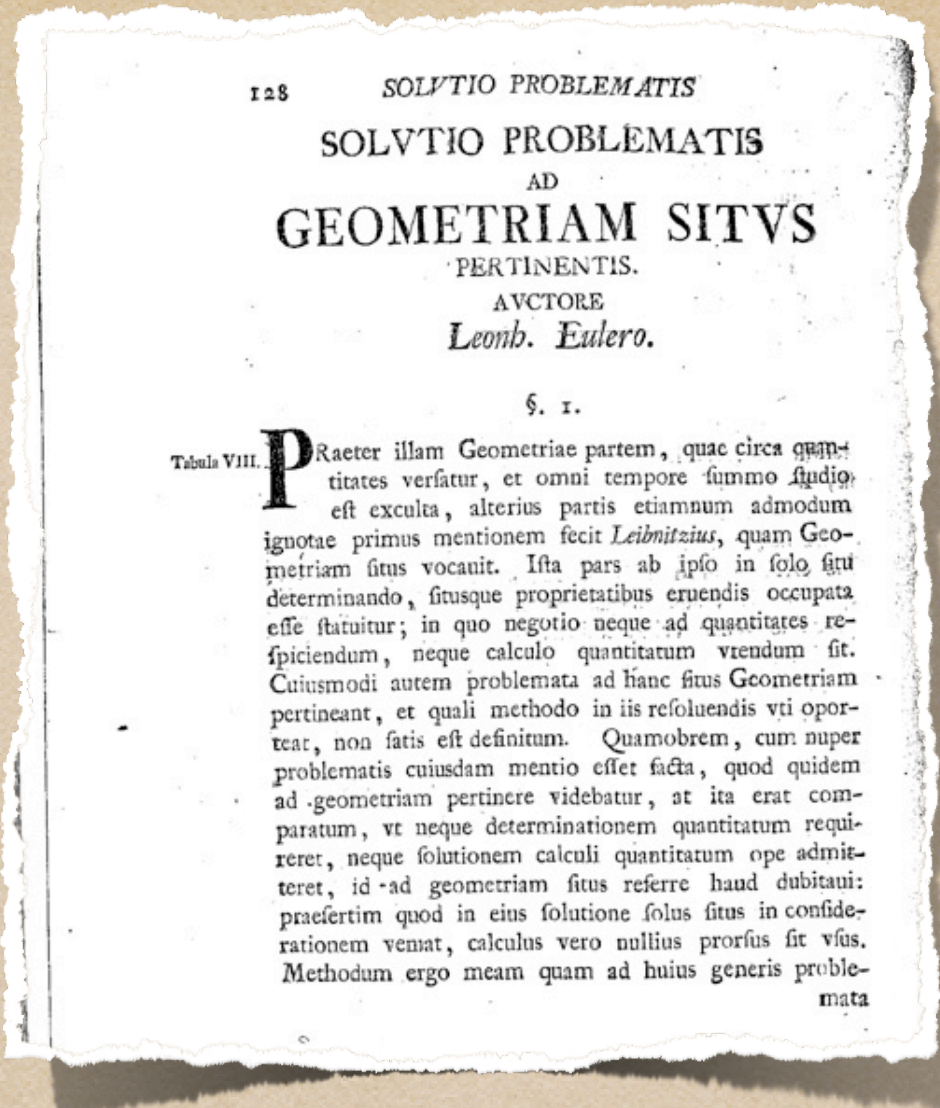
- Das geht nicht an einem Stück!

Euler: (1) Das gilt für jede beliebige Instanz: Mit mehr als zwei ungeraden Knoten gibt es keinen solchen Weg.

(2) Man kann auch charakterisieren, unter welchen Bedingungen es einen Weg tatsächlich gibt.



128 SOLVTIO PROBLEMATIS

SOLVTIO PROBLEMATIS
AD
GEOMETRIAM SITVS
PERTINENTIS.
AVCTORE
Leonh. Eulero.

§. 1.

Tabula VIII. PRaeter illam Geometriae partem, quae circa quantitates verſatur, et omni tempore ſummo ſtudio eſt exculta, alterius partis etiamnum admodum ignotae primus mentionem fecit *Leibnitzius*, quam Geometriam ſitus vocauit. Iſta pars ab ipſo in ſolo ſitu determinando, ſitusque proprietatibus eruendis occupata eſſe ſtatuitur; in quo negotio neque ad quantitates reſpiciendum, neque calculo quantitatum vtendum ſit. Cuiusmodi autem problemata ad hanc ſitus Geometriam pertineant, et quali methodo in iis reſoluendis vti oporteat, non ſatis eſt definitum. Quamobrem, cum nuper problematis cuiusdam mentio eſſet facta, quod quidem ad geometriam pertinere videbatur, at ita erat comparatum, vt neque determinationem quantitatum requireret, neque ſolutionem calculi quantitatum ope admitteret, id ad geometriam ſitus referre haud dubitaui: praeſertim quod in eius ſolutione ſolus ſitus in conſiderationem veniat, calculus vero nullius prorſus ſit vſus. Methodum ergo meam quam ad huius generis problemata

- Alle Knoten sind ungerade?!
- Man müsste an allen anfangen oder aufhören!
- Das geht nicht an einem Stück!

