AI in Health Care Problem Statements

1. Multi-Modal Surgical Navigation System: Real-time guidance during complex neurosurgery procedures.
   Task: Build an AI system that integrates MRI, CT, ultrasound, and microscopy data for real-time surgical navigation.
   Features:
   - Simultaneously process multiple imaging modalities during surgery
   - Use deep learning for real-time tumor boundary detection and vessel mapping
   - Integrate with robotic surgical systems for haptic feedback
   - Provide augmented reality overlays with sub-millimeter precision
2. Personalized Drug Discovery Platform: End-to-end AI–wet-lab integration with regulatory filters.
   Task: Build a platform that designs novel therapeutic compounds and validates them in vitro under regulatory constraints.
   Features:
   - Automate wet-lab validation via robotic pipetting and automated plate-reader assays
   - Embed regulatory rule engines to screen candidates for toxicity, off-target activity, and patentability
   - Maintain audit trails from in silico design through preclinical validation for submissions
   - Provide end-to-end tracking and reporting for design decisions and lab results
3. Comprehensive ICU Patient State Predictor: Forecast multi-organ failure cascades in critical care.
   Task: Build a system that predicts complex patient deterioration patterns across multiple organ systems.
   Features:
   - Ingest continuous multivariate time-series from 50+ monitoring devices
   - Use transformer networks to model long-term dependencies
   - Predict organ failure sequences 24–72 hours in advance
   - Integrate genomic and biomarker data for personalized risk stratification

4. AI-Powered Precision Oncology Advisor: Recommend optimal treatment combinations based on tumor genetics.
   Task: Build a system that analyzes tumor genomics, proteomics, and patient history for treatment recommendations.
   Features:
   - Process whole-genome sequencing and RNA-seq data in real time
   - Use graph convolutional networks for pathway and network analysis
   - Predict therapy responses with multimodal deep learning
   - Generate personalized combination therapy plans and resistance models
5. Autonomous Medical Laboratory System: Fully automated diagnostics with chain-of-custody, QC anomaly detection, and human-in-loop oversight.
   Task: Build an AI system that manages end-to-end lab workflows, ensures sample integrity, and escalates critical results.
   Features:
   - Maintain immutable digital chain-of-custody records for every sample
   - Implement anomaly detection on QC metrics (e.g., reagent drift) with automated alerts
   - Route flagged or high-risk results to designated experts for review before release
   - Log all human interventions and justification notes in the LIMS
6. Real-Time Epidemic Modeling Platform: Privacy-preserving, bias-aware outbreak simulation at population scale.
   Task: Build a system that models transmission dynamics using secure, equitable data handling.
   Features:
   - Integrate federated learning and differential privacy for mobility and case data
   - Monitor and correct sampling biases using reweighting or causal adjustments
   - Document data sources, privacy guarantees, and bias mitigation methods transparently
   - Enable secure auditability of modeling outputs and policy recommendations

7. Comprehensive Medical Imaging Biomarker Extractor: Automated extraction of quantitative features from multimodal images.
   Task: Build a system that extracts thousands of imaging biomarkers across CT, MRI, PET, and ultrasound.
   Features:
   - Use self-supervised learning for novel feature discovery
   - Implement federated learning across multiple hospital networks
   - Generate prognostic models using radiomic and deep imaging features
   - Provide uncertainty estimates for each extracted biomarker
8. AI-Driven Clinical Trial Design Optimizer: Optimize trial protocols and patient recruitment strategies.
   Task: Build a system that designs adaptive clinical trials and identifies optimal patient cohorts.
   Features:
   - Use reinforcement learning to adapt trial protocols dynamically
   - Analyze electronic health records for patient matching
   - Simulate trial outcomes with digital patient cohorts
   - Optimize endpoints, sample sizes, and randomization schemes
9. Advanced Robotic Rehabilitation System: Personalized physical therapy using AI-guided robotics.
   Task: Build a robotic system that delivers adaptive rehabilitation therapy.
   Features:
   - Use computer vision for real-time motion analysis and correction
   - Implement reinforcement learning for personalized therapy progression
   - Process EMG, force sensors, and motion capture data in tandem
   - Predict recovery trajectories with longitudinal modeling
10. Comprehensive Genomic Health Risk Predictor: Ancestry-calibrated risk scoring with counseling and recontact policies.
    Task: Build a system that calculates personalized lifetime health risks from genomic data with clinical support.
    Features:
    - Calibrate polygenic risk scores across diverse ancestries using transfer learning

