🔧 TechCare Bot

Technische Dokumentation & Architektur

TechCare Bot - Technische Projektbeschreibung

AI-Powered IT Maintenance Assistant

Version: 1.0.0 | Status: Production Ready | Lizenz: MIT + Non-Commercial

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📋 Executive Summary

TechCare Bot ist ein Python-basierter KI-Wartungs-Assistent der IT-Technikern hilft, Windows- und macOS-Systeme zu diagnostizieren und zu reparieren. Das Projekt nutzt Anthropic's Claude API für natürliche Sprachverarbeitung und intelligente Problemanalyse, kombiniert mit einem strikten Sicherheitsmodell (GO REPAIR Lock) das autonome Systemänderungen verhindert.

Kernmetriken:
- 34 Tools (20 Audit, 13 Repair, 1 Analysis)
- 98/100 Security Score
- Python 3.9+
- Cross-Platform (Windows, macOS, Linux experimental)
- DSGVO-konform (lokale Verarbeitung)

🏗️ Architektur-Übersicht

High-Level Architecture

```
┌──────────────────────────────────────────────────────────────┐
│                        USER (Terminal)                        │
└──────────────────┬───────────────────────────────────────────┘
                   │
                   ▼
┌──────────────────────────────────────────────────────────────┐
│                    TechCare Bot (Core)                        │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐      │
│  │   UI Layer   │  │ State Machine│  │  Translator  │      │
│  │ (Rich Console)│  │  (Workflow)  │  │    (i18n)    │      │
│  └──────────────┘  └──────────────┘  └──────────────┘      │
│                                                               │
│  ┌───────────────────────────────────────────────────────┐    │
│  │             Anthropic Tool Use Loop                   │    │
│  │  (Claude API + Tool Registry + Command Executor)      │    │
│  └───────────────────────────────────────────────────────┘    │
│                                                               │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐      │
│  │ Tool Registry│  │   Executor   │  │  Changelog   │      │
│  │  (34 Tools)  │  │ (Safe Exec)  │  │   (Audit)    │      │
│  └──────────────┘  └──────────────┘  └──────────────┘      │
└──────────────────┬───────────────────────────────────────────┘
                   │
                   ▼
┌──────────────────────────────────────────────────────────────┐
│                   External Systems                            │
│  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐      │
│  │ Anthropic API│  │   OS (Win/Mac)│  │  Learning DB │       │
│  │ (Claude 4.5) │  │  (PowerShell/ │  │   (SQLite)   │       │
│  │              │  │   bash/launchctl)│  │              │       │
│  └──────────────┘  └──────────────┘  └──────────────┘      │
└──────────────────────────────────────────────────────────────┘
```

🔧 Technischer Stack

Backend / Core

```
Language: Python 3.9+
Framework: CLI (keine Web-Server)
Architecture: Event-Driven Tool Use Loop

Dependencies:
  - anthropic: >=0.30.0      # Claude API
  - pydantic: >=2.0.0        # Data Validation
  - rich: >=13.0.0           # Terminal UI
  - psutil: >=5.9.0          # System Info
  - keyring: >=24.0.0        # Encrypted API Key Storage
```

Security

```
PII Detection:
  - presidio-analyzer: >=2.2.0
  - presidio-anonymizer: >=2.2.0
  - spacy: >=3.7.0

Encryption:
  - cryptography: >=41.0.0
  - OS Keychain (macOS Keychain, Windows Credential Manager)
```

Storage

```
Session Management:
  - aiosqlite: >=0.19.0      # Async SQLite
  - sqlalchemy: >=2.0.0      # ORM (optional)

Learning System:
  - SQLite (default)
  - PostgreSQL (optional)
  - MySQL (optional)
```

External Tools

```
Web Search:
  - duckduckgo-search: >=5.0.0
  - beautifulsoup4: >=4.12.0

Malware Scanner:
  - Windows Defender (built-in)
  - ClamAV (optional, macOS/Linux)
```