Euler: (1) Das gilt für jede beliebige Instanz: Mit mehr als zwei ungeraden Knoten gibt es keinen solchen Weg.

(2) Man kann auch charakterisieren, unter welchen Bedingungen es einen Weg tatsächlich gibt.

2.1 Historie


SCHWEIZERISCHE NATIONALBANK
BANCA NAZIUNALA SVIZRA
10
Leonhard Euler
1707–1783
Zehn Franken
Diesch francs
10

2.1 Historie

2.1 Historie

Euler hat:

2.1 Historie

Euler hat:

- eine Instanz betrachtet

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Euler hat:

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- ein Problem gelöst

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Euler hat:

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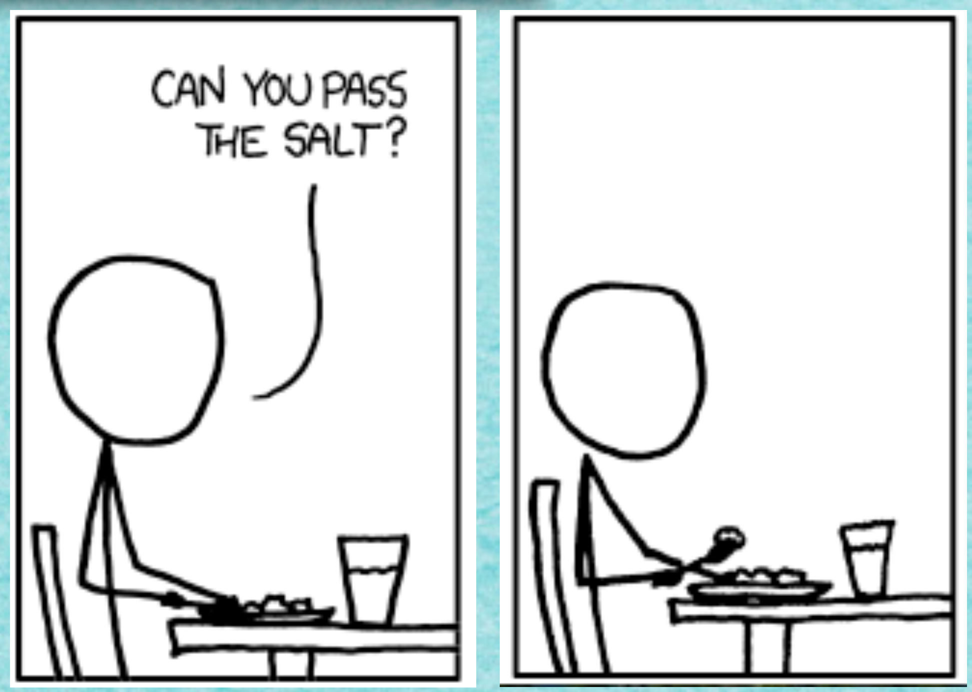

