Ebola Superspreading Analysis

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2025-07-22

## 1. Load Libraries

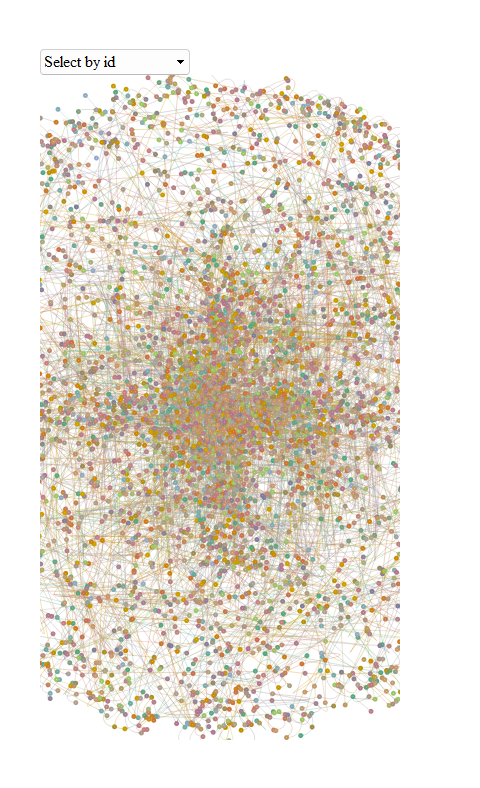
library(epicontacts)  
library(fitdistrplus)  
library(superspreading)  
library(tidyverse)  
library(outbreaks)

## 2. Load and Prepare Ebola Data

# Retrieve Ebola simulated line list and contacts data  
ebola\_linelist <- outbreaks::ebola\_sim\_clean$linelist  
ebola\_contact <- outbreaks::ebola\_sim\_clean$contacts  
  
# Create an epicontacts object  
ebola\_epicontacts <- epicontacts::make\_epicontacts(  
 linelist = ebola\_linelist,  
 contacts = ebola\_contact,  
 directed = TRUE  
)

## 3. Visualize the Contact Network

# Plot the contact network  
plot(ebola\_epicontacts)



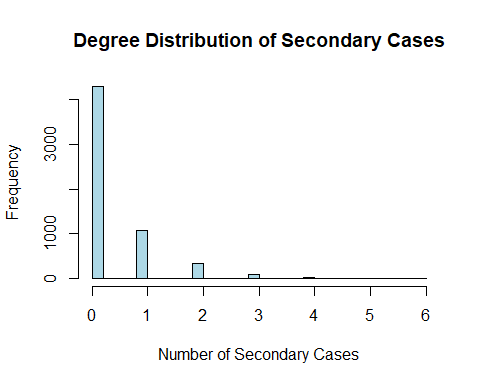
## 4. Analyze Secondary Cases (Out-Degree)

# Get secondary case counts (number of people each case infected)  
secondary\_cases <- epicontacts::get\_degree(  
 x = ebola\_epicontacts,  
 type = "out",  
 only\_linelist = TRUE  
)  
  
