

Web Crawler

By

Jignesh Suryakant Satam



Black Hole

Black Holes:

The crawler is designed for collecting information about Black Holes. It crawls the links related to black holes from starting site. These links are saved in `urls.txt`. Then data is collected from each URL and stored in text files under `/data/documents` directory. Each document from the directory is cleaned and stored in the `/data/clean-documents` directory. All the clean documents are parsed to find the most 50 common words using TF-IDF. Related terms are selected from the common words manually. A knowledge base is created using these selected terms and stored in the database for querying.

Starter site:

<https://www.space.com/15421-black-holes-facts-formation-discovery-sdcmp.html>

Kind of data:

Various kind of data is found like text, images, and videos. Out of which only **text** was used for processing.

Clean up:

Following steps were used for cleaning:

Filtering Related Links:

1. Discard the link if it contains **facebook**.
2. Discard the link if it contains **twitter**.
3. Discard the link if it contains **whatsapp**.
4. Discard the link if it contains **reddit**.
5. Discard the link if it contains **pinterest**.
6. Discard the link if it contains **flipboard**.
7. Discard the link if it contains **mailto**.
8. Discard the link if it contains **amazon**.
9. Discard the link if it starts with #.
10. Discard the link if it contains **www.nasa.gov**.

Cleaning Data:

1. Converting all the `\n` to `.`.
2. Converting all the `\t` to `.`.
3. Converting all the `'` to empty space.
4. Converting all the `(opens in new tab)` to `.`.
5. Replacing two or more dots to a single dot.

Top terms:

hole, black, space, star, galaxy, science, mass, time, new, supermassive, image, energy, telescope, would, event, universe, horizon, dark, object, may, said, one, light, way, milky, gas, search, university, news, subscribe, gravitational, matter, astronomer, nasa, center, scientist, around, sun, study, expansion

Knowledge Base:

The following shows the related keywords selected manually and their first 10 relevant lines.

```
{
  "hole": [
    "massive black hole bends light to magnify distant galaxy | space",
    ".",
    "massive black hole bends light to magnify distant galaxy .",
    "a giant black hole spouting energy from inside a galaxy is acting",
    "like a cosmic magnifying glass , giving astronomers a clear view of an",
    "evenmore distant galaxy behind it.it is the first time a quasar ?",
  ],
}
```

"the central region of a galaxy dominated by an energy-spewing black hole ?",

"view. in this case , scientists are more interested in studying the lens itself than the magnified image. galaxies that host quasars are hard to study because their light is often overpowered by the blaring radiation from material falling onto the supermassive black holes in their centers .",

"a detailed map of a quarter of the sky. it was through that study that researchers found the quasar sdssj0013+1523 acting as a cosmic lens. we were delighted to see that this idea actually works , said georges meylan , a professor of physics at école polytechnique de lausanne. this discovery demonstrates the continued utility of gravitational lensing as an astrophysical tool. the researchers published their findings july 20 in the journal astronomy & astrophysics. how black holes gobble dark matter top 10 strangest things in space video : black holes : warping time & space .",

"more from space. 1 japan's new h3 rocket aborts 1st-ever launch attempt 2 virgin galactic carrier plane flies for 1st time since 2021 33 mystery objects shot down by us likely weren't spy craft , biden says 4 black holes may be the source of mysterious dark energy 5 pictures from space !",

"astrophysics : fire in the hole !",

"astrophysics : fire in the hole ! .",

"astrophysics : fire in the hole ! ."

],

"black": [

"massive black hole bends light to magnify distant galaxy | space .",

"massive black hole bends light to magnify distant galaxy .",

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"will an astronaut who falls into a black hole be crushed or burned to a crisp ? .",

"a string theorist at the kavli institute for theoretical physics in santa barbara, california, polchinski was pondering what would happen to an astronaut who dived into a black hole .",

"but how ? according to the then-accepted account, he wouldn't feel anything special at first, even when his fall took him through the black hole's event horizon : the invisible boundary beyond which nothing can escape ."

