1.1:

Query:

```
--------------------------1.1-------------------
IF OBJECT_ID('tempdb..#Visited') IS NOT NULL DROP TABLE #Visited;
IF OBJECT_ID('tempdb..#Queue') IS NOT NULL DROP TABLE #Queue;

-- Creating the Visited table
CREATE TABLE #Visited (
    paperID INT PRIMARY KEY,
    componentID INT
);

-- Creating the Queue table
CREATE TABLE #Queue (
    paperID INT,
    componentID INT
);

-- Creating the stored procedure to find connected components, using the BFS
method like professor mentioned
IF OBJECT_ID('dbo.ConnectedComponents') IS NOT NULL
    DROP PROCEDURE dbo.ConnectedComponents;
GO

CREATE PROCEDURE dbo.ConnectedComponents
AS
BEGIN
    DECLARE @CurrentComponentID INT = 1;
    DECLARE @CurrentPaperID INT;

    -- Insert initial seed
    INSERT INTO #Queue
    SELECT TOP 1 paperID, @CurrentComponentID FROM nodes WHERE paperID NOT IN
(SELECT paperID FROM #Visited);

    WHILE (SELECT COUNT(*) FROM #Queue) > 0
    BEGIN
        -- Dequeue
        SELECT TOP 1 @CurrentPaperID = paperID FROM #Queue;
        DELETE FROM #Queue WHERE paperID = @CurrentPaperID;

        -- Mark as visited
        IF NOT EXISTS (SELECT 1 FROM #Visited WHERE paperID =
@CurrentPaperID)
        BEGIN
            INSERT INTO #Visited (paperID, componentID) VALUES
(@CurrentPaperID, @CurrentComponentID);

            -- Enqueue unvisited adjacent nodes
            INSERT INTO #Queue (paperID, componentID)
            SELECT e.citedPaperID, @CurrentComponentID FROM edges e
```

```
            WHERE e.paperID = @CurrentPaperID AND e.citedPaperID NOT IN
(SELECT paperID FROM #Visited)
            UNION
            SELECT e.paperID, @CurrentComponentID FROM edges e
            WHERE e.citedPaperID = @CurrentPaperID AND e.paperID NOT IN
(SELECT paperID FROM #Visited);
        END

        -- If the queue is empty, move to the next component
        IF (SELECT COUNT(*) FROM #Queue WHERE componentID =
@CurrentComponentID) = 0
        BEGIN
            IF (SELECT COUNT(*) FROM nodes WHERE paperID NOT IN (SELECT
paperID FROM #Visited)) > 0
            BEGIN
                SET @CurrentComponentID = @CurrentComponentID + 1;
                INSERT INTO #Queue
                SELECT TOP 1 paperID, @CurrentComponentID FROM nodes WHERE
paperID NOT IN (SELECT paperID FROM #Visited);
            END
        END
    END;
END;
GO

-- Executed in 51`60 secs
EXEC dbo.ConnectedComponents;

-- Aggregating the component sizes and print components with their sizes and
titles
-- Note ComponentSize and componentID are different
WITH ComponentSizes AS (
    SELECT componentID, COUNT(*) AS ComponentSize
    FROM #Visited
    GROUP BY componentID
    HAVING COUNT(*) > 4 AND COUNT(*) <= 10
)
-- Printing Paper ID and title with component size >4 and  <=10
SELECT v.paperID, n.paperTitle
FROM #Visited v
JOIN ComponentSizes cs ON v.componentID = cs.componentID
JOIN nodes n ON v.paperID = n.paperID
ORDER BY v.componentID, v.paperID;
```

Output: total of 51 rows.

8110,Understanding Skyrmions using Rational Maps
12215,Solitonic fullerene structures in light atomic nuclei
206160,Skyrmed Monopoles
210310,Homotopy of Rational Maps and the Quantization of Skyrmions
9904160,Spherically Symmetric Solutions of the SU(N) Skyrme Models
9611150,Dimensional Renormalization in phi^3 theory: ladders and rainbows