# Print secondary cases  
secondary\_cases

## d1fafd 53371b f5c3d8 6c286a 0f58c4 49731d f9149b 881bd4 e66fa4 20b688 40ae5f   
## 1 0 2 0 1 0 3 0 0 3 1   
## f547d6 f1f60f d58402 d8a13d a3c8b8 2ae019 974bc1 6a9004 72b905 b8f2fd 09e386   
## 3 1 1 0 0 2 0 0 0 0 0   
## 8689b7 6285c9 865581 5fe599 79ad06 9d4019 c43190 900021 102363 11f8ea dce5cc   
## 0 0 0 0 0 0 0 0 1 5 0   
## d4ff47 b8812a 4b38b7 f96aa5 893f25 be99c8 c29eb5 bc9ace 49d786 e7ee34 c4e706   
## 0 0 1 0 1 0 1 1 1 0 1   
## 76b97a 5ed02c e02f66 bd8c0e 0445d8 d0523a 47a5f5 4b9ead dae8c7 9e0998 ac6fdf   
## 1 0 1 3 0 0 0 0 1 0 0   
## 566f9e acf422 275cc7 56d39e d2f586 07e3e8 133ee7 1a4ac9 7be92f 5387a2 96e309   
## 0 0 0 0 0 2 2 0 0 1 0   
## db4b96 1511c5 80663c 8a4580 968888 dbebea 369449 1d7c8a dfdf88 ab034a be6c4b   
## 0 1 0 0 0 1 1 0 0 0 0   
## 3680d3 f393b4 30c98c 30574c 5837cf 1389ca 7e95d1 788a99 2b8773 9f6884 e85785   
## 0 0 1 0 1 0 1 0 0 1 0   
## 2978ac 211b45 60f0c2 fc05c1 88f67f 8f227d 50adde 6fa4bf a3c50c d6f195 7b82a8   
## 0 0 0 0 0 0 0 0 0 0 0   
## e0fb09 9f5d3b 31b9f9 e61cb9 3002bc 37a6f6 57a565 057e7a 4cff96 be502d bab455   
## 0 0 0 1 0 2 0 2 0 1 0   
## 9ae2d7 fc15ef 2eaa9a 528572 e33327 a48f5d a6c614 8e104d 3ef3d9 c15f36 c97dd9   
## 0 0 0 2 0 0 2 1 0 1 0   
## bbfa93 02d8fd af9f9a 01fcc4 2ebf95 88eff2 c36eb4 47ebbc db5a62 bd14fc 922012   
## 0 4 0 0 0 0 1 0 0 0 0   
## 88a4e0 542d07 f50e8a 821030 70baad d36a83 9e74c4 3a7673 7b7f62 e4bee8 ae96ac   
## 0 1 0 1 0 0 0 0 0 1 0   
## 0082bf daddbc 589e9f 341efa f86ce2 2afc42 cd2dd3 3cf6cf df4951 7f5a01 920c1b   
## 0 0 0 0 0 1 0 0 1 0 0   
## 6c2783 61cf79 ddddee e33ec5 8940e5 c9e790 99e8fa af1c1f acbbf6 ea7119 c9bb92   
## 0 0 0 0 1 0 0 2 0 0 0   
## fdeb61 9f41d3 bc648d ec8ee4 ab78c0 8ea7f8 f81c5e 567136 c62127 e5ee23 797b15   
## 0 0 0 0 0 1 0 1 0 0 0   
## 0ae14e d9fce7 b799eb 0fb364 f648f5 dd20a4 fce46c 67184b f1d5e5 71577a 92b1ef   
## 1 0 2 0 0 0 0 0 0 4 0   
## 895618 b0c500 72a142 a6ff85 a8180e 43dbe6 f700ff 415e3a c2e83e afe616 eabb2a   
## 0 3 0 0 1 0 0 2 0 0 0   
## 5400a2 d33032 564653 df3a12 ceed40 9371a9 bc2adf e27816 aa2a57 8cd47f 9c688b   
## 1 0 1 1 0 0 1 0 0 0 0   
## 170473 d0dbe0 c57efb 3e6957 403057 188c88 f3881f 82c2d2 f15aec c2f1cf abd4af   
## 0 0 0 1 1 0 0 0 0 0 0   
## f0461f 569a34 a33e38 7fd086 f327be 959170 576d23 f531eb dec212 823533 1c1848   
## 0 0 1 3 0 0 0 2 0 1 0   
## 42e1a9 006e2f 90e5fe 8ebf6e 06fd73 542fcc f8318d 64c8ef 45a9ab 0b46a0 8c9de8   
## 0 1 0 1 1 1 0 1 0 0 0   
## dd9d20 e56412 66f2cd 3c09c4 6d788e 916d0a d0eead 835e68 c5f2fb f29067 8e776a   
## 1 0 1 0 0 6 3 0 1 0 0   
## 7ee3ea 67b897 a47529 cfd79c c7f0e6 eeadcf 704a5e d145b7 10eefc 2057a1 88306e   
## 1 2 0 3 0 0 0 1 0 0 0   
## 67be4e 188619 62a2ef 021718 d6867c 26c588 23b6a6 52ea64 da8ecb 92ab68 a42ade   
## 1 0 1 1 1 1 0 1 0 0 0   
## 148f18 4c1040 0cf4fb 401e94 989ed6 7f153f a9feb3 d6584f 58b968 f36729 f81362   
## 0 0 0 0 0 0 0 1 0 0 0   
## 1cf6fc fe06e6 f9e20a 7a17c7 6670a5 2cb9a5 9db018 3bcd28 02db47 31467e b408cb   
## 0 0 0 0 0 0 1 0 0 0 0   
## 386dfb def13f fd2ea2 bc3392 342b03 f5c142 3f5a00 3ad520 700448 a05efe 0e6834   
## 0 0 1 0 0 2 0 0 1 0 0   
## 2390e8 ce4ec6 92ddf7 886626 69446e eae3e8 c76676 b6237e 7ff746 51b8e2 7e3dab   
## 0 2 0 0 0 1 0 0 0 0 0   
## 70a9fe 1f1620 ac683a df7c34 0b7666 9b8ec4 ae50c8 062638 9735dc 917506 baacc1   
## 0 0 1 1 1 0 0 0 0 0 1   
## 8d11a4 2a2ca0 36f228 896214 171c5d 583717 781b3a 38d740 90dc67 2894b2 c2595d   
## 0 2 0 0 0 1 0 1 1 0 1   
## ded352 158459 ae4a36 f5e184 51cf15 b7641e 0a9827 2ed605 770e5e 0277c7 b013ab   
## 0 0 0 0 0 1 0 0 2 0 0   
## 19e1d4 3db8ed 8637e7 9d69e4 1e1825 497372 9fcf61 06ccaa f77573 c8b7a1 174288   
## 0 0 1 0 0 0 1 0 0 0 1   
## 8a1feb 3b8407 77afbe c6d29c 60158e 44c12d d79494 23e499 db7b54 09a68f de1c99   
## 1 2 1 0 0 0 0 0 1 1 0   
## 1e26db 0cd7d3 4d9fa7 c5bc73 3789ee c8c030 14224c c5d4ec c71dcd 292db2 d2d95d   
## 0 0 1 0 1 0 0 0 1 0 0   
## 3546f6 b38db1 8c1915 792590 24f9d8 cb9e72 86845e 38cc4a cc7393 069ea8 d9f1b9   
## 0 0 0 0 1 0 0 1 0 0 1   
## 8188cd 6a3ea1 e71272 30dc63 1e061f 70e40f b6a6c7 0f5c6e 34cd90 8bfb52 01c442   
## 0 1 0 1 0 0 0 0 1 0 0   
## 62cdc2 085802 53f4ae b56849 316781 a81f7d 6b70f0 675f57 730b25 111d92 fb2536   
## 0 2 1 1 0 1 0 1 0 0 0   
## fd01de c03424 001ecc 13f887 b24bb3 422831 df2113 2b36fa 72bb4b bbbd13 1f8797   
## 0 0 0 0 1 1 0 2 0 0 1   
## c13247 b6c0ed 059cc0 ee65e4 e0894e d9e72d d325d9 517931 eea609 90360f 52f612   
## 1 1 1 0 0 1 1 0 1 1 0   
## 064dc0 68623f bd0983 1a9636 4b501e 6f8d06 b801a2 839761 30ed05 e0efe5 472fef   
## 2 2 0 0 2 1 0 0 0 1 0   
## 1d1d8e 9cd6d0 5c1d6e a41ea4 5b2dd9 64e8e6 42022a 5a782d 35ab60 c34e48 fc7155   
## 0 1 0 0 1 0 0 1 2 1 0   
## b18be6 df8dbb b2a4f5 9f0c37 571076 969b08 19bb49 e93b86 a5307c d49d6c 2d4c92   
## 0 0 0 1 2 0 1 1 1 0 1   
## 4221c9 ccba7c 5b1d5e 42663b 4ade58 f97626 834a39 6e3e1b 665aa3 82b823 281dd1   
## 0 1 0 0 0 2 0 0 1 0 1   
## 7d99f2 6dca26 aecc48 ce6c0d 579c1d 5bddef 8e6dc1 dbe763 b44247 1552a3 305a1e   
## 0 1 0 0 0 0 0 0 1 0 0   
## a2e5d2 267434 9cc857 8e455c 890447 82fe4d 75ba0b c2b809 92e129 034a98 590dc9   
## 0 0 0 0 0 0 0 0 2 0 0   
## d6a409 e13621 426446 29ea50 2999ed 866488 06e8de 332efa fc969c 5037a5 699cea   
## 0 2 0 1 0 0 0 0 0 0 0   
## 108b95 6207c2 4fc4c3 18f408 ba7db9 babc2d 6963ab 7c056b 0e705a a4da16 74bfe4   
## 1 0 0 0 1 0 0 0 1 0 0   
## dab5bd a2b14c 27adef d8c398 a8214f feea26 582196 d5f3c0 c094f6 a905b2 3d9364   
## 1 0 0 1 0 0 0 0 0 1 0   
## 8dbd02 f9e3c4 ad3141 01230c 00dd75 f750fe c9e824 a40341 1bdf6f 5c3fb4 bbdbda   
## 0 0 1 0 0 0 2 0 0 2 0   
## 55f73f fa058c aeee08 096455 bb360f 21dc16 38d7b2 83b446 e15861 c41648 e5935b   
## 0 0 0 0 0 1 0 0 0 0 0   
## bd5a25 818a12 f13395 d66413 eb0e7c 46e52d e01b69 469367 4178d1 2965bd b03473   
## 0 2 3 0 1 1 0 0 1 0 0   
## b8fe69 7d8f6b af9abd 6c1669 c96992 c9fc3d b016e0 f36b95 ef1f68 a005bf 3e7820   
## 0 0 0 0 0 2 1 0 0 0 0   
## 4a5d1a 2cfb2f b3f687 46ba9d 8b4b24 d75fe5 d2ad03 90d7c3 eaf447 d8e8cd 3c3367   
## 0 1 0 0 1 1 0 0 1 1 0   
## d2be27 6af269 c8c4d5 828cdc 5f8013 93bcfc 8898e5 264472 bdb1a2 fd7cfd 8e085c   
## 1 0 4 1 0 0 0 0 3 0 1   
## cdc233 c5a328 d6c6fa 337df1 2c7786 baa64c 9a9a84 3ee0db f87eb8 46eae7 2feb68   
## 0 0 0 0 0 1 4 0 0 0 0   
## 44de7a 9b2957 088b66 a94c67 ad8c07 a674c8 174e87 92d002 f7957d 2746fe 88632e   
## 0 0 1 0 2 0 1 2 0 0 0   
## 3f8c8c d3da33 f65235 7276c8 240da4 c4c05a 5cbd2f 4618c1 2763fd e9c49d a6c499   
## 1 0 0 1 0 1 2 2 1 0 1   
## 7d25a6 0c7a9b 2416e5 f06a8a 2d864d 68caa7 c6d726 a3a599 a182a5 564652 890de4   
## 1 1 0 0 0 0 0 0 1 1 1   
## f830d5 6856f4 3dcaaa a4e1a8 034b46 659025 49e2eb cd76e0 f8ab8f 640da5 655d6c   
## 0 0 0 1 0 0 0 1 0 1 2   
## 08fa30 c63d35 92ac32 0fc866 63bc2e 8ebf51 37d5ba cc71ea 948d51 94144a 7b6a3c   
## 0 0 0 0 0 2 0 0 0 0 1   
## 7a84e1 c94b98 840a9a 6403bd 9f9fd5 cf6c0e 9ba10f 544af7 7b7d83 3bbcd7 320198   
## 2 1 2 1 0 2 1 1 0 0 0   
## 3c0ca7 91247c cb451c 6ca927 68f4a0 a5f628 3de974 c3ba87 e8c235 9849ee 754429   
## 0 0 1 0 1 1 0 0 0 0 0   
## b3f614 ffe2ec 875dd1 13bc7a b2333b 6696ec 1eb9b6 3f5fe1 1aa3cf effb9d 