],

"space": [

"massive black hole bends light to magnify distant galaxy | space .",

"all about space magazine .",

". why subscribe ? your monthly guide to stargazing & space sciences subscribe today and save an extra 5 % with code love5 issues delivered straight to your door or device from \$ 3.99 . view .",

"subscribe to all about space magazine ! .",

"trending meteorite from european fireball ! best telescopes best star projectors next full moon space calendar best binoculars lego star wars deals artemis 1 updates best drone solar system planets night sky tonight russia-ukraine war space impacts .",

"the cosmic lens phenomenon was first predicted by albert einstein's theory of general relativity. the discovery gives astronomers a glimpse at two galaxies at once, allowing researchers to photograph the distant

object while weighing and measuring the intervening galaxy and the bright powerhouse at its core. the quasar is known as sdss j0013+1523 and located about 1.6 billion light-years from earth. warped space-time according to the theory, very large masses warp the space-time around them, even causing light to bend as it travels through the region.",

"thus, light from faraway objects sometimes can be magnified by the bent space-time to provide a larger and brighter?",

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"join our space forums to keep talking space on the latest missions, night sky and more!",

"and if you have a news tip, correction or comment, let us know at community@space.com."

],

"galaxy": [

"massive black hole bends light to magnify distant galaxy | space",

"massive black hole bends light to magnify distant galaxy.",

"this labeled image of the first-ever foreground quasar (blue) lensing a background galaxy (red) was taken with the Keck II telescope and its NIRC-2 instrument using laser guide star adaptive optics.",

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"scientists can measure how matter is distributed in the lensgalaxy .",

"they can even calculate the total matter of the quasar and its hostgalaxy.often quasarsare discovered when their light is being magnified by an intervening galaxyacting as a gravitational lens .",

"scientists set out to look for a case of thisreverse lensing of a galaxys light by a quasar by looking through the dataobtained by the sloan digital sky survey ?"

],

"mass": [

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"by studying the way a quasar magnifies light as a gravitational lens, he said, we now can measure the masses of these quasar host galaxies and overcome this difficulty. weighing quasars the new found lens, and similar ones being sought by researchers, could provide an opportunity to learn about the galaxies that shelter quasars in their centers. by studying the way the quasar magnifies the distant light? including the shape of its distortion and the number of magnified images the lens produces?",

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"but hawking's result was still startling – not least because the equations of general relativity say that black holes can only swallow mass and grow, not evaporate.",

"that negative energy would then get subtracted from the black hole's mass, causing the hole to shrink. hawking's original analysis has since been refined and extended by many researchers, and his conclusion is now accepted almost universally.",

"the event horizon telescope has captured a historic first image of the supermassive black hole at the center of our galaxy. the image, which was taken in the light of submillimeter radio waves, confirms that there is a black hole in the heart of the milky way that is feeding on a trickle of hydrogen gas. until now, we didn't have the direct picture to prove that this gentle giant in the center of our galaxy is a black hole, feryal özel, an astrophysicist at the university of arizona, said during a national science foundation news conference held thursday (may 12)."

],

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"star": [

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subscribe today and save an extra 5 % with code love5issues
delivered straight to your door or device from \$ 3.99 .view .",

"trending meteorite from european fireball ! best telescopes
best star projectors
next full moon
space calendar
best binoculars
lego star wars deals
artemis 1 updates
best drone
solar system planets
night sky tonight
russia-ukraine war space impacts .",

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"she covers everything from astronomy to human spaceflight and once
aced a nasa suborbital spaceflight training program for space
missions .",

"but hawking ' s result was still startling – not least because the
equations of general relativity say that black holes can only swallow
mass and grow , not evaporate .",

"so they posted a paper on the preprint server , arxiv , presenting
physicists with a stark choice : either accept that firewalls exist and
that general relativity breaks down , or accept that information is
lost in black holes and quantum mechanics is wrong1 .",

"astrophysics : two black holes found in a star cluster 2012-oct-03
.",

"blogpost : nasa spies black holes in galactic web .",

"why subscribe ? your monthly guide to stargazing & space sciences
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delivered straight to your door or device from \$ 3.99 .view ."