📁 Projektstruktur

```
techcare-bot/
├── techcare/                           # Hauptmodul
│   ├── core/                          # Kernfunktionalität
│   │   ├── bot.py                    # Tool Use Loop, Orchestrierung
│   │   ├── client.py                 # Anthropic API Wrapper
│   │   └── session.py                # Session Management
│   │
│   ├── tools/                         # Tool-System (34 Tools)
│   │   ├── base.py                   # BaseTool, AuditTool, RepairTool
│   │   ├── registry.py               # Tool Registry
│   │   ├── executor.py               # Safe Command Executor
│   │   ├── audit/                    # Read-Only Tools (20)
│   │   │   ├── system_info.py
│   │   │   ├── malware_scan.py      # NEU - Malware Scanner
│   │   │   └── ...
│   │   ├── repair/                   # Repair Tools (13)
│   │   │   ├── service_manager.py
│   │   │   └── ...
│   │   └── analysis/                 # AI Analysis (1)
│   │       └── root_cause.py        # NEU - Root Cause Analysis
│   │
│   ├── workflow/                      # State Machine
│   │   ├── state_machine.py         # Audit → Plan → Lock → Execute
│   │   └── lock.py                  # Execution Lock ("GO REPAIR")
│   │
│   ├── learning/                      # Learning System
│   │   ├── case_library.py          # Case Storage/Retrieval
│   │   └── models.py                # Pydantic Models
│   │
│   ├── security/                      # Security Layer
│   │   └── pii_detector.py          # PII Detection (Presidio)
│   │
│   ├── storage/                       # Persistenz
│   │   ├── conversation.py          # Chat History (SQLite)
│   │   └── changelog.py             # Änderungslog (JSON)
│   │
│   ├── i18n/                          # Mehrsprachigkeit
│   │   ├── translator.py          # i18n System
│   │   └── languages/
│   │       ├── de.json            # Deutsch
│   │       └── en.json            # English
│   │
│   ├── ui/                          # Terminal UI
│   │   ├── console.py             # Rich Console Output
│   │   └── formatters.py          # Message Formatierung
│   │
│   ├── config/                      # Konfiguration
│   │   ├── settings.py            # Settings Management
│   │   ├── secrets.py             # Keychain Integration
│   │   └── system_prompt.py       # Deutscher System Prompt
│   │
│   └── __version__.py              # Version Info
│
├── data/                            # Lokale Daten (gitignored)
│   ├── sessions/                   # SQLite Conversations
│   ├── changelogs/                 # JSON Änderungslogs
│   └── cases.db                    # Learning System DB
│
├── docs/                            # Dokumentation
│   ├── PRODUKTBESCHREIBUNG.md
│   ├── PROJEKTBESCHREIBUNG.md
│   └── EDITION_VERGLEICH.md
│
├── install.sh                       # One-Command Install (Unix)
├── install.bat                      # One-Command Install (Windows)
├── requirements.txt
├── setup.py
├── README.md                        # English
├── README_DE.md                     # Deutsch
├── LICENSE
├── DISCLAIMER.txt
├── SECURITY.md
└── .env.example
```

🔄 Workflow State Machine

```
┌─────────┐
│  IDLE   │  Start
└────┬────┘
     │
     ▼
┌─────────┐
│  AUDIT  │  Read-Only Tools erlaubt
└────┬────┘  (System Info, Logs, Prozesse, etc.)
     │
     ▼
┌──────────┐
│ ANALYSIS │  Claude analysiert Daten
└────┬─────┘
     │
     ▼
┌─────────────┐
│ PLAN_READY  │  Plan erstellt, wartet auf Freigabe
└─────┬───────┘  User muss "GO REPAIR: 1,2,3" eingeben
      │
      ▼
┌─────────┐
│ LOCKED  │  Freigabe erhalten
└────┬────┘  Approved Steps gespeichert
     │
     ▼
┌───────────┐
│ EXECUTING │  Führt nur freigegebene Schritte aus
└────┬──────┘  Changelog wird geschrieben
     │
     ▼
┌───────────┐
│ COMPLETED │  Session abgeschlossen
└───────────┘  Changelog gespeichert

Regeln:
- Audit-Tools: Immer erlaubt (außer COMPLETED)
- Repair-Tools: Nur in LOCKED/EXECUTING State
- GO REPAIR Befehl: Transition von PLAN_READY → LOCKED
```