568050   
## 0 0 0 0 0 1 0 0 2 0 0   
## 7b46ff 374fb5 563994 e8c88c 294457 d11927 e596ab 4fb46f 9d70c3 d24787 6a87ca   
## 0 1 1 0 0 1 1 0 0 0 0   
## 932c54 a52437 322dfe e444ca e7dcdd 269ddd f61980 cfae3b 036b0d cb48bf 7f8dd2   
## 0 0 0 0 1 1 0 0 0 1 0   
## 5faceb 5c5a0e 2abc5b 0223d3 47d0b3 7a7629 9ef8ed c53f9c 198a37 bb2398 10b627   
## 0 0 0 0 0 0 0 0 1 1 0   
## f51a50 3f3a40 2e9570 884f1c 18a089 2591c9 4753ca 9c8045 32118a 8b33bc 86b3df   
## 1 0 0 0 0 0 0 1 0 2 0   
## defa28 32c4d7 e12efa c1eb6f 2f2ebc ad2c76 31b710 2d42a8 3d26f2 305c08 ed1033   
## 0 3 1 0 1 0 1 0 2 0 0   
## 2b73f4 c86866 5f5f78 c5caa6 ab27c7 480eea 63618e 55d542 141102 86d2f0 3457f6   
## 0 0 0 2 0 1 0 1 1 0 1   
## d73b9d bb299f 96a12a 20b07b ed3983 265c28 839951 d3907d 0f7452 d8e226 31cd66   
## 0 1 1 0 0 2 0 0 1 0 0   
## 31e797 573a83 9eed85 c432cd fc674d 70230e 0afd15 b3c066 09b61b 75a20a 12d3e5   
## 1 1 0 1 2 0 0 1 0 0 1   
## db97c6 a17a22 55d2a7 47eb8b 6e3dfe c1bb8a 0a07b5 3c5404 f2e84b 63610a 9d20d6   
## 0 0 0 1 2 0 0 1 0 1 0   
## 31b6f4 eeee61 c44cba fa03ea e6d478 97c128 607956 ac760b bb791f ed514e edc86c   
## 0 0 1 0 0 0 1 0 0 0 0   
## 9b4647 6f045a bec959 2da0cc 64f737 7801c6 0ec3fb de6cfc d29e8c 2f862f 56a617   
## 0 0 0 0 0 1 1 0 0 0 1   
## daec42 378436 1234bb 3dca80 61c40f 911db7 805ca4 3f590f c42468 6647f1 544bd1   
## 1 1 1 0 0 0 0 0 0 0 0   
## c68c23 d7a0dd 852f36 9df68c 944fd9 a5a004 ea2955 5abcf9 e0c344 314c66 fd9e03   
## 0 0 0 1 0 0 0 0 1 1 1   
## 212254 ab06a5 28eea4 a38384 7f1332 b5c984 e7f655 0c97ee b06702 b3203c 3fa147   
## 0 0 0 1 0 0 0 0 0 0 0   
## aa3c55 d7a110 2b34d6 8de0e7 352520 be8b45 0bd916 e8bcf6 9f9725 98992e 9854a5   
## 0 1 1 0 2 0 0 1 0 1 0   
## fcd62f f72284 9acb86 034082 c10877 635fd7 b694b3 e90722 61fcce ba0bd3 1f954e   
## 0 0 4 0 0 0 0 2 0 1 0   
## a11d21 bcf93e a4f245 ce9888 1d9907 fa8d63 9b2315 3f7c0b 145445 8bd455 8f0055   
## 0 0 0 0 0 0 0 0 0 0 1   
## ecd845 5c8ec9 0d315c cd38d3 7e2732 e898af a759b6 2463fc 5ab9fc c1418a 3efdc1   
## 0 0 0 2 0 1 1 0 0 0 0   
## 67fa5e fa5e64 6a9bcc f62965 cc9f7b 88f8aa f775f4 c0bd90 f137aa 111ca6 1ced59   
## 0 0 1 2 0 0 0 3 0 0 0   
## c1ff7b 7d0678 e6982a ce13e7 213d39 3c5666 f0251f 42086d 270603 cb7ca3 cf4399   
## 0 0 0 0 1 0 0 1 1 2 1   
## 723d2e 9ae82c d50b21 840043 a3b42e f733a0 74f85d 56ceb5 61fd0a bdeb35 9c7fb5   
## 0 1 1 0 0 0 0 0 1 0 0   
## dc67b4 96ef04 5eeb7c f71019 2b281d ff00a6 7938cb 0c7850 9ab208 793d75 a67d8e   
## 0 0 2 1 2 0 1 1 0 0 0   
## cccca6 953cbc 597f6e d9fd28 ad2bdb 3749ef 0c7e8d 09a876 e3278e 672ab9 74bea1   
## 0 0 0 0 0 0 0 1 0 2 0   
## 9a2d0d 61751f c899b0 fcaf3f 05dc7d 7633ea 0755ac bd7b50 9bb8bf 5a792c ce64f7   
## 0 0 0 0 0 0 0 0 0 0 0   
## 187c24 cfed8b 6133b9 0f10f4 cf428f 469e19 a26cae 6bf085 15e738 8d7580 707f4e   
## 0 0 0 1 0 0 0 0 0 0 0   
## 660b34 511f56 eefd21 ed5a66 f08f3b 49e88d c939ba 730684 aebdac 40ecd2 fd4dd4   
## 1 0 0 1 0 1 1 0 1 0 1   
## bf4da8 ff9ddd 95c347 01b1fd de5eab f59fe2 ae0163 9e7f2c 5f8f6c fb1e59 769af3   
## 0 1 2 0 2 0 0 0 0 0 0   
## 8426e2 f1a689 4bb524 627db7 21689b ddd916 6a007d c1a925 444590 858426 cc7360   
## 0 0 0 0 1 1 0 0 0 5 1   
## 77eb09 09915f 181506 ee82d4 41a390 f90030 b9f2e5 72ea9c 994861 0df8bd 151773   
## 0 1 0 0 1 0 0 0 0 0 3   
## 3f8c71 ebb14f 16dcd2 926639 b02c4a 5b6630 eb9efc c35e20 eb7d13 ade678 751025   
## 0 1 0 1 0 1 0 0 0 0 1   
## af25ae 9bfc0d a51e77 0adb7e 8b1029 a84993 a3b05a ab2418 8897a6 18ae3d 83e5cd   
## 0 0 0 0 0 0 0 0 0 1 0   
## 9c244a 508984 f42008 e9c422 52735e 928154 cdbbfd 59ec09 74f64d 0fde59 e547ab   
## 1 0 0 0 0 0 0 0 0 4 0   
## 64a537 bbf32f c4408d 0fe585 027e28 b4bb29 45d75d 363c80 f4bb37 6a5996 0c69a9   
## 0 1 1 0 3 0 0 0 0 0 0   
## a8a69f 8939e3 ee70dd 552efe 9e2fb0 ffb30f 407e7e 1154b1 04041a efe8f2 897945   
## 0 0 0 0 0 0 0 0 0 0 0   
## 04935b 0d8d9b 8fedec ca1223 b151c5 2dbecc c3ada1 13f839 3c9b29 ffb2d3 8d80da   
## 0 0 0 0 0 0 0 0 0 0 0   
## 982559 9feec9 93bb41 08bf40 770220 5faf51 59c557 504452 83d537 45042d cd182c   
## 0 0 0 1 0 0 0 0 0 1 0   
## b04d23 c6a69c b48f8f 628fbd d4df19 cad2c1 2f8552 ee5bf1 41d1dc 215cee 7c6980   
## 1 0 0 0 0 0 2 0 0 0 0   
## 112c9b 4e27f5 66e4e3 7f62e6 d0288c ac22bf 5a54ea e256c8 6e9925 32f781 aaf754   
## 0 0 1 1 0 0 0 0 0 3 1   
## 464b83 8947cf 1bc942 87f699 098ddf 303b01 3b998d 0e7ec8 3c7205 cbbbee 60fa80   
## 0 0 0 0 1 0 0 0 0 2 0   
## 318947 4af758 7b9afb 2a812e d05c48 fffa4f e8ffa5 9b5dec 0620d9 b56d86 ed0554   
## 1 0 0 0 0 1 0 0 0 0 0   
## 5154ca c9783b 0abbab b1c664 2193f8 4cd617 44d182 db38e1 7acd6f e4af66 f027f8   
## 0 2 0 1 0 0 0 0 0 0 1   
## d5d56f e3d90b 8ce67b 10ae4c 6cd9e9 f15ceb 056471 0c7230 282013 64b7b0 28429e   
## 0 0 0 0 0 0 1 0 2 0 2   
## 272fb6 67e509 c800a4 5a7acc 99bd62 7ce43b a8c00d ced945 53f02f 32d4ad 96bea3   
## 0 0 0 2 0 0 1 1 0 1 1   
## 8afd94 08382e 4b1adb 04a2cd a91508 8a6984 8c2e93 7839d4 3e93ea 4a17d6 5ea6c5   
## 0 0 0 0 0 0 1 0 0 1 0   
## eddc4e ab8deb f70e4c f0b93e a49172 3857bf 26aec8 fe2849 8d81ff eadc76 1961e9   
## 1 0 0 0 0 0 0 0 0 1 0   
## 474f41 51f606 93adc6 c3cd3c 00086d d6a852 9e495c a4a7ae d7c424 2ae08e 2786b7   
## 0 1 0 0 0 1 0 2 1 1 0   
## 3ae04e c37475 8c1837 39223a 81217a e6590f e4b6af 427cd3 3da144 4d87b0 48abb6   
## 2 0 0 0 1 1 0 0 0 0 0   
## f5ab74 b38ca8 1dcaff 734753 0d14a0 bd6ed2 830af5 d45263 fc57cc 89a628 914ad2   
## 0 1 0 0 0 0 2 2 0 0 0   
## c0c70a 09c9b9 f570e4 e13cd9 363eb4 b458e2 4288fd 268b99 add239 c1e533 70bcb6   
## 0 0 1 0 0 0 1 0 0 0 1   
## 9fc6bb 2e70ff ed1a0a fb76e3 85f0fa 0b2579 15d750 c1ee8a 54b10f d78767 c51f04   
## 0 1 1 1 1 0 0 2 0 0 0   
## b80a5a ee9a23 a7f48b 53d721 43dea0 8d2424 24ef7d a851f3 9fa063 58cf19 acca05   
## 0 0 1 2 3 0 0 0 1 0 0   
## 9f88b9 e61715 f18564 1c5a89 c40cd0 b2f5d7 bb7af6 f5e8d0 a23a64 d3cff4 da1f29   
## 0 0 1 0 1 1 0 1 0 0 1   
## 7c67f1 dc1027 b8346e 9711b8 a06123 1747f1 029202 27c07d 2667b6 7ea9a5 4a5f7e   
## 1 0 0 0 0 0 0 0 0 0 1   
## a5ea95 a0173e fc6146 c10e49 1a1418 c07362 670a0a bc0b51 8a0025 082607 8f6324   
## 0 0 0 0 3 0 0 2 2 0 0   
## 524eaf af46a6 f4a472 b050c7 7b51e1 862f64 82aac6 4cd1eb efa34f 7256ff 2937f6   
## 0 3 0 1 0 3 0 0 1 0 0   
## a190d3 d74499 6833d7 b52c9a eefbfa 47eaae 19d49c 14ff8d 271ca3 85d699 2eb309   
## 1 0 5 0 0 0 1 0 0 0 0   
## d43684 37c512 187a52 315f76 946a96 911ded 8e1819 414c20 52f06c 79f62b 09a0eb   
## 0 0 1 1 0 0 0 0 0 0 0   
## ee4030 420837 41b557 696e71 d07c17 c51081 512f7e 43b220 b49023 a6a35a 45e942   
## 0 0 0 0 0 0 0 0 1 1 0   
## 5b1176 f94a8f 1dffed e4511f d9f6dd 251fec f06e87 50076e 812492 0e1974 a10c6f   
## 0 0 0 0 0 0 1 0 0 0 1   
## 85c4bf 472b8b 0756b9 3d64c2 f0a4f8 c72be4 261373 363c6e e5cb01 fa9cc3 cddde6   
## 0 0 0 0 0 1 0 0 1 2 0   
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## 2 3 0 1 0 0 0 0 0 0 0   