- Embed workflows for genetic counselor review and automated report generation
- Implement opt-in recontact policies for significant score updates as evidence evolves
- Maintain audit logs of score recalibrations, counseling sessions, and recontacts

11. AI-Powered Organ Transplant Matching System: Optimize organ allocation using complex compatibility algorithms.
    Task: Build a system that matches organs to recipients using genetic, immunological, and clinical compatibility factors.
    Features:
    - Process HLA typing, cross-matching results, and recipient urgency scores
    - Use deep learning for immunological compatibility prediction
    - Optimize allocation considering geographic constraints and survival probability
    - Generate real-time matching recommendations with rejection risk assessment
12. Medication Adherence Predictor: Identify patients at risk of non-adherence.
    Task: Build a tool that forecasts which patients will miss or stop medications.
    Features:
    - Use demographics, prescription history, and side-effect profiles
    - Apply machine learning to predict adherence probability
    - Generate personalized intervention plans
    - Track adherence over time with automated alerts
13. Faithfulness-Focused Medical Image Report Summarizer: Link summaries to original findings to avoid hallucinations.
    Task: Build a summarizer that anchors each summary sentence to specific report content.
    Features:
    - Use extractive-then-abstractive NLP anchored to report sections
    - Provide interactive links from summary statements back to original report sentences or images
    - Validate summary accuracy with automated consistency checks

- Display confidence scores and provenance for each summary element

14. Chronic Disease Progression Monitor: Track and predict chronic condition trajectories.
    Task: Build a tool to model progression of diseases like diabetes, COPD, or CKD.
    Features:
    - Ingest lab results, vitals, and symptom logs
    - Use survival analysis and recurrent neural networks
    - Predict exacerbations and hospitalization risk
    - Provide personalized self-management advice
15. AI-Powered Medical Coding Assistant: Automate ICD-10 and CPT code assignment.
    Task: Build a system that extracts codes from clinical notes.
    Features:
    - Use NLP for entity recognition and relation extraction
    - Map extracted entities to billing codes with confidence scores
    - Flag potential miscoding and suggest corrections
    - Integrate with EHR workflows
16. Personalized Exercise Prescription System: Recommend safe exercise plans for patients.
    Task: Build a tool that generates tailored workout programs based on medical history.
    Features:
    - Use rules and ML models for risk stratification
    - Adjust intensity and duration dynamically
    - Monitor performance with wearable integration
    - Provide progress tracking and safety alerts
17. Medical Equipment Predictive Maintenance: Forecast failures in hospital devices.
    Task: Build a system that predicts when equipment needs service.
    Features:
    - Analyze usage logs, sensor data, and maintenance records
    - Use time-series and anomaly detection models

- Generate maintenance schedules with cost optimization
- Alert staff to high-risk equipment

18. Sub-Second Clinical Decision Support for Emergency Medicine: Low-latency, auditable reasoning with medico-legal safeguards.
    Task: Build a decision support tool that delivers recommendations in under 250ms with full audit trails.
    Features:
    - Architect pipelines for <250ms inference latency
    - Record complete reasoning chains in tamper-evident logs
    - Flag high-risk recommendations for secondary human review
    - Embed consent tracking and post-hoc review workflows for legal compliance
19. Pharmacy Drug Interaction Checker: Detect dangerous medication combinations.
    Task: Build a system that identifies and explains potential drug–drug interactions.
    Features:
    - Use graph algorithms on drug interaction networks
    - Provide severity ratings and management advice
    - Integrate over-the-counter and herbal supplements
    - Offer alternative medication suggestions
20. Wound Healing Progress Tracker: Monitor chronic wounds using image analysis.
    Task: Build a system that assesses wound healing from photographs.
    Features:
    - Use computer vision to segment wound and measure dimensions
    - Predict healing timelines with ML models
    - Recommend treatment adjustments based on progress
    - Generate patient and clinician reports
21. Personalized Cancer Treatment Response Predictor: Forecast individual therapy outcomes based on tumor and patient genetics.
    Task: Build a system that predicts treatment responses for oncology patients.
    Features:

- Accept tumor biopsy results, genetic markers, and treatment history
- Use machine learning to predict response probabilities for different therapies
- Generate personalized treatment rankings with expected outcomes
- Monitor treatment response and update predictions over time

22. Hospital Infection Risk Predictor: Forecast healthcare-associated infection risk.
    Task: Build a model that predicts patient infection risk in real time.
    Features:
    - Ingest patient comorbidities, procedures, and environmental data
    - Use ML for risk stratification
    - Generate personalized prevention protocols
    - Track infection clusters for outbreak detection
23. Telemedicine Quality Assessor: Evaluate telehealth consultations for quality metrics.
    Task: Build a system that analyzes video, audio, and documentation.
    Features:
    - Use NLP to assess consultation completeness
    - Apply computer vision to detect non-verbal cues
    - Score quality and highlight improvement areas
    - Provide clinician feedback dashboards
24. Medical Training Simulator: Generate realistic AI-driven patient case scenarios.
    Task: Build an educational platform for medical trainees.
    Features:
    - Use NLG to create diverse case narratives
    - Simulate vital sign changes over time
    - Adapt scenario difficulty based on learner performance
    - Provide analytics on decision pathways
25. AI-Enhanced Pathology Diagnosis Assistant: Support pathologists with image analysis and diagnostic suggestions.
    Task: Build a system that assists pathologists in analyzing histopathology samples.
    Features:

- Process high-resolution histopathology images and patient clinical data
- Use computer vision for cellular pattern recognition and abnormality detection
- Generate diagnostic suggestions with confidence levels and supporting evidence
- Provide second-opinion analysis for complex or rare cases

26. Healthcare Resource Allocation Optimizer: Balance staffing and supplies.
    Task: Build a system to optimize allocation of staff, beds, and equipment.
    Features:
    - Use optimization algorithms on historical usage data
    - Predict demand surges (e.g., flu season)
    - Recommend staffing levels and supply orders
    - Visualize resource utilization trends
27. Simple Allergy Alert System: Highlight patient allergies in EHRs.
    Task: Build a basic alert tool for allergy–medication conflicts.
    Features:
    - Match allergy lists against prescribed drugs
    - Display visual alerts in patient charts
    - Generate printable allergy summary cards
    - Allow clinicians to confirm or override alerts
28. Intelligent Medication Dosing Optimizer: Calculate optimal drug dosages based on individual patient factors.
    Task: Build a system that personalizes medication dosing using pharmacokinetic modeling and patient characteristics.
    Features:
    - Accept patient weight, age, kidney/liver function, and genetic variants
    - Use pharmacokinetic models to predict drug levels over time
    - Calculate personalized dosing regimens with safety margins
    - Monitor therapeutic levels and suggest dose adjustments
29. Medical Appointment Reminder System: Send automated patient reminders.
    Task: Build a scheduler for appointment notifications.
    Features:

- Support SMS, email, and phone calls
- Allow patients to confirm, cancel, or reschedule
- Track reminder delivery and response rates
- Optimize send times for maximal recall

30. AI-Powered Medical Emergency Triage System: Automatically prioritize patients in emergency departments based on severity.
    Task: Build a system that assesses patient urgency and assigns appropriate triage levels in emergency settings.
    Features:
    - Accept vital signs, chief complaints, and observable symptoms
    - Use machine learning to classify emergency severity levels
    - Generate triage scores with recommended wait times and interventions
    - Alert staff to critical cases requiring immediate attention