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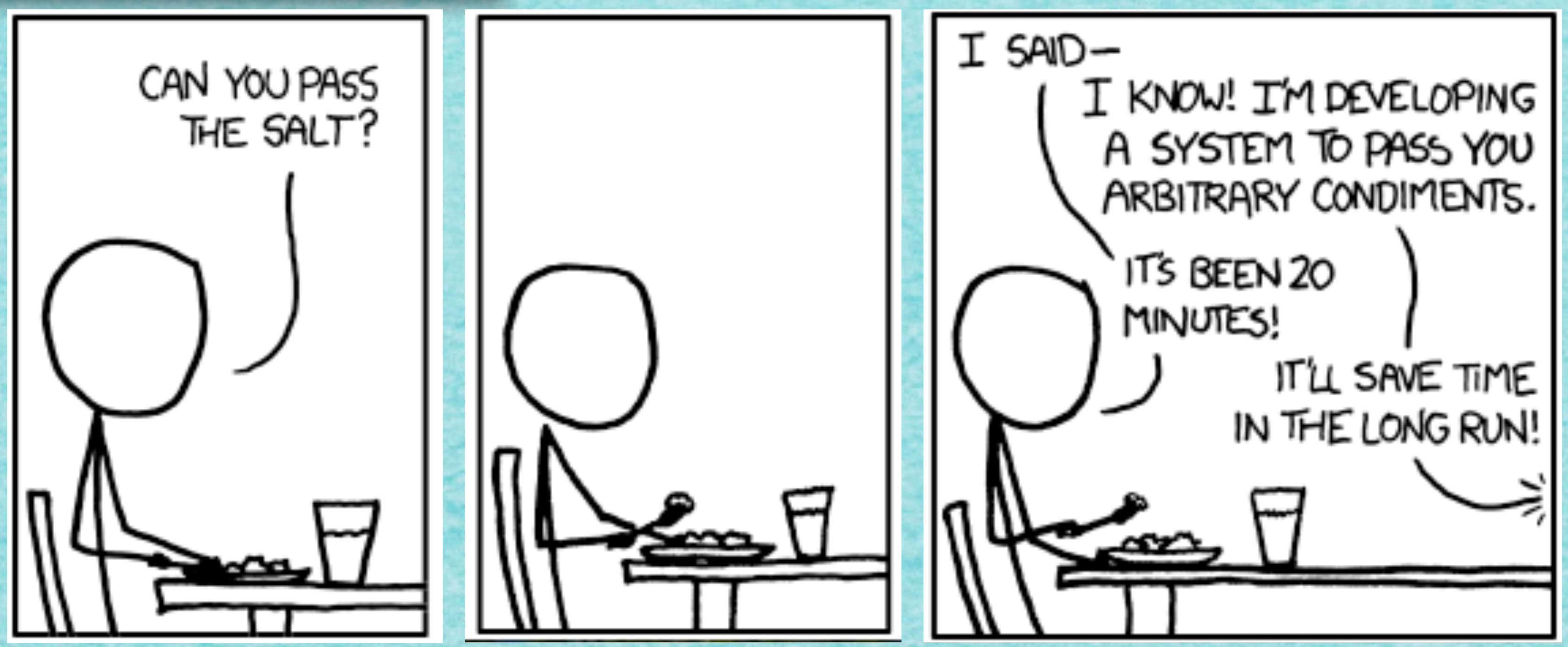

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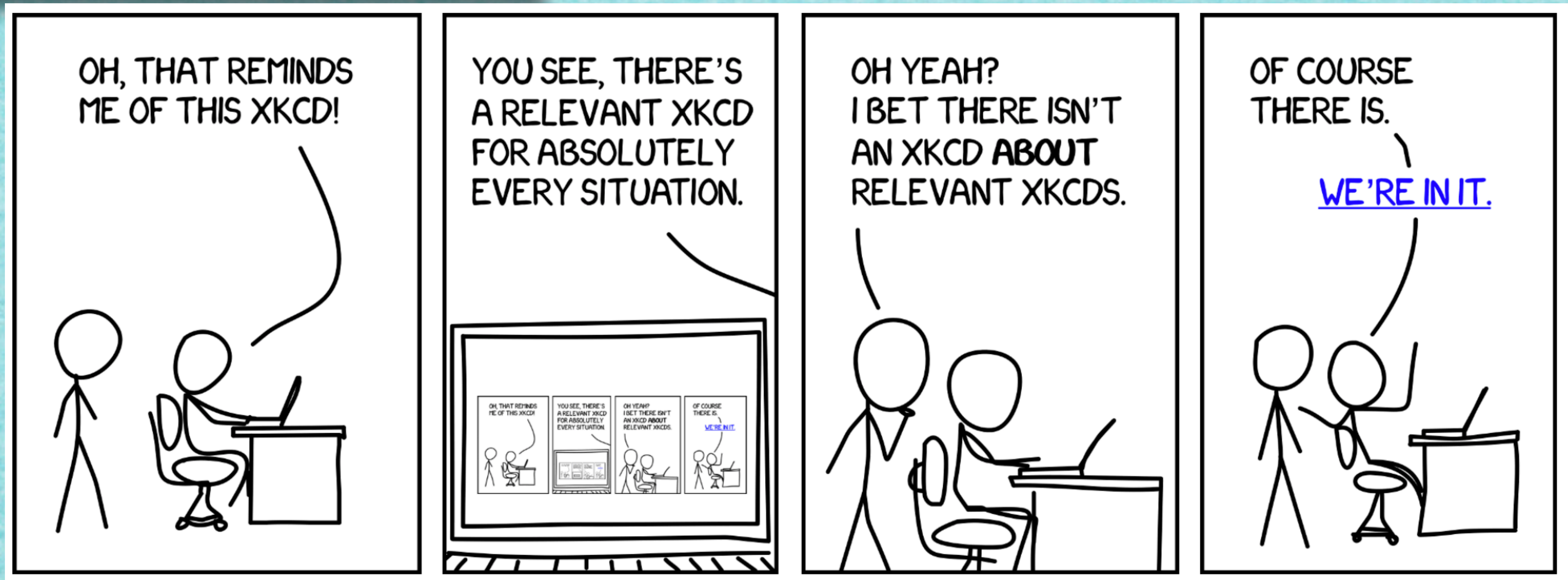