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"time": [

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"in the meantime , to ensure continued support , we are displaying the site without styles .",

" for a time , i did seriously try to build an alternative theory that included information loss , " he says .",

"at the cern meeting , participants were tantalized by the possibility that giddings ' model could be tested : it predicts that

when two black holes merge , they may produce distinctive ripples in space-time that can be detected by gravitational-wave observatories on earth .",

" to completely understand the firewall paradox , we may need to flesh out that dictionary , " he says , " but we won ' t need to throw it out. " the only consensus so far is that this problem will not go away any time soon ."

],

"energy": [

"a giant black hole spouting energy from inside a galaxy is acting like a cosmic magnifying glass , giving astronomers a clear view of an even more distant galaxy behind it.it is the first time a quasar ?",

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"the doomed particle would balance the positive energy of the outgoing particle by carrying negative energy inwards – something allowed by quantum rules .",

"that negative energy would then get subtracted from the black hole ' s mass , causing the hole to shrink.hawking ' s original analysis has since been refined and extended by many researchers , and his conclusion is now accepted almost universally .",

" but after doing more mathematics , it seemed to make literal sense that the universe is a projection of information on the boundary. " what maldacena came up with was a concrete mathematical formulation6 of the hologram idea that made use of ideas from superstring theory , which posits that elementary particles are composed of tiny vibrating loops of energy .",

" it ' s a violent process , like breaking the bonds of a molecule , and it releases energy , " says polchinski .",

"the energy generated by severing lots of twins would be enormous .",

"he has calculated that if the entanglement between the outgoing hawking radiation and its infalling twin is not broken until the escaping particle has travelled a short distance away from the event

horizon , then the energy released would be much less ferocious , and no firewall would be generated¹⁰ .",

"the black hole of m87 is much larger than sagittarius a * , and therefore it takes days for changes to become apparent , whereas sagittarius a * is much smaller and , as material whips around it , the brightness of the ring can change in mere minutes.it is teeming with activity , always gurgling with turbulent energy , johnson said of the ring around the event horizon.to try to explain what they were seeing , the eht team – which is made up of more than 300 researchers across 80 institutions – performed more than 5 million supercomputer simulations to try and find one that was a match for what they observed ."

],

"supermassive": [

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"it shows a bright ring surrounding the darkness , and the telltale sign of the shadow of the black hole.related : heres how scientists turned the world into a telescope (to see a black hole) an image of the supermassive black hole at the center of the milky way , a behemoth dubbed sagittarius a * , revealed by the event horizon telescope on may 12, 2022 .",

"at the same time as it gathered the data that became that image , the eht also performed observations of sagittarius a * , which is the name given to the milky ways supermassive black hole .",

"the power of imaging the black holes ring is that , if you know the mass and distance to the black hole – in other words , the size of the event horizon – then you can use that to compare to theory.the new

image shows that the size of sagittarius a * s event horizon is 51.8 microarcseconds on the sky.our image is in very close agreement with theoretical predictions , said özel , who described it as the biggest test of einsteins theory of general relativity ever made , noting that the theory passed with flying colors.its a great laboratory for trying to understand how gravity works in the vicinity of a supermassive black hole , ghez said.a comparison of event horizon telescope views of the black holes at the center of the galaxy m87 , on the left , and of the one in the milky way , at right .",

"` if you were just to take a picture of a random supermassive black hole in a galaxy somewhere in the universe , then this is what it would look like.this image of sagittarius a * , and of the black hole in m87 before it , has been made possible through the magic of a technique known as very long baseline interferometry , which allows astronomers to combine data from radio telescopes all across the world as though they were one large telescope , effectively making the eht the largest telescope on earth .",