## 7dacd2 35a38e 083766 2ae536 620d08 21c020 e55bce 25f3d9 2f29c3 9bc1ff 52c435   
## 0 0 0 0 0 0 0 0 2 0 3   
## 60838b 4d06ed fd9c82 e6f47c 6f5d6a d5091f cd9a93 29235d f1102e 1ea519 ef8b5c   
## 0 1 2 0 0 0 0 0 1 0 0   
## b255c3 7fd65e 2a3e15 bf302f 4d4af8 d26ed9 cbf70c f1d575 994fad 611f69 8d27c2   
## 1 1 0 2 2 1 0 0 0 0 0   
## 9368c1 e81e72 8b643c 56c3f9 fe852a 165731 927fb0 ec10ca f23f4e 457e24 68bd03   
## 0 0 1 1 0 0 1 1 0 0 2   
## 2512d7 e13eb6 567255 db5332 4b0f10 1411c3 04415a 3b0141 c06dc9 e1d798 09f73e   
## 0 0 0 0 0 0 1 1 0 0 0   
## 4704e2 7b6887 95c85f fc0d62 5bc984 a0bc11 8a79c5 e5998f 44163c 29734b b6f403   
## 0 0 0 0 1 0 0 2 0 1 0   
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## 0 0 1 0 0 1 0 0 0 2 0   
## 349ae7 5c033b 9e9114 28e4d3 5e95bb 23a93d 2ccd21 06da4f 846579 765861 1ae61f   
## 0 3 2 1 0 3 0 0 0 0 0   
## e0424f 08a632 7aa231 435e4f b1b252 68f609 816793 64ef8d 36391a 21e293 785e65   
## 1 0 0 0 0 0 0 0 2 0 0   
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## 0 2 0 1 0 3 0 0 1 1 0   
## 4d3855 0197b6 671f40 95a292 faf2aa ebe990 336bf0 4a985e ea5c01 1fd12e 78409a   
## 0 0 0 0 0 0 1 0 0 0 0   
## 76cf53 a23bee 050888 fbb2a1 cee3a1 a4d0d0 a4df9d 788d03 daa60c 898eab 62b067   
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## 0f4976 7f8471 9ed61d 03a7ba 5d6f13 af2f4a 08c2f2 097ab6 adf13f 7df257 156d44   
## 1 0 0 0 0 0 1 0 0 0 0   
## dbc17e 26b551 625d9d c4a7f0 f40f7b fcf236 8d58c4 752c63 a1365c fdfabb d7ff31   
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## 1 0 0 1 0 0 0 2 0 0 2   
## 056b1a 5ee95c da5cd3 93f42a b4671f 471584 5d2042 a9bd2f 13cafd b7cf2a 96d147   
## 0 0 2 0 0 0 0 0 1 2 0   
## d8b891 1e7b26 fb0976 bef7db e93394 dbfad8 10cb7a 73a653 c46e1a cf51e0 5fea67   
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## 0 1 0 0 3 1 0 0 0 0 0   
## e067e0 7d8ecb cd52c0 a6ed82 bdfe4b 1b85c4 51c325 0c4e4c 95b91a c6cdb2 61264e   
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## 32feca 51c203 9d0f57 305144 bb0230 f7b14d 5265ed 4cf5da 5a65bb 29dc06 9e2de0   
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## 0 0 0 0 1 1 0 0 0 1 1   
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## b8c40d 5114fe 0b33f5 26250e 919feb af4c4c 07a2bc 0dfe67 477506 5cc99a fe60e3   
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## c6a679 505c6f 6d3b3f c68c31 280d54 9da8ec 6032ec 9d522f 36e19e 114361 c5dd17   
## 0 0 1 0 0 0 0 0 0 0 0   
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## 0 0 1 1 0 0 0 0 0 4 2   
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## 392896 327213 416072 25bfe6 fb2c5a a52491 49a14d 745527 68aaf2 ebe2aa 80107b   
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## d4d8c4 1f3f18 dc1730 e97396 43915f a003a1 439526 e185f9 8a3c52 17374f 4d563f   
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## 1 0 0 0 0 0 3 0 0 1 1   
## 81e476 54bf32 8ed116 57db21 f37052 41323d a269e3 305fcc c2a34f a5f1d1 26b565   
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## f309db e39b8c 9a944a 640d83 451920 dd2889 ed373a 1f4955 f17c55 0e999d 39f4e0   
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## 5fe731 d0ff5f 02502c 3edb41 05f8a1 a4b72c ebe4df 4e7571 e98078 4029d8 60dbf4   
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## 4d9850 ec465b 6cf8ac 9df611 973351 237181 f2fc3f da9565 bb2f5e a7ca2d 0211d7   
## 2 1 0 0 0 1 0 0 0 0 0   
## 617373 9b61c9 1f1cfd 767320 a66fa5 a93984 66c2f6 a127a7 545b3b 95e386 b6ddab   
## 0 0 1 1 0 1 0 4 0 3 0   
## 136ae9 e6be32 254e90 5fa181 fe8345 baf868 10153b 20a1ec 579792 7c8fe4 6c1185   
## 1 1 0 0 1 0 1 0 2 0 0   
## ecb1de e278e6 039299 e0a4cd a5d3bb 1a4d67 47872e f64442 b48c42 00612b acbf49   
## 1 1 3 0 2 1 0 0 0 0 0   
## aa2c15 45117a 717b92 471fd7 65f435 c45a92 9f9bc0 1d6ffd aa3701 aae55a 96a73e   
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## f02cb8 2a3578 8e5bba ed6805 2456a8 68abab 312518 cfdcd3 beec14 227baf 47b89e   
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## 33da93 c2ae34 04ebc8 441130 4e54ad a2b371 e0ac78 19374d 7ca4c0 2a25c6 318ea3   
## 1 3 0 0 2 4 0 1 1 0 2   
## 8905fc dcea0f 351e27 1dcf17 a44c7f 796c7c 203a9e a95dd9 9d197f fd6a50 e36e1f   
## 0 0 0 0 0 0 0 0 0 0 0   
## 724b24 eb51dc 6be1fc 140f9e 3724e6 21089f 6f0149 ab6e76 bbefb9 c2a1ce a2df92   
## 0 3 0 2 0 0 0 0 0 0 1   
## e61c07 08877f 127ae1 0e6823 ce1a9f 14b1c5 847ead 827491 ed507f aba6e2 fef2b4   
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## 7632dd 26d162 747ece 37e101 2adcc8 595529 bb1899 4b1a88 856abf 2b6134 4360db   
## 1 0 0 0 0 0 0 0 1 0 0   
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## 9cd0c9 c3f82b e6b3fa a77514 ba66a6 47dfcd 8ba52d 2d1aa7 89de0e 76a4f9 a32a1b   
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## 7a1964 979ba4 ca5478 e0669c 54f524 8bf53d 7f3916 8e5f6d a6cbbc 3c498e 30b41e   
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## 5e1c71 07df1a 8a0cb1 52d564 15b0f9 306557 5e9cf3 464ebf ac8a1d 022e0b f5bff6   
## 0 0 1 0 0 0 3 0 2 0 0   
## 7a7df9 969195 e8a7e7 a33434 10362e d4549a d17f34 3a4372 27ff7a 8e106e 2bf2f3   
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## 84c751 0a9c74 f044b4 0b5ad0 ee177b 5c796b d33dc6 474608 992ff2 d00e49 db564d   
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## d81314 217b74 a22ee3 616a17 f85d5d 4a9b27 fc9869 d335b4 d8ff1e a46d91 fd960a   
## 0 0 0 0 1 0 0 2 1 0 1   
## b934da 130e2a 82d4cb 3b925b b3860b 35ada6 b59de2 c75eac 7a590d 80a84a 5b0184   
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## 2d469a ab7dc1 af18c5 11939c fe2e5a edf379 764d43 d582d0 aac953 229914 7c39f5   
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## e466cc 71adce 2d0f27 9a1d89 998786 f8633d f03e2e 67bbe8 9d515f 7f82f3 cc9a2d   
## 1 0 0 0 0 0 0 2 0 0 0   
## 721b5b 546037 8ec7e8 366494 133f77 6ad9f7 808597 26615a 176b73 50fb75 96f892   
## 1 0 0 1 0 1 0 0 0 4 0   
## c94f47 b502c5 686293 686738 efaaed 8c8cb0 d53b99 9cd79f b5fe63 9a889e d24777   
## 0 0 3 0 0 0 1 0 0 2 0   
## 5224aa d5b8b2 8968ee 5721f2 deed70 b30365 75d401 72b4aa e74721 2349f6 5a7920   
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## c9c621 72f036 b62313 e42e33 ba2431 2d7ae3 36177d 158b05 cfbd0a b7cc75 c8aa5e   
## 1 0 0 0 1 0 0 0 0 0 0   
## 9c6ca0 7938aa 49ecbd df052c a1c20a a0aa88 f1292f 3b9e24 445b55 013436 c8fc59   
## 0 0 0 0 0 0 0 0 0 0 0   
## 6937f8 263041 5355c3 5439ab 7a094b 05c075 d07161 8d09f3 05d68d 5b6843 c17eda   
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## 216a1b 41fa1e 4545c9 456f0f 2f05b5 b1f49c 05067a 7cf540 33f478 a1d509 db9dc8   
## 0 0 0 0 1 0 0 0 1 0 0   
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## 0 0 0 0 1 1 0 0 0 0 1   
## f4c88f df0c06 882b62 7ee824 bd033e 954a8b 6bc802 0687e1 473f30 320c06 c18e5f   
## 0 0 0 0 0 1 0 0 1 0 0   
## a430ad 8e65fc 1101b1 8c3a73 37262e 8f5a90 da99b7 c24c42 1f4b5e 6b7905 da5f22   
## 0 0 1 0 0 1 0 0 0 0 1   
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## c23f01 597f17 8399fe 01dad0 9be9f0 78fbe1 d62ad7 b80e39 a14835 df37cf b326fb   
## 0 1 0 0 0 0 0 0 0 2 0   
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## 1 0 0 0 0 0 0 4 0 0 0   
## 159dbe 171f70 0120b9 6cc65f 7ca88d 5da423 a986fe 42c23b 6c440c a2a82c 79b312   
## 0 0 0 1 4 0 0 0 1 1 1   
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## 725dc1 8cea01 82486a c31a53 216c70 9f84d7 07d12e 25d635 96c70a 9e438b 18cb55   