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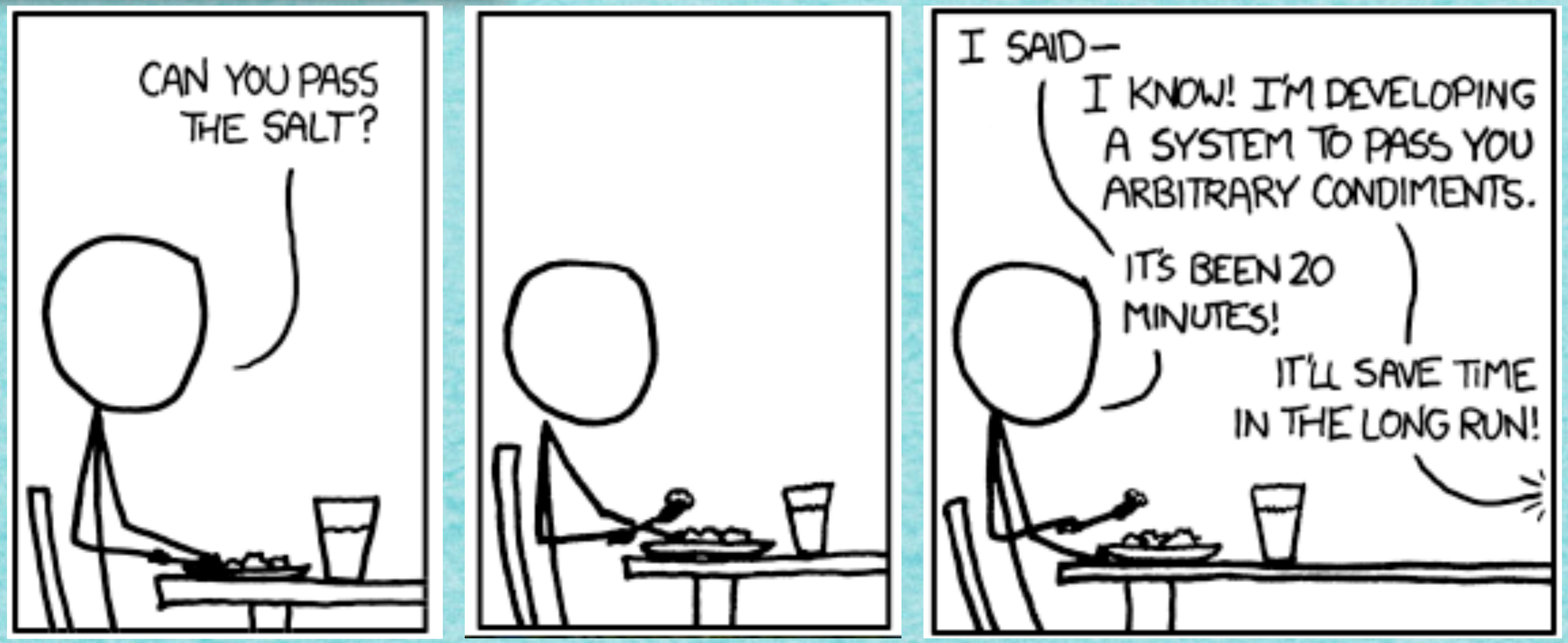

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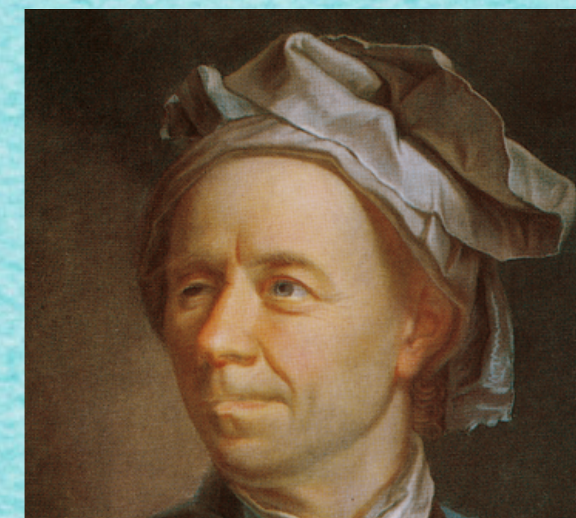