"supermassive black holes in other galaxies appear far smaller on the sky , beyond even the abilities of the eht to image their event horizon .",

"simply , these black holes could themselves be that never before observed dark matter , the evidence for which has so far failed to materialize , despite the fact that the universe as we understand it can not exist without it.related : astronomers peer deeper into milky ways heart than ever before in new imagesour study shows that without introducing new particles or new physics , we can solve mysteries of modern cosmology from the nature of dark matter itself to the origin of supermassive black holes , nico cappelluti , assistant professor in physics at the university of miami and co-author of the new study , said in a statement.the theory of primordial black holes , originally proposed by hawking , was later abandoned for the current dominant view of black holes being born after massive stars collapse at the end of their lives .",

"we dont understand how supermassive black holes could have grown so huge in the relatively short time available since the universe existed.according to the theory , black holes existed from the beginning of time , accelerating star formation in the early millions of years after the big bang .",

"this work also sheds light on how different types of black holes might form and how supermassive black holes (SMBH) could get so massive ."

],

"dark": [

"a detailed map of a quarter of the sky. it was through that study that researchers found the quasar SDSSJ0013+1523 acting as a cosmic lens. we were delighted to see that this idea actually works , said Georges Meylan , a professor of physics at Ecole Polytechnique Université de Lausanne. this discovery demonstrates the continued utility of gravitational lensing as an astrophysical tool. the researchers published their findings July 20 in the journal Astronomy & Astrophysics. how black holes gobble dark matter top 10 strangest things in space video : black holes : warping time & space .",

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"first , these black holes could explain the existence and nature of dark matter , the invisible stuff that , according to estimates , makes up some 85 % of all matter in the universe .",

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"the gravity of these black holes would also speed up the formation of first stars and galaxies as it would lead to a faster collapse of the dust and gas clouds that filled the dark universe in the first millions of years after the big bang .",

"as a result , those mysterious dark ages would be shorter , and the first stars would form much earlier.primordial black holes , if they do exist , could well be the seeds from which all black holes form , including the one at the center of the milky way , priyamvada natarajan , a professor of astronomy at yale university and a co-author of the study , said in the statement .",

"and when exactly that happened will show which theory is more correct : that black holes existed since the beginning of time or that they only started forming after the first generation of stars died out.if the first stars and galaxies already formed in the so-called dark ages , webb should be able to see evidence of them , hasinger said.the new study has been accepted for publication in the astrophysical journal and is available online on the preprint site arxiv ."

],

"event": [

"but how ? according to the then-accepted account , he wouldn ' t feel anything special at first , even when his fall took him through the black hole ' s event horizon : the invisible boundary beyond which nothing can escape .",

"but eventually – after hours , days or even weeks if the black hole was big enough – he would begin to notice that gravity was tugging at his feet more strongly than at his head .",

"in their account , quantum effects would turn the event horizon into a seething maelstrom of particles .",

"left in isolation , the holes will slowly spew out thermal radiation – photons and other particles – and gradually lose mass until they evaporate away entirely (see ' the information paradox ') .these particles aren ' t the firewall , however ; the subtleties of

relativity guarantee that an astronaut falling through the event horizon will not notice this radiation .",

"but when a particle-antiparticle pair appears just outside a black hole ' s event horizon , hawking realized , one member could fall in before the two recombined , leaving the surviving partner to fly outwards as radiation .",

"when polchinski and his team set themselves the task of clearing up that loose end in early 2012, they soon stumbled on yet another paradox – the one that eventually led them to the fatal firewall.hawking had shown that the quantum state of any one particle escaping from the black hole is random , so the particle can not be carrying any useful information .",

"“ the event horizon would literally be a ring of fire that burns anyone falling through , ” he says .",