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## 0 0 0 0 0 2 0 1 0 0 0   
## 3f4696 90dd40 b56b84 7cbe2e d5ef6e aedcdb 7980f0 92fc4e ba6491 24e5bd 3d63de   
## 1 0 0 0 0 0 0 0 0 1 0   
## 7ffacc cbce06 d6d8d0 090d77 1d662c 134e88 b0059b 55addb 61f671 3334d0 dbc8c4   
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## 5cadcf 1fe8ce a1e166 087daf 2e312f 657880 5dc8fd dab451 3e1e8d f32857 f2a707   
## 0 1 1 0 3 0 0 1 2 3 0   
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## 0 2 0 0 0 1 0 1 2 1 0   
## 3eb7a7 766d3b c3c129 532394 40a505 b8bd29 2aedd6 8bd6ee 499dad 24cca5 8f7522   
## 0 0 0 0 0 0 0 3 0 0 3   
## a8be18 37789b d02a8f 9a0ec7 8fcead bd6ae2 7f1314 e7d420 4ce742 866ea2 0563d7   
## 0 1 0 0 1 0 2 0 1 0 0   
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## 0 0 1 0 0 1 0 0 0 0 2   
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## 0 0 0 0 1 0 0 0 0 1 0   
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## 0 0 0 2 0 0 0 0 0 0 0   
## f6c560 8202a8 7ba3ff 1b1958 e8bbf8 b0fa52 d083bd aa7ad1 db3c10 c39d06 2955ba   
## 0 0 0 3 1 0 0 1 0 0 0   
## f6cf40 f4f203 1ee9ac 7400b3 18399b e6ea96 217fe6 2ce30f 3ca785 beb534 44e1df   
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## 0 1 0 0 1 0 1 0 0 0 0   
## e8da84 bfedf6 32711a d72009 f8489a a4812b ae27e9 6bcb8a b345c5 8a06eb 749559   
## 0 1 0 0 0 0 0 0 1 0 0   
## b9b671 121e5b 479c75 777761 2003a1 9b2b8f 021ca8 c9eb1f e1c081 02d21b 08a5e0   
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## 6d1191 0406d7 433862 953e83 0ac325 0be051 731a9a 420b88 15cd11 41f5c5 aa33e2   
## 0 1 0 0 0 3 1 1 0 0 0   
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## 1e017c cc5abd ffaebd eca3d5 cb45ad 608039 81fcc9 3a96bc 6a37d9 874378 842e45   
## 3 0 0 0 0 0 0 0 1 0 0   
## 7a5936 818a86 b3f116 4f3db1 4f4264 da8432 2e3e18 5dc1f8 a55830 18b45d f66f72   
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## 0b0502 5b4020 fd9d9a 0e9eb1 b48b63 bb40ed 6b53e9 7174dc 24e36a 63f7af e11d3a   
## 0 0 0 1 0 1 0 0 0 1 0   
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## 0 2 0 0 0 0 2 0 0 1 0   
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## 0 3 0 0 0 0 1 1 1 0 0   
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## 6c4792 63ef14 879126 ca5f7a f87828 c5d735 93e068 9e3394 ea88e4 e9eab9 9653dc   
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## f68db4 f16c92 ebe5ff cc7c6a 1cab44 cf7ef4 0f2991 0c6a2f d92e21 7291ba af1997   
## 0 0 0 0 0 0 0 0 0 3 0   
## fa8529 dfcfa3 561cdc 99e1a5 98bf9a 075855 0ae2de 9d8358 43fb82 56cca2 b37ed0   
## 0 1 0 0 0 0 0 0 0 0 1   
## 10cae2 63be3a c41075 cf1cd3 b613da ece4f9 7be7b6 e59fa0 d9e5bf 47aa13 1b6f79   
## 1 0 1 0 1 0 1 0 0 0 2   
## 795410 c0967d d44890 f088b8 93be1b 55a837 65ed43 da5d58 f8cd8f e283cb 318295   
## 0 0 0 0 0 2 0 0 0 0 0   
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## 0 0 0 0 0 1 0 0 0 0 0   
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## 1 2 0 0 1 3 1 1 0 0 0   
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## 0 0 2 2 0 0 0 0 0 0 1   
## 5a31a5 ca2688 cb38a4 d01454 a35667 da5e7b 6ef35b 5cf6ac 702fa9 172614 14dcc9   
## 1 0 0 0 1 0 0 0 0 0 2   
## 904f64 e48c67 de2f3f 4231b0 61f3ae b24dc8 722b68 503cad ebfc5f e5cce5 04f823   
## 0 0 2 0 1 0 2 0 0 0 0   
## e9c263 1f7a60 cf357f 6a9f62 d60bc8 87713c 76b7b3 eb9fd2 626a3c 99d5b7 36d4b5   
## 0 0 2 0 0 0 1 1 0 0 0   
## c1d878 6056ba 5dcccf e7eee2 ce86cc 987c1f a747f4 7180ae 169ce2 0a2d01 75da44   
## 0 0 1 0 1 0 0 1 0 1 0   
## 6ba40d 240dd1 6877f8 80fd79 9a2286 b63de1 bc2924 156665 e78ac6 df931f 771728   
## 0 0 1 0 0 0 0 2 0 2 1   
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## 2 0 0 0 0 0 0 2 0 1 0   
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## e642c5 1b46f4 668458 2b8990 1df3c0 b5e2ec 136869 35e767 96c2fe fc8149 c5c04b   
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## 0 0 1 1 3 1 0 1 1 3 0   
## f9fed8 446c5c 9ad9f1 5f3457 07c4ad 98c40c 1901ec fccbd3 a4abee dd9011 2eb14c   
## 0 0 0 0 4 0 0 1 0 0 1   
## 3a36b5 17948b 5b6cdd b69767 b9a31a edf907 278880 6baf4d 1329a6 ad57b6 0b9f56   
## 0 0 1 0 0 2 0 1 0 1 1   
## a93d55 37812a b70d1f 1ed136 e666e2 d282b9 74e599 1fa5a7 6e0760 16b50d 684fd1   
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## 94b6ac 8a839c f036b1 770761 69c029 f1b281 c0aeb4 0762c8 8bce15 77c5fc 1c2447   
## 0 0 0 0 1 0 0 0 0 0 1   
## c2a904 c3ad0d db9a83 740dcc 6bc3c5 915acd 3a314f a61e66 30bda7 960948 526e8d   
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## 689cc9 c80572 2d5aac 443ded a7634a 5aec1f aac55e 318954 2a61fd ba831c 381ae1   
## 0 4 0 0 0 0 0 0 0 0 2   
## 9b3ec6 a98246 7c4fcd 655168 6a18e6 c6dcd9 b16658 ced83e baae42 febd83 e4eaea   
## 0 0 0 4 1 0 0 0 0 0 0   
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## e55ec4 a748cf 5c3d96 9c03ca 59eb95 e5a442 a38790 a0de7d 8ec975 e8a0b1 04a0c1   
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## 0 3 0 0 3 0 0 0 0 0 0   
## 1a454f b65355 6198a5 12d0c8 fc4476 f76807 d9cc15 6ed3df 7f9a91 25fb41 18f1c9   
## 0 0 0 2 0 0 0 0 2 0 0   
## 679c45 35b23e a507a8 60813f 8a3edc d304e0 2d7305 8f534a 170c8d 259c1d 457f57   
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## 1bf83a a4b625 0c4516 9ba7a6 3e714e 3094ce 6f8a3e 6c9e8a cfb521 aac49d 8e43e6   
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## 0 0 1 0 0 0 1 0 1 0 0   
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## 1 2 0 0 0 1 0 1 0 0 0   
## ae3ac3 e018ae 0bdf6b 69647e 8a4b27 70c0e6 550664 3cc3c2 b1ccbe bc505d c182ce   
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## c228f0 551aef 01d4b5 88ed04 8979e3 3d7f21 e05f33 973c48 ca492f 1d5f62 f0332e   
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## dc4329 501241 e3b7b8 5ccf35 35cad9 27f706 7bb524 72268f 75d9f2 4fa236 9f0522   
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## 623061 bbfba1 1704ad 74f674 dbc86f f19093 bd9f32 639e4b 99b140 3b3e9f d3dac6   
## 0 0 0 0 1 0 0 0 1 0 2   
## 2d6a6a 7923b4 0a14e6 b7b32a 1a9f61 f0766b 72d8f9 c9e829 f28e60 5b8293 0701ee   
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## 5da51f cc4b7f 6c94f4 570c28 3fd6e5 391f22 165763 208be8 3c0d38 b4e767 7eb202   
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## 0 0 2 0 0 1 1 0 0 0 1   
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## 0 0 0 0 0 3 1 1 0 0 1   
## db2f5c 98c633 c08ed9 1ebd20 5ef186 694928 89006a 0474d6 32ce2a e62e62 eb9a3f   
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## 9432d0 b39dac 9c5424 0349c7 de3b80 980dd5 cffdea 8311d8 8f32e8 62bb46 f65e8a   
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## bc475c 3f7fa4 012ea3 1edcc2 21258e f99f12 055d3a 99766a 710ee1 be0b16 c1a0c6   
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## ad9518 8ae775 3968f9 4f7847 6c1a00 45216b d7d495 f56065 6d7ce4 904052 18bd2a   
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## f63811 ef99f8 4420da 4f1fb5 38e146 a76671 19d151 0b6eb8 e4c638 60e50c 7cbd05   
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## 0 0 1 0 0 1 0 0 0 0 0   
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## 0 0 0 0 0 0 1 0 1 0 0   