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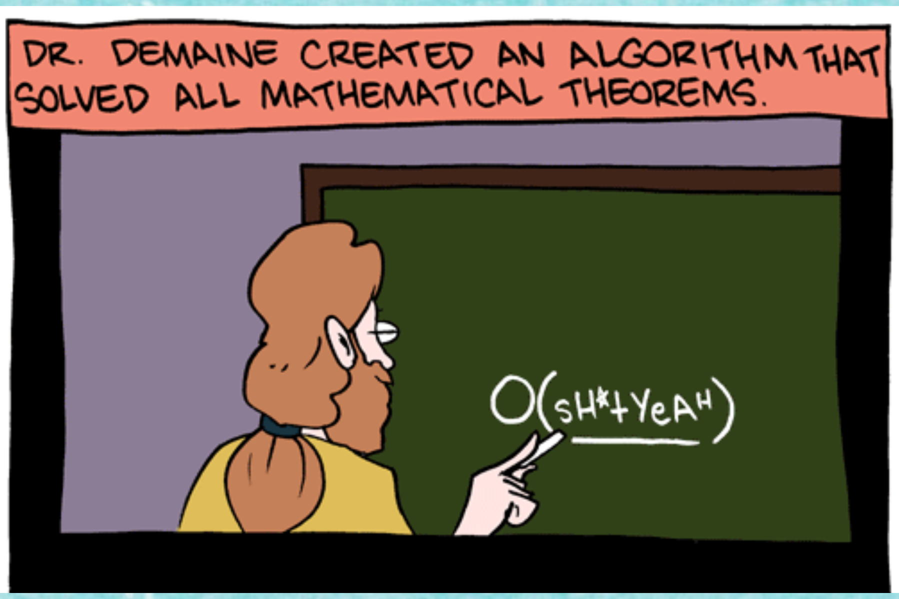
- 2005 Full Professor am MIT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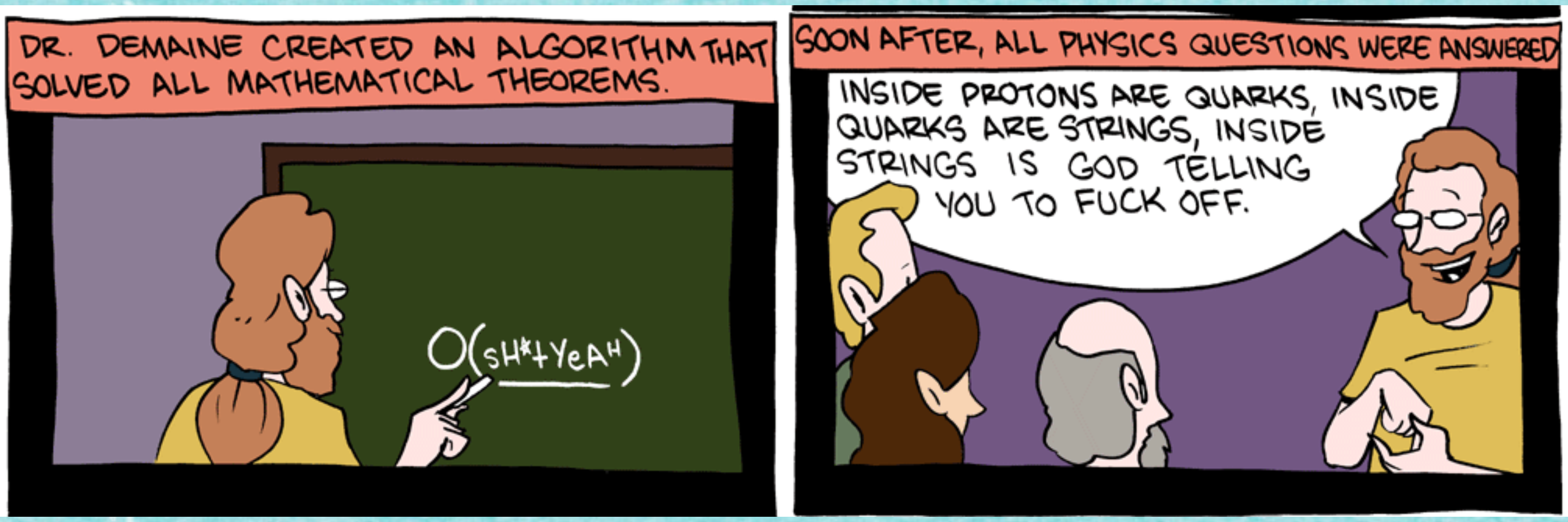
O(sH*tYeAH)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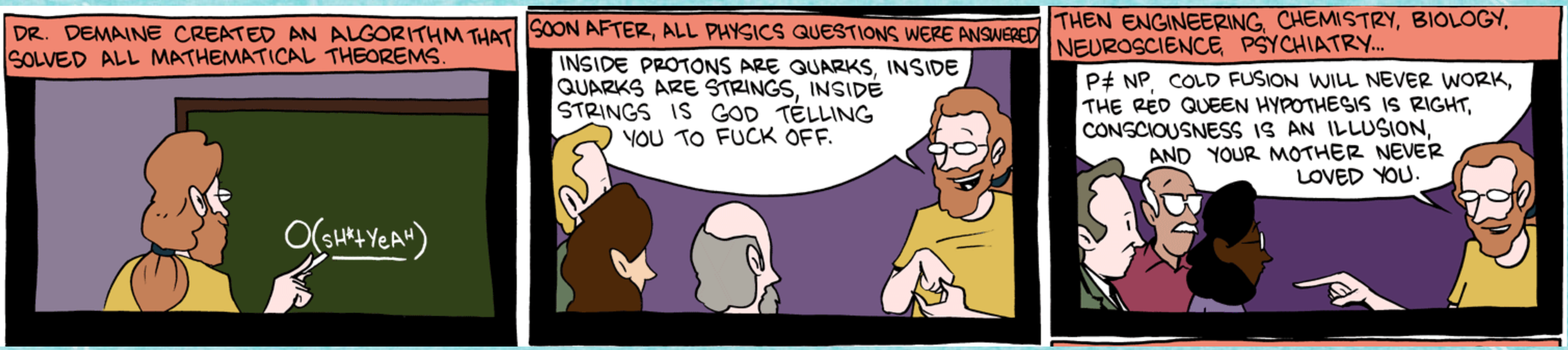
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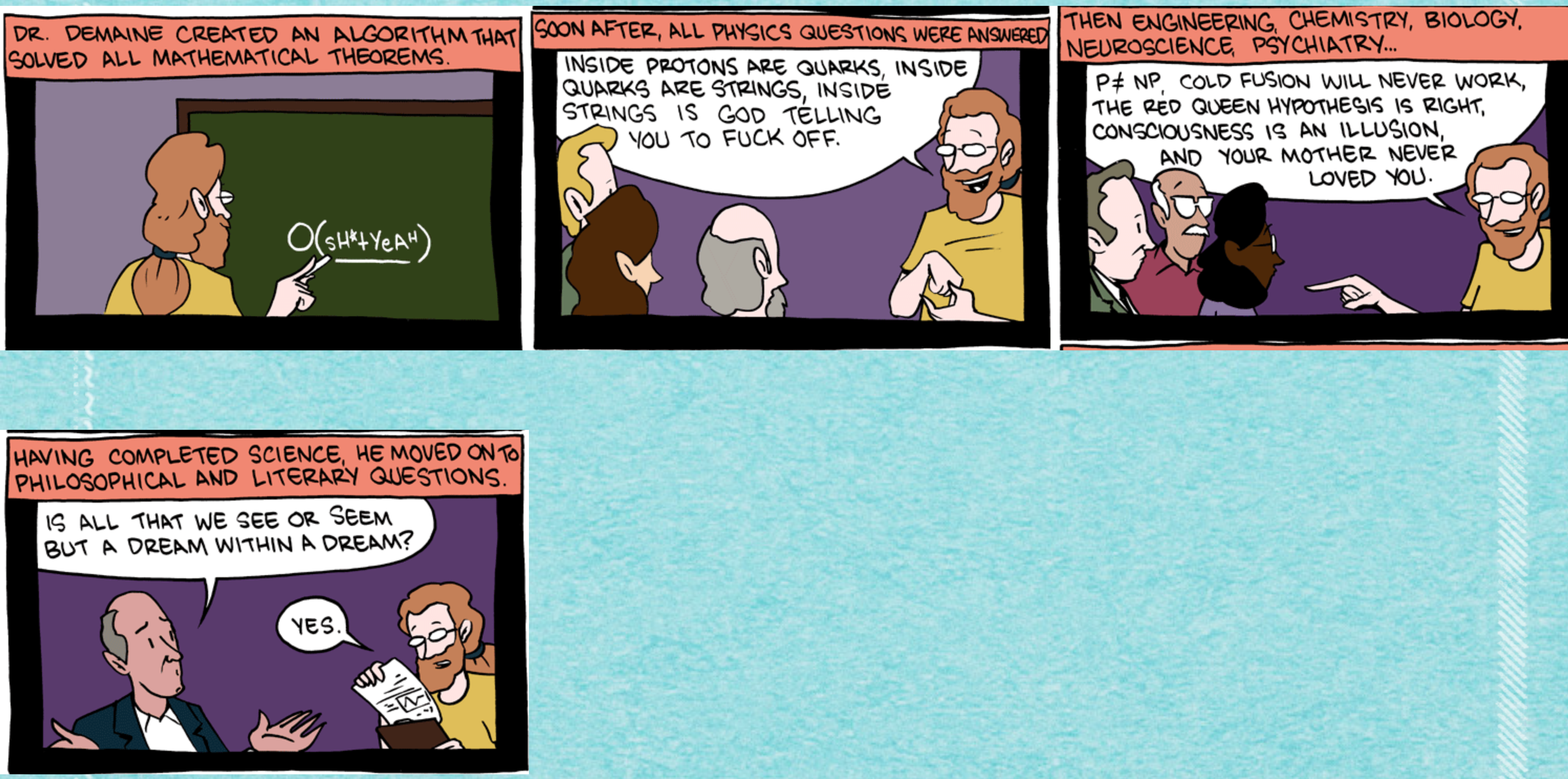
P≠ NP, COLD FUSION WILL NEVER WORK, THE RED QUEEN HYPOTHESIS IS RIGHT, CONSCIOUSNESS IS AN ILLUSION, AND YOUR MOTHER NEVER LOVED YOU.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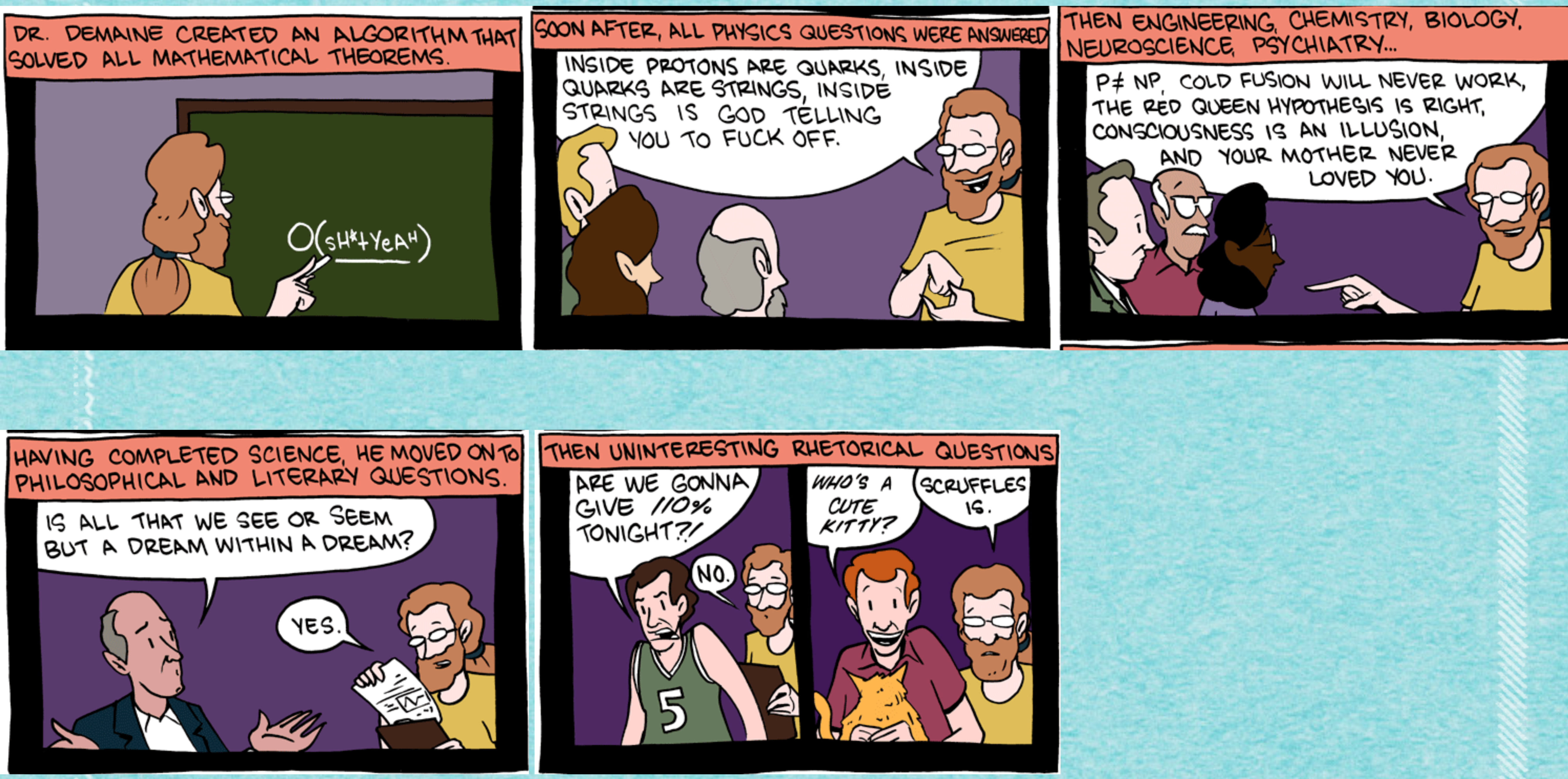