"bousso agrees , adding : “ a firewall simply can ' t appear in empty space , any more than a brick wall can suddenly appear in an empty field and smack you in the face. ” if einstein ' s theory doesn ' t apply at the event horizon , cosmologists would have to question whether it fully applies anywhere.polchinski admits that he thought they could have made a silly mistake .",

"“ there ' s no fundamental law preventing someone from measuring the paradox , ” says harlow .",

"he has calculated that if the entanglement between the outgoing hawking radiation and its infalling twin is not broken until the escaping particle has travelled a short distance away from the event horizon , then the energy released would be much less ferocious , and no firewall would be generated10 ."

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"bousso agrees , adding : " a firewall simply can ' t appear in empty space , any more than a brick wall can suddenly appear in an empty field and smack you in the face. " if einstein ' s theory doesn ' t apply at the event horizon , cosmologists would have to question whether it fully applies anywhere.polchinski admits that he thought they could have made a silly mistake .",

"he has calculated that if the entanglement between the outgoing hawking radiation and its infalling twin is not broken until the escaping particle has travelled a short distance away from the event horizon , then the energy released would be much less ferocious , and no firewall would be generated10 .",

"the event horizon telescope has captured a historic first image of the supermassive black hole at the center of our galaxy.the image , which was taken in the light of submillimeter radio waves , confirms that there is a black hole in the heart of the milky way that is feeding on a trickle of hydrogen gas.until now , we didnt have the direct picture to prove that this gentle giant in the center of our galaxy is a black hole , feryal özel , an astrophysicist at the university of arizona , said during a national science foundation news conference held thursday (may 12) .",

"it shows a bright ring surrounding the darkness , and the telltale sign of the shadow of the black hole.related : heres how scientists turned the world into a telescope (to see a black hole) an image of the supermassive black hole at the center of the milky way , a behemoth dubbed sagittarius a * , revealed by the event horizon telescope on may 12, 2022 .",

"(image credit : event horizon telescope collaboration) this is an astounding achievement , ryan hickox , an astrophysicist at dartmouth college who is not a member of the eht team , told space.com ."

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"universe": [

"maldacena ' s insight built on an earlier proposal that any three-dimensional (3d) region of our universe can be described by information encoded on its two-dimensional (2d) boundary^{3,4,5}, in much the same way that laser light can encode a 3d scene on a 2d hologram .",

"` but after doing more mathematics , it seemed to make literal sense that the universe is a projection of information on the boundary. " what maldacena came up with was a concrete mathematical formulation⁶ of the hologram idea that made use of ideas from superstring theory , which posits that elementary particles are composed of tiny vibrating loops of energy .",

"his model envisages a 3d universe containing strings and black holes that are governed only by gravity , bounded by a 2d surface on which elementary particles and fields obey ordinary quantum laws without gravity .",

"but that wouldn ' t matter : anything happening in the 3d universe could be described equally well by equations in the 2d universe , and vice versa .",

"it took several years to refine the image and confirm what he had.black holes are the densest objects in the universe , and their gravity is irresistible , to the extent that within a certain distance of a black hole , not even light can escape .",

"in particular , the simulations all predicted more and faster variability than what was actually seen , and could relate to how gas is accreting onto the ring , or how magnetic fields are interacting with that inflow.reacting to the image , hickox said that its just remarkable to see an image of the black hole that we know best , and to see the ring and measure the shadow size as accurately as they did.furthermore , this image of sagittarius a * can now act as a template for other quiescent black holes in the universe.this black hole is more typical of the overall set of black holes in the universe than the one in m87 , hickox said .",

"` if you were just to take a picture of a random supermassive black hole in a galaxy somewhere in the universe , then this is what it would look like.this image of sagittarius a * , and of the black hole in m87 before it , has been made possible through the magic of a technique known as very long baseline interferometry , which allows astronomers to combine data from radio telescopes all across the world as though

they were one large telescope , effectively making the eht the largest telescope on earth .",

"the nature and origin of black holes and their role in the evolution of the universe still puzzles scientists .",

"now , a new study suggests that the existence of black holes from the earliest moments of the universe could explain more than one astronomical mystery .",

"the new study suggests that small primordial black holes filled the early universe right after the big bang , acting as an accelerator of star and galaxy formation ."

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"*milky*": [

"this is the first photo of the milky ways monster black hole sagittarius a * | space .",

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"at the same time as it gathered the data that became that image , the eht also performed observations of sagittarius a * , which is the name given to the milky ways supermassive black hole .",

"a collage shows the first image of the black hole at the center of the milky way at its location on the sky .",

"the power of imaging the black holes ring is that , if you know the mass and distance to the black hole – in other words , the size of the event horizon – then you can use that to compare to theory.the new

image shows that the size of sagittarius a * s event horizon is 51.8 microarcseconds on the sky.our image is in very close agreement with theoretical predictions , said özel , who described it as the biggest test of einsteins theory of general relativity ever made , noting that the theory passed with flying colors.its a great laboratory for trying to understand how gravity works in the vicinity of a supermassive black hole , ghez said.a comparison of event horizon telescope views of the black holes at the center of the galaxy m87 , on the left , and of the one in the milky way , at right .",

"simply , these black holes could themselves be that never before observed dark matter , the evidence for which has so far failed to materialize , despite the fact that the universe as we understand it can not exist without it.related : astronomers peer deeper into milky ways heart than ever before in new imagesour study shows that without introducing new particles or new physics , we can solve mysteries of modern cosmology from the nature of dark matter itself to the origin of supermassive black holes , nico cappelluti , assistant professor in physics at the university of miami and co-author of the new study , said in a statement.the theory of primordial black holes , originally proposed by hawking , was later abandoned for the current dominant view of black holes being born after massive stars collapse at the end of their lives .",

"as a result , those mysterious dark ages would be shorter , and the first stars would form much earlier.primordial black holes , if they do exist , could well be the seeds from which all black holes form , including the one at the center of the milky way , priyamvada natarajan , a professor of astronomy at yale university and a co-author of the study , said in the statement .",

"esas gaia mission , which creates the most detailed three-dimensional map of our galaxy , the milky way , has produced evidence of a large number of smaller black holes scattered all over the galaxy that are too small to be born from the death of giant stars ."

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Fututre perspective for chatbot:

Hi, I am SingularityBot, a knowledge bot for Black Holes. I love to talk about Black Holes! What is your name?

I am Jignesh.

Hi Jignesh. What would you like to know about Black Holes?

Well, what exactly is a black hole?

A black hole is an area in space where the gravitational pull is so strong that nothing, not even light, can escape from it. It's created when a massive star dies and its core collapses under the force of its own gravity.

That sounds pretty intense. How big can black holes get?

Black holes come in different sizes, from small ones that are just a few times more massive than the sun, to supermassive ones that are billions of times more massive. The largest known black hole is located in the center of the galaxy M87 and has a mass equivalent to 6.5 billion suns.

Wow, that's mind-boggling! What happens if something gets too close to a black hole?

If an object gets too close to a black hole, it will be pulled in by the black hole's gravity and be torn apart by intense tidal forces. This is known as spaghettification because the object is stretched out into a long, thin shape that resembles spaghetti.

Yikes! Is there any way to escape a black hole once you're inside its event horizon?

No, once you're inside a black hole's event horizon, you're trapped. The gravitational pull is so strong that not even light can escape, so you're essentially cut off from the rest of the universe.

That's pretty scary. Is there anything else I should know about black holes?

Well, black holes are still a bit of a mystery to scientists, and there's still much we don't know about them. But studying them can give us insights into the nature of gravity and the structure of the universe. And who knows, we might discover some new and unexpected things along the way!