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## 0 0 1 0 0 0 0 0 0 0 0   
## aa65c0 31624f 00fe56 b680a2 00da2b 84e6b7 c17746 d6c884 983f4f e453f5 b65499   
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## 0 0 0 0 0 0 0 1 1 1 0   
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## 0 0 0 0 0 0 0 1 2 0 1   
## c51ef1 f543f0 8ddf66 09f77f ef9e7d b82030 31b16e ceee63 b80d85 54497f cde85f   
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## 0 0 0 0 0 0 1 0 0 0 0   
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## 0 3 0 0 0 0 0 2 0 0 0   
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## 0 0 0 0 1 0 0 0 0 0 0   
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## e21920 824b21 fa0689 2ed407 5fbeea 7933b4 55ba20 b4cf42 b38a3c fafe2a 07a9d7   
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## 0 0 0 0 1 0 2 0 0 0 1   
## bfa806 d0935a cddf12 185ac2 7cfdb0 092a68 bb32b5 b4c917 b2645b f5bc7b 03908f   
## 0 0 0 0 1 1 0 0 1 1 0   
## 3a6cfd f20095 3e32bb 307db6 738d00 5b1ded 201cea 1c8934 f21b61 13161d 8cdbaf   
## 0 0 0 0 0 0 0 0 2 0 0   
## 364186 08d2e4 a96703 0dfa70 cc2a1b 5495b2 03a7c4 814186 f587f9 028e18 d1f6d6   
## 3 1 1 0 0 0 0 0 0 1 0   
## 5f366f 8ef882 0a7fdc 4e7da8 a5ed2a 0b6dd9 cd425b e913df 984db4 877f18 f862b5   
## 2 0 0 0 1 0 0 0 1 0 0   
## 3a347c 709eb5 c22886 f6a5a3 f77c27 4415ef cf8c4b 09ed19 6bec10 c70a36 8da8dd   
## 0 1 0 2 0 1 0 0 0 0 1   
## 7dc183 93e764 b35511 f59aea 138b00 542c65 75a2d8 fcf892 8e672f 7dfdc3 f5910d   
## 0 0 1 0 0 0 1 0 2 1 0   
## 29a821 822ab9 9bb96e 7c2c63 4986a4 410308 9b15b6 d4d2ee 8fb471 ca3045 d9f981   
## 0 2 0 0 0 0 0 0 1 0 0   
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## 78703f 376cb7 cb24a0 a818f3 410db8 9a37b0 e3a5f4 417395 d5aa1e 40f55d 55a332   
## 0 0 1 0 0 0 0 1 1 0 0   
## f3172a 0e032d c33f09 5cc9fe e56bd5 6db85f fdc2f3 a28cf0 c3c7f8 11d41f 49d9e9   
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## 910d80 3fb7ff 5600b6 e4eb71 c5ab0c c268bd 67a995 667306 fe1c26 ab9826 5ff856   
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## 47b031 58982e 6e30bf d4ca3a 6cef2b fa2e97 a9fb04 f07864 6dd218 169a87 129637   
## 0 2 0 0 0 1 0 0 0 0 1   
## 78a343 bd9224 b3975a f023fd 54894e 34bb5b b001a1 30ccf6 75f61e e59e91 83787e   
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## d220a1 acf0b1 584f90 811fb2 893101 2cb848 f81d7a 1b3f3b 3d282d 85fdc7 e26cc4   
## 0 1 0 0 0 0 1 0 0 0 0   
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## e7c9b0 01d241 d01309 c4954b 75e99b 2be397 f1015d 2ca1a1 97abc7 9cfce3 0a5a50   
## 2 0 0 0 1 0 1 0 0 0 0   
## 1da54a 2fb179 3cca0c f3e81a c593b8 813666 0d3aaa 5cb908 a12310 f4954c 1a5984   
## 0 0 0 0 2 0 0 0 0 2 0   
## b22b9f bb99b5 f5747f d81435 bf2630 79755d 6574f5 4941d4 9f8894 91c9d5 c0f45e   
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## e983d0 d794cf cf66b5 36b175 fd57a9 67c1d1 4a29c5 ac416a 42072f 792a9d ccc67b   
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## 7bf9e9 774e90 02b80b 2a438e 449fc8 b0ea66 815a1f 4c510b 22fa1b 31225f 875c20   
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## fb49ca 3ac609 9017fd 053846 b0f129 8be0d1 fc387e e22e2b c4aefb 746883 3cc639   
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## 194db3 135bec 2fa04a ac574f fc2482 93f8bb 23f4a4 64ace5 511953 0be743 31d199   
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## ccaff9 f6c282 56bbfd aac9b3 1f854a 24eb61 fd7cbe 84b603 16e9eb 282cf3 c8a598   
## 3 0 1 0 0 0 0 0 0 0 1   
## a751b6 420582 4ec8b9 b39e78 01e000 a5b683 43979e 97d5cf d64a1d 31b15d 0631c9   
## 0 0 2 0 0 1 1 0 0 0 0   
## 7b1f2b 22439d a11a97 a91f59 de3026 0c9f13 cc84f6 02d91d 054a82 786126 ca31dc   
## 0 0 0 1 0 0 0 1 0 0 2   
## b83aa4 be4bd6 9e6e85 f12773 26130e 63a410 f0ef4f 2f9320 11c217 1631ed 669316   
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## 0 0 1 0 0 0 0 0 1 0 2   
## 2e40ff 2aef65 399954 5fd613 5ed881 1024e3 831fbf eb460a 931bcb c7348c c5dd13   
## 0 0 1 0 1 0 0 0 3 0 0   
## 33fa7e a929fd 9c0dc3 1e34f2 4d4f6b fa5b1c 5d0389 bda467 a431eb 9111a4 95d454   
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## 0 2 0 0 0 0 0 0 0 1 0   
## dec59b c82c6c b6956d a6667a e6ddb0 614c9e 7a4e7e 959a4d 707e10 52ae99 ba1bc1   
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## 945878 6c1a37 beb67f 2aa344 1ae9d3 362338 cf65e1 b3a5a8 a8742f 2c368b ffcf2b   
## 0 0 3 0 0 0 2 0 1 0 1   
## e798c4 6bd49d ba5d9e 36f617 6aaae6 32e296 a8a0c7 d2b34f 5d1d95 86b28f b9923b   
## 2 0 0 0 0 0 0 0 1 1 0   
## fbf75d 91ca67 8bafed d647e1 ee9d55 efccf6 80ef5b 424758 6102bd 61f4bb 7e41ee   
## 0 0 0 0 0 0 0 1 0 0 0   
## 9f157b 7b22fa b5f8da 288dc4 5315f9 03097a ced958 0f6629 567c3a b031a5 2868a7   
## 0 0 0 0 0 0 2 1 0 0 0   
## cb6862 21c5c7 4bad76 1c70a3 db1f72 fefb15 1ed966 fdd23c 713b6f 4d509f f04442   
## 0 1 1 0 0 0 0 0 0 1 1   
## e66a5b be41fc d242b8 13ac74 e62aee 063476 3971cd 176c0a b74b2c f93840 229ccd   
## 0 0 1 1 0 0 0 0 0 2 0   
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## f498c6 e3ba2c 5c369b 72fbc1 10e2d2 720700 368bd0 070cdb 0a54ec c79172 018a41   
## 1 0 0 0 0 0 1 0 1 0 0   
## f78697 736d44 33e53b ce1823 48dbf5 8ab204 6e8df3 b5fdeb b21b3e 86e6ec de0f2d   
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## e9cb32 ecf37d 4dd6ba c49435 065d05 f058b3 7485f2 916b5f fa49c3 ffae72 419ab1   
## 0 1 1 0 1 0 0 0 2 0 0   
## 13c5f2 f67350 56c9fc 2adefe 95cfe5 aae7de f24600 3a1038 b73559 0b32d8 cd84c3   
## 1 1 0 0 0 1 1 1 0 1 0   
## 725286 5c5407 438fdf 0d8448 0c34da 5c1d27 6e3138 05865b fcdd60 5efc6c 5e1765   
## 3 0 2 0 0 0 0 3 0 0 0   
## 8f625e f0297e ff211d 391f09 e0fc0f 89e1aa 24f7fd 72f732 7253cd fb77bf ec0a4c   
## 1 2 0 0 0 0 0 0 0 0 0   
## f4c548 3e6e2d 82102a ea2e70 e08590 e1b1fd 436581 f71d07 ca24ef 644ba9 128e35   
## 0 0 0 0 0 0 0 1 0 0 2   
## ec8d4d ed227c 3e8ea0 2ec920 e6ccd6 500d0e ce3b46 b4ee6c 150962 af3507 caa35a   
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## 2 0 0 0 3 0 2 0 1 0 0   
## 40039e 42d6ea 83f0cf 880ddb 2ca9ef 741fb1 5a30df 2ba4c0 8a2f1d fdf9d3 317a09   
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## 0 0 0 0 0 0 0 0 0 0 1   
## bcaa94 7def47 1c09e2 ab4313 542d7d 3d9d40 f3441c e972f8 febc40 e9f509 dcecc6   
## 0 0 1 0 0 0 0 0 3 0 1   
## 956213 2f0e48 8c1f48 2baac8 52e642 29c3a0 b7de4f 55067b 58351c 9710eb dc8ed8   
## 0 0 0 0 0 1 0 1 0 0 0   
## a51b37 0fb819 c0a732 a3ea15 502ec1 8e84a9 9c3a56 76a224 baeb99 d216df 9c81f7   
## 2 0 0 3 0 0 0 0 0 0 1   
## 4e70b9 2a9e39 ab2111 d13224 378526 b69f2f 3dec24 eb8b71 5feec4 031d46 3eb28f   
## 0 1 0 0 0 0 0 0 0 0 0   
## a2ffdf 068e38 6235ed 6b740b a01bba b8cc83 3895b0 c69921 793fcf cfd8c7 d8ab7a   
## 0 0 1 0 0 0 0 2 0 1 0   
## f1e813 413bec ac5760 39c2d9 fe06bc db9404 aafd50 b66e0d 6351a7 054225 5801ca   
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## 0d1e5f 556fc4 98b277 5eb78d ebdead 5481ec 7b55a4 c49630 58b28a fd46be 63109b   