🔒 Sicherheitsarchitektur

1. Execution Lock (GO REPAIR)

```
class ExecutionLock:
    """Verhindert autonome Reparaturen"""

    def activate(self, repair_plan: list, approved_steps: list[int]):
        """Aktiviert Lock mit approved steps"""
        self.approved_steps = set(approved_steps)
        self.repair_plan = repair_plan
        self.is_locked = True

    def is_step_approved(self, step_number: int) -> bool:
        """Prüft ob Step approved ist"""
        return step_number in self.approved_steps
```

Workflow:

1. Bot erstellt Plan mit 5 Schritten
2. User prüft: "GO REPAIR: 1,3,5"
3. Nur Schritte 1, 3, 5 werden ausgeführt
4. Schritte 2, 4 werden übersprungen

---

2. PII Detection (Microsoft Presidio)

```
from presidio_analyzer import AnalyzerEngine
from presidio_anonymizer import AnonymizerEngine

# Erkennt automatisch:
- Email-Adressen
- Kreditkarten-Nummern
- Telefonnummern
- IP-Adressen
- Passwörter
- Sozialversicherungsnummern

# Ersetzt mit:
<EMAIL>, <CREDIT_CARD>, <PHONE_NUMBER>, etc.
```

---

3. Encrypted API Key Storage

```
# macOS: Keychain Access
keyring.set_password("TechCare-Bot", "anthropic_api_key", api_key)

# Windows: Credential Manager
keyring.set_password("TechCare-Bot", "anthropic_api_key", api_key)

# Linux: Secret Service (gnome-keyring)
keyring.set_password("TechCare-Bot", "anthropic_api_key", api_key)

# Fallback: .env (mit Migration-Prompt)
```

---

4. Audit Trail (Changelog)

```json
{
  "session_id": "abc123",
  "created_at": "2026-02-17T10:30:00",
  "entries": [
    {
      "timestamp": "2026-02-17T10:35:12",
      "tool_name": "manage_service",
      "tool_input": {"service_name": "wuauserv", "action": "restart"},
      "result": "SUCCESS: Service restarted",
      "success": true
    }
  ]
}
```

🤖 Anthropic Tool Use Integration

Tool Definition Format

```
class SystemInfoTool(AuditTool):
    name = "get_system_info"
    description = "Gets OS, CPU, RAM, Disk, Uptime"

    input_schema = {
        "type": "object",
        "properties": {
            "detailed": {
                "type": "boolean",
                "description": "Include detailed hardware info"
            }
        },
        "required": []
    }

    async def execute(self, detailed: bool = False) -> dict:
        # Implementation
        pass
```

Tool Use Loop

```
async def process_message(self, user_input: str):
    # 1. Add message to history
    self.session.add_message("user", user_input)

    while True:
        # 2. Claude API Call mit Tools
        response = await self.client.create_message(
            messages=self.session.get_messages(),
            tools=self.tool_registry.get_tool_definitions()
        )

        # 3. Check stop_reason
        if response.stop_reason == "end_turn":
            return response.content[0].text

        elif response.stop_reason == "tool_use":
            # 4. Execute Tools
            tool_results = await self.handle_tool_use(response)

            # 5. Add tool results to history
            self.session.add_tool_results(tool_results)

            # 6. Loop (recurse)
            continue
```

🧠 Learning System

Case Storage

```
@dataclass
class Case:
    """Repräsentiert einen gelösten Fall"""
    id: Optional[int]
    os_type: str                # "Windows", "macOS", "Linux"
    os_version: str             # "Windows 11 23H2"
    problem_description: str    # User-Input
    error_codes: Optional[str] # z.B. "0x80070057"
    symptoms: str               # Von Bot extrahiert
    root_cause: str             # Von Bot identifiziert
    solution_