HAVING COMPLETED SCIENCE, HE MOVED ON TO PHILOSOPHICAL AND LITERARY QUESTIONS.
IS ALL THAT WE SEE OR SEEM BUT A DREAM WITHIN A DREAM?
YES.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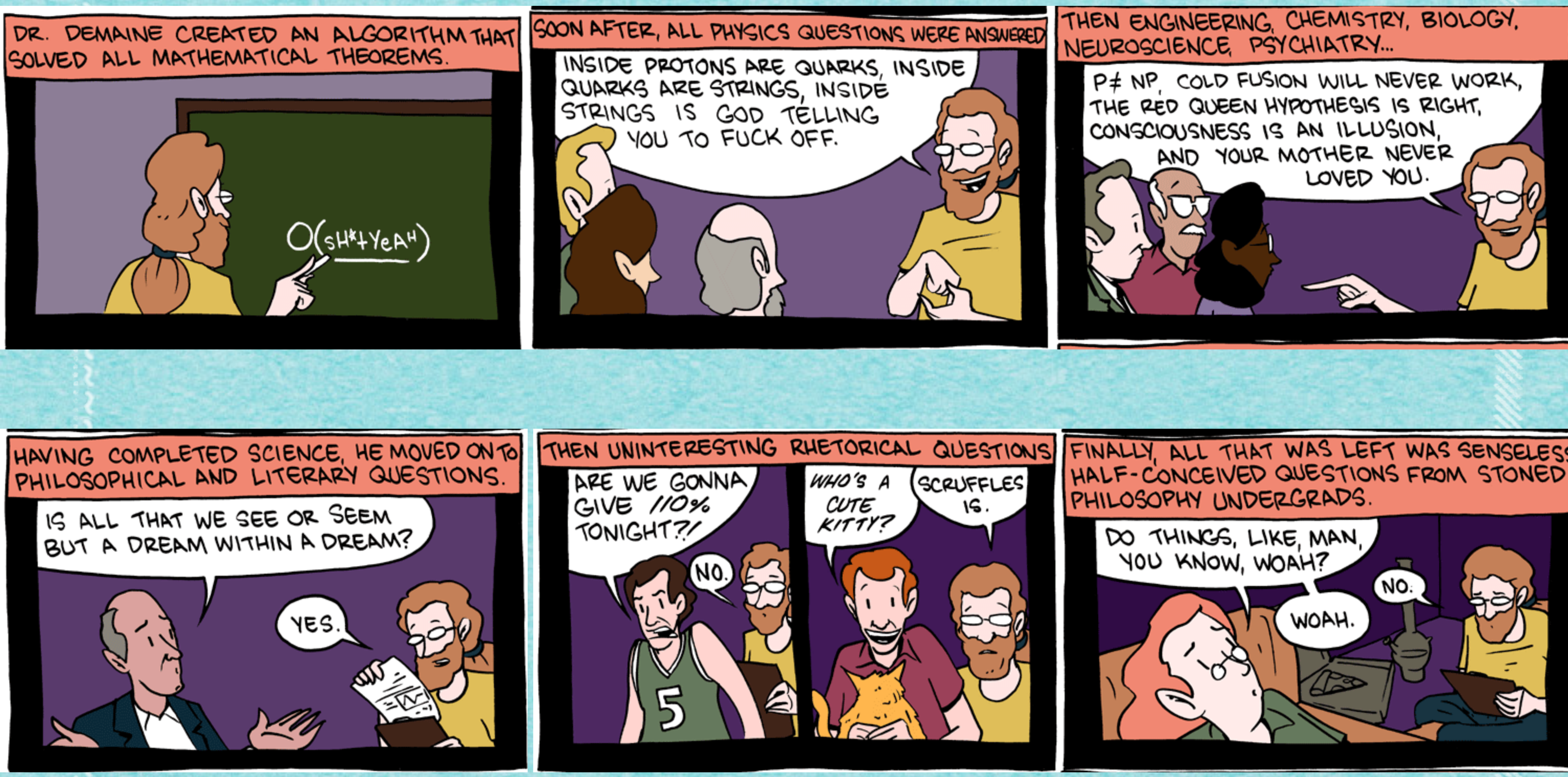
THEN UNINTERESTING RHETORICAL QUESTIONS
ARE WE GONNA GIVE 110% TONIGHT?!
NO.
WHO'S A CUTE KITTY?
SCRUFFLES IS.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ARE WE GONNA GIVE 110% TONIGHT?!
NO.
WHO'S A CUTE KITTY?
SCRUFFLES IS.
FINALLY, ALL THAT WAS LEFT WAS SENSELESS HALF-CONCEIVED QUESTIONS FROM STONED PHILOSOPHY UNDERGRADS.
DO THINGS, LIKE, MAN, YOU KNOW, WOAH?
WOAH.
NO.

ELSEVIER

Theoretical Computer Science

Volume 671, 6 April 2017, Pages 4-18

New geometric algorithms for fully connected staged self-assembly ☆

Erik D. Demaine [a], Sándor P. Fekete [b], Christian Scheffer [b], Arne Schmidt [b]

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Abstract

We consider *staged self-assembly systems*, in which square-shaped tiles can be added to bins in several stages. Within these bins, the tiles may connect to each other, depending on the *glue types* of their edges. Previous work by Demaine et al. showed that a relatively small number of tile types suffices to produce arbitrary shapes in this model. However, these constructions were only based on a spanning tree of the geometric shape, so they did not produce full connectivity of the underlying grid graph in the case of shapes with holes; self-assembly of fully connected assemblies with a polylogarithmic number of stages was left as a major open problem.

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Volume 93, February 2021, 101700

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