## 1 1 0 0 1 0 0 0 0 3 1   
## 4f0791 d69791 8b4794 a696dc a9cf5a dce319 5fab80 7bc4d0 43312d cc1e41 7a6d1d   
## 1 0 0 0 0 1 0 0 0 0 0   
## ac2903 048ebc b8fe46 076202 05467b 3d94b1 acb2d4 acdb39 ca3e99 9cc2da 1439f9   
## 0 0 0 0 0 0 0 0 0 1 0   
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## 6bba7d 5db78c c21701 194b20 6b7c62 4a6075 c1aa0f 2523bc 2eb1c8 ba0a1c cb415b   
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## 8e21c8 b4b2f8 0e7d4e 506bd7 786ac0 72e7f4 c0b5f1 4410a7 c31079 34df64 9453ed   
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## 0 1 0 1 0 2 0 1 0 0 0   
## 409f64 9b4757 0039db 628aab bb6bfb e10537 35d712 4f3e96 013644 a044d9 da57be   
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## a0d32f d86510 d311dd fc4286 9bc59e 245281 efa253 4d5950 5e18a9 26c788 c80810   
## 0 0 0 1 0 0 0 0 0 0 0   
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## 0 1 0 0 0 2 0 0 0 0 0   
## b4b458 342054 cafbb0 db2b99 36a376 4d5c6b 004298 6751e8 eddd6f 599f49 9f7775   
## 1 0 0 0 0 0 0 0 0 0 0   
## 892abe 946267 a6b63d 675cb4 d8b0ae 6bdef0 45ac21 b0a018 060017 a68682 15cf92   
## 0 0 0 1 1 1 0 2 0 0 0   
## fb0c35 65ea49 1999d1 87fca9 95037f 86f641 b7f508 577f9a 54e22b 86257d 3a831d   
## 0 0 0 1 0 0 0 0 0 0 0   
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## 0 0 1 1 0 0 1 0 0 0 0   
## 970084 a833cc 3de966 090661 4878f3 cabf28 0606ac fc3077 87e28c 27a56a 8911bd   
## 0 0 1 0 0 0 0 0 0 0 0   
## da69ae 18f5ec 6fb9f6 65fb4c f47241 c8eca6 a1666d ba5769 69c4ab 4cc2ef 9635bd   
## 2 0 0 2 0 0 0 1 0 1 0   
## 226a55 b42467 55a24b c50bd7 bdbe4a 688dfe 62be40 1ad254 758088 c62376 20d053   
## 0 0 0 0 1 0 0 0 0 0 0   
## 8d0a15 6cddda 420c7e c9f979 4bb65e 73f728 3427d1 5cc81f 15e0a2 5b17ae 63c76b   
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## 96a3d4 8bdcd1 9b7ee3 62910b e2cff7 8da173 ee3831 a9107c 87d192 c0891f 80e6cf   
## 1 0 0 0 1 0 0 0 1 0 0   
## a8b1b9 24a268 3e763d df0754 a827f1 d04295 fdb1fd d5d522 f2dd52 cc22c5 2bf250   
## 0 0 0 0 0 0 0 3 0 2 0   
## 14b942 1643d8 8d5295 a0e81b 191866 aaf8a5 c5f40f f90512 2efabd 61e7e2 b083d0   
## 0 0 0 0 0 0 0 3 0 0 0   
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## 0 0 1 2 0 0 1 0 0 1 1   
## 200a8a 60ce1f 68eca6 6fbf2f 02a723 60d1e7 949d49 235bb0 3aed70 ca8208 53a9e1   
## 2 0 3 1 0 1 0 0 1 0 2   
## abd770 ade3e9 830cd4 564958 22739e f7dcc9 f6dcd0 56f9a0 fa0cbf 5cc32a ebfad4   
## 0 0 0 0 0 0 3 0 0 1 0   
## 0db181 08b94c e18133 5a25c5 14230d 99eee9 786b8c 97c72a 36b5fd 0fc4a9 3b1ae8   
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## 0 0 0 2 0 2 2 0 0 2 0   
## d91592 37e612 b18861 1dccec ec72f3 ee55ee fd4705 95dfcf 43d43d 97cc68 52ee65   
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## f37d64 4fcfcc d9e084 114944 9ec237 14544d 2942ce ab4e21 2dd798 986e99 02efe3   
## 1 0 0 0 0 0 2 2 0 2 1   
## adebd3 b23bea 30ad0e 5fe1a8 a05b57 51f8d6 36ea75 c6f68b 137813 eb6ae3 380567   
## 0 1 1 0 1 0 0 0 0 1 0   
## f5f0ec b3c7c2 3616d2 673d0c 74190b 2b883d ade522 cc4d42 e06706 661c0f dd269b   
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## 0 3 0 0 1 0 0 0 0 1 0   
## c5f7aa d3fdb6 a1cec3 3e81e0 d0c042 6c6621 cf9fa2 c49942 31abc3 72febb adcf52   
## 0 1 0 2 1 0 0 1 0 0 0   
## fffc9d a392c4 68bfa3 68b66d 66ff28 7e6407 8066c5 ab5fe1 7e2883 54b117 7c0110   
## 0 0 1 1 0 0 1 3 0 1 1   
## 4669b3 78869f fb5f91 e9315f c27215 bdf90b fc5d3c 5fd8c8 db54fe 170f6e 2c1bcf   
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## 0 0 0 0 0 0 0 2 0 0 0   
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## 0 0 0 1 0 2 0 0 1 0 0   
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## 478c45 975680 92309f 7caaa2 065ba0 505dd4 146f6d 095df3 2d791e 711539 cde621   
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## 22d644 70e019 90239b 2acf57 0607f9 bb8128 3ae4d6 71a4ae ec8fca c0a01d 559cce   
## 0 0 0 0 0 0 1 0 0 0 0   
## 1c5a11 3930fb 957384 89a9a9 e46a61 3d9daf c6513a 1b2feb 2603fb 1c398f 738f5d   
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## 3b8f45 188d1e 6dcae2 abaf55 1cafff 99e12e 1f0436 ca0e92 1e900f 61d786 cf05f9   
## 0 0 0 0 0 0 1 0 3 0 0   
## f47682 d8117d 70dee3 95b138 a6757c b8ca5d 73c73a a30ff8 07c5fb b90477 7525ac   
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## b3e1a6 a7ca26 fdafe3 fc674a ee738a 22ab70 7a9d42 038f4d bd7102 a568bb 16f847   
## 0 0 0 0 0 0 0 1 0 0 0   
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## 1 0 1 0 0 0 0 0 0 0 1   
## bce608 b70d13 7ebc55 c80978 f390df ed1e89 a9c48f 4ca38f aaea82 d2ce23 e4cbf4   
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## 0283ed fb4316 e7433f 128a51 e4cc2b f5dccc 85f387 4a74e6 e8b57f 8c97e2 6ee878   
## 0 0 0 0 0 3 0 0 0 0 1   
## 620b62 4a36c0 be98bf 9d8c54 724d69 99a397 3eb2ba c8a055 adbb4a 4798d2 3d9b03   
## 0 2 1 1 0 1 0 0 0 0 0   
## f713bf 934ba5 8763d8 162f96 427fb1 05a71f 8fc47f b18217 489045 8e0af5 91d95c   
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## 1 0 0 2 1 0 2 0 0 0 0   
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## bdb7da aeea23 f9a362 15b9b4 2ddf38 b796bd 680f1b 3cfdf5 8d77ce 38027f a23b03   
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## 1 0 0 0 0 0 1 0 2 1 0   
## e91bb5 827e4d 4ee1dd 76ac25 83dea4 c1b99b 6026c7 a2f0d5 0c8e73 15da23 97d8a8   
## 0 0 0 0 0 0 0 2 0 1 0   
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## 0 0 1 0 0 0 1 3 0 0 0   
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## 0 1 0 1 0 0 2 0 0 1 0   
## bb889e 0c9550 615c91 e6da7f 00d25b c60bcb bb67a9 ef309f 88206d af2809 9058f6   
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## ad7ec4 45ce63 2b7efd 3c1944 740f39 2ed933 dab0c9 a8a470 ba638b 33deff b74af7   
## 1 2 0 0 0 0 0 0 1 0 0   
## 0b3986 668a25 d3d026 9e0b3f b6b4d3 166b5b 9e99f4 3ad7c4 d12222 f4c35a e59e18   
## 0 0 0 0 0 0 0 0 0 0 0   
## ea630b dd9090 cc3e84 52b16e 59f810 abd392 699c88 cc5040 f06cde 0fd97d 3cb126   
## 2 0 0 0 0 0 1 0 1 2 1   
## b5c7f2 f3719c 634beb 147cf7 d78e46 8128c0 704621 908686 1655de 425802 21ea92   
## 0 0 0 0 0 0 1 0 0 0 0   
## 9db487 50eafd 2314ad 02a954 2afe7c 836bed 2d7c2b be2e8b 0ef5f8 231d93 fac717   
## 0 0 0 0 0 0 0 0 0 0 0   
## 126e1c 0544ce 2f22a3 8c6a51 b0fc8c 374b59 9dd60a 44db04 a2d142 2dbe33 4c9078   
## 0 1 1 1 1 0 0 0 0 0 0   
## a148fa fccbf5 2e893b 028cee ce6ce0 f144de 615929 7b0e09 ea85e8 841429 81f8ee   
## 1 0 0 2 1 1 1 0 0 1 0   
## 43912c 1d7c22 db7f71 c529a2 1a320f d6a3a0 e4473c bc5870 cc6729 bbf39f 2e2b73   
## 1 0 0 1 0 0 0 0 0 1 0   
## e0b275 241b41 8eb172 e6d994 4799df 3da96a 50f681 e8de39 a9e570 bcda77 2ab6c0   
## 0 2 0 0 0 0 0 1 0 0 0   
## 901d4a 23a675 cbb8f4 89d357 f6a2c3 4589d7 29af75 76d8fe 287458 358739 6a380e   
## 0 0 0 0 1 2 0 0 0 0 0   
## 83e699 ca1aee cd776c 07e9fb e04ac4 1bd38b c4d7e3 a1021c 0256b1 10d1de dd6664   
## 0 1 0 0 0 1 0 0 0 0 0   
## b8969e 801839 ba5658 2363e1 ea0bce 40d948 635ef3 7c3354 4b859a e0159d 602aa1   
## 1 0 0 0 0 0 0 0 0 0 1   
## 58d0b1 f0cafa 947c61 6d716c 40db65 254509 c1fc7b 54d760 e37efd 928429 01c751   
## 0 0 0 0 0 0 0 0 0 2 0   
## 632cc9 47bde4 88761b 1f9f0f 313188 7c302d 82eba1 02e044 16bbcc bee5e8 fe494f   
## 0 0 0 0 0 0 0 0 0 0 0   
## 643d16 061d90 0a133e ddbb95 cb78e4 7f0cc8 2068d6 5f53f7 e7e88e 534b3c   
## 0 0 0 0 0 0 0 0 0 0

## 5. Plot Degree Distribution

# Histogram of secondary cases  
hist(secondary\_cases,   
 breaks = 30,  
 main = "Degree Distribution of Secondary Cases",  
 xlab = "Number of Secondary Cases",  
 ylab = "Frequency",  
 col = "lightblue",  
 border = "black")



## 6. Fit a Negative Binomial Distribution

# Fit negative binomial to secondary cases  
fitnb <- fitdistrplus::fitdist(secondary\_cases, "nbinom")  
print(fitnb)

## Fitting of the distribution ' nbinom ' by maximum likelihood   
## Parameters:  
## estimate Std. Error  
## size 0.8539443 0.072505326  
## mu 0.3675993 0.009497097

The negative binomial distribution is characterized by two parameters: - size (k): Dispersion parameter - mu: Mean number of secondary cases

Example estimates might look like: - size = 0.854 - mu = 0.368

## 7. Superspreading Risk Assessment

# Estimate probability of clusters from backward tracing  
superspreading::proportion\_cluster\_size(  
 R = fitnb$estimate["mu"],  
 k = fitnb$estimate["size"],  
 cluster\_size = c(5, 10, 15)  
)

## R k prop\_5 prop\_10 prop\_15  
## 1 0.3675993 0.8539443 2.66% 0% 0%

## 8. Interpretation

Using the estimated parameters (R ≈ 0.368, k ≈ 0.854), the chance of a backward-traced case causing: - ≥5 secondary cases: ~2.6% - ≥10 or ≥15 secondary cases: near 0%

### 📌 Implication:

Backward tracing likely provides limited added value for containing Ebola transmission in this scenario, as the superspreading potential is low.