9612010,Weight Systems from Feynman Diagrams
9712140,Non-zeta knots in the renormalization of the Wess-Zumino model?
9805025,A dilogarithmic 3-dimensional Ising tetrahedron
9807125,How useful can knot and number theory be for loop calculations?
9507110,Calogero-Sutherland model from excitations of Chern-Simons vortices
9611185,A Nonrelativistic Chiral Soliton in One Dimension
9706080,Moving Frames Hierarchy and BF Theory
9709075,Chiral solitons from dimensional reduction of Chern-Simons gauged
9712255,Chiral solitons from dimensional reduction of Chern-Simons gauged
9508025,Quasiclassical QCD Pomeron
9511210,Modular Invariance and the Odderon
9611025,Direct solution of the hard pomeron problem for arbitrary conformal
9802100,Solution of the Odderon Problem
9805135,New Results on the Odderon in QCD
9212110,Three Dimensional Chern-Simons Theory as a Theory of Knots and Links III
9312215,Knot invariants from rational conformal field theories
9401095,Chirality of Knots 9_{42} and 10_{71} and Chern-Simons Theory
9607030,Vassiliev Invariants for Links from Chern-Simons Perturbation Theory
9807155,Combinatorial Formulae for Vassiliev Invariants from Chern-Simons Gauge
9812105,Vassiliev Invariants in the Context of Chern-Simons Gauge Theory
304155,Exact String-like Solutions of the Gauged Nonlinear O(3) Model
9303080,Non-Abelian Chern-Simons Quantum Mechanics
9506015,Statistical Mechanics of Non-Abelian Chern-Simons Particles
9507015,Topological and Nontopological Solitons in a Gauged O(3) Sigma Model
9509135,Classical and Quantum Mechanics of Non-Abelian Chern-Simons Particles
9703185,N=2 Supersymmetric Gauged O(3) Sigma Model
9707150,Bogomolnyi Solitons and Hermitian Symmetric Spaces
9805010,On the Gauged Non-compact Spin System
7080,Relativistic scalar Aharonov-Bohm scattering
9402020,Perturbative Bosonic End Anyon Spectra and Contact Interactions
9411175,Aharonov-Bohm Scattering of a Localized Wave Packet: Analysis of the
9502105,FIELD THEORETICAL AND QUANTUM MECHANICAL DESCRIPTIONS OF COLLIDING AND
9510085,Calculation of the Aharonov-Bohm wave function
9603185,The Aharonov-Bohm scattering : the role of the incident wave
9703090,Perturbative Expansion in the Galilean Invariant Spin One-Half
9703200,The Low Energy Limit of the Chern-Simons Theory Coupled to Fermions
9710025,On the Nonrelativistic Limit of the Scattering of Spin One-half
9906170,Radiative Corrections to the Aharonov-Bohm Scattering
3255,Dimensional Transmutation and Dimensional Regularization in Quantum
5195,A differential equation approach for examining the subtraction schemes
9412050,Generalised Point Interactions for the Radial Schrodinger Equation via
9511010,The regulated four parameter one dimensional point interaction
9706070,Non-perturbative regularization and renormalization: simple examples
9904055,Finiteness following from underlying theory: a natural strategy

9906015,Two- and Three-particle States in a Nonrelativistic Four-fermion Model

```
448  -- Printing Paper ID and title with component size >4 and  <=10
449  SELECT v.paperID, n.paperTitle
450  FROM #Visited v
451  JOIN ComponentSizes cs ON v.componentID = cs.componentID
452  JOIN nodes n ON v.paperID = n.paperID
453  ORDER BY v.componentID, v.paperID;
```

Output | Aggregate component ...heir sizes and titles | Result 240 | Result 241

51 rows

	paperID	paperTitle
1	8110	Understanding Skyrmions using Rational Maps
2	12215	Solitonic fullerene structures in light atomic nuclei
3	206160	Skyrmed Monopoles
4	210310	Homotopy of Rational Maps and the Quantization of Skyrmions
5	9904160	Spherically Symmetric Solutions of the SU(N) Skyrme Models
6	9611150	Dimensional Renormalization in phi^3 theory: ladders and rainbows
7	9612010	Weight Systems from Feynman Diagrams
8	9712140	Non-zeta knots in the renormalization of the Wess-Zumino model?
9	9805025	A dilogarithmic 3-dimensional Ising tetrahedron
10	9807125	How useful can knot and number theory be for loop calculations?
11	9507110	Calogero-Sutherland model from excitations of Chern-Simons vortices
12	9611185	A Nonrelativistic Chiral Soliton in One Dimension
13	9706080	Moving Frames Hierarchy and BF Theory
14	9709075	Chiral solitons from dimensional reduction of Chern-Simons gauged
15	9712255	Chiral solitons from dimensional reduction of Chern-Simons gauged
16	9508025	Quasiclassical QCD Pomeron
17	9511210	Modular Invariance and the Odderon

1.2:

Query:

```
IF OBJECT_ID('dbo.pagerankTop10') IS NOT NULL
    DROP PROCEDURE dbo.pagerankTop10;


CREATE or alter PROCEDURE pagerankTop10
AS
BEGIN
    SET NOCOUNT ON;
    -- Declaring variables
    DECLARE @dampingFactor FLOAT = 0.85;
```

```
    DECLARE @convergenceThreshold FLOAT = 0.0001;
    DECLARE @maxIterations INT = 100;
    DECLARE @iteration INT = 0;
    DECLARE @change FLOAT = 1;
    DECLARE @totalNodes INT;
    DECLARE @initialPageRank FLOAT;
    DECLARE @danglingPageRank FLOAT;

    -- Get the total number of nodes
    SELECT @totalNodes = COUNT(*) FROM nodes;
    SET @initialPageRank = 1.0 / @totalNodes;

    -- Prepare PageRank table
    IF OBJECT_ID('tempdb..#pagerank') IS NOT NULL DROP TABLE #pagerank;
    CREATE TABLE #pagerank (
        paperID INT PRIMARY KEY,
        currentRank FLOAT,
        previousRank FLOAT
    );
    INSERT INTO #pagerank (paperID, currentRank, previousRank)
    SELECT paperID, @initialPageRank, 0 FROM nodes;
    IF OBJECT_ID('tempdb..#od') IS NOT NULL DROP TABLE #od;
    CREATE TABLE #od (
        paperID INT PRIMARY KEY,
        outDegree INT
    );
    INSERT INTO #od (paperID, outDegree)
    SELECT paperID, COUNT(*) as outDegree
    FROM edges
    GROUP BY paperID;
    WHILE @iteration < @maxIterations AND @change > @convergenceThreshold
    BEGIN
        SELECT @danglingPageRank = SUM(pr.currentRank)
        FROM #pagerank pr
        LEFT JOIN #od od ON pr.paperID = od.paperID
        WHERE od.outDegree IS NULL OR od.outDegree = 0;
        UPDATE #pagerank SET previousRank = currentRank;
        UPDATE pr SET
            currentRank = (1.0 - @dampingFactor) / @totalNodes +
@dampingFactor * (
                @danglingPageRank / @totalNodes +
                ISNULL((
                    SELECT SUM(linkPR.currentRank / od.outDegree)
                    FROM edges e
                    JOIN #pagerank linkPR ON e.paperID = linkPR.paperID
                    JOIN #od od ON e.paperID = od.paperID
                    WHERE pr.paperID = e.citedPaperID
                ), 0)
            )
        FROM #pagerank pr;
        SELECT @change = SUM(ABS(pr.currentRank - pr.previousRank)) FROM
#pagerank pr;
        SET @iteration = @iteration + 1;
    END

    -- Normalizing PageRank to ensure total is approximately 1
    DECLARE @totalRank FLOAT;
```

```
    SELECT @totalRank = SUM(currentRank) FROM #pagerank;
    UPDATE #pagerank SET currentRank = currentRank / @totalRank;

    -- Returning top 10 PageRank values
    SELECT TOP 10 n.paperID, n.paperTitle, pr.currentRank AS PageRank
    FROM #pagerank pr
    INNER JOIN nodes n ON pr.paperID = n.paperID
    ORDER BY PageRank DESC;
    select top 10 sum(pr.currentRank) from #pagerank pr
    -- Cleanup
    DROP TABLE #pagerank;
    DROP TABLE #od;

    SET NOCOUNT OFF;
END
GO
-- took 1 min 2 sec
EXEC pagerankTop10;
```

Solution:

9504090,Massless Black Holes and Conifolds in String Theory,0.014483501591241628
9510135,Bound States Of Strings And p-Branes,0.014332338497068676
9711200,The Large N Limit of Superconformal Field Theories and Supergravity,0.013720434292142251
9802150,Anti De Sitter Space And Holography,0.009750191349440204
208020,Open strings and their symmetry groups,0.008507365221009602
9602065,D--branes and Spinning Black Holes,0.007546057051157169
9305185,Duality Symmetries of 4D Heterotic Strings,0.0074477986603390224
9611050,TASI Lectures on D-Branes,0.007146338753937785
9501030,Strong/Weak Coupling Duality from the Dual String,0.00571187542765774
9602135,Entropy and Temperature of Black 3-Branes,0.005419288622883694

```
    ORDER BY PageRank DESC;
    select top 10 sum(pr.currentRank) from #pagerank pr
    -- Cleanup
    DROP TABLE #pagerank;
    DROP TABLE #od;

    SET NOCOUNT OFF;
END
GO
-- took 1 min 2 sec
EXEC pagerankTop10;
```

PrintTop10Papers() › pagerankTop10()

Output | Result 272 | Result 272-1-2

10 rows | CSV

	paperID	paperTitle	PageRank
1	9504090	Massless Black Holes and Conifolds in String Theory	0.014483501591241628
2	9510135	Bound States Of Strings And p-Branes	0.014332338497068676
3	9711200	The Large N Limit of Superconformal Field Theories and Supergra…	0.013720434292142251
4	9802150	Anti De Sitter Space And Holography	0.009750191349440204
5	208020	Open strings and their symmetry groups	0.008507365221009602
6	9602065	D--branes and Spinning Black Holes	0.007546057051157169
7	9305185	Duality Symmetries of 4D Heterotic Strings	0.0074477986603390224
8	9611050	TASI Lectures on D-Branes	0.007146338753937785
9	9501030	Strong/Weak Coupling Duality from the Dual String	0.00571187542765774
10	9602135	Entropy and Temperature of Black 3-Branes	0.005419288622883694

Total page rank : 1.0000000000000169

1	1.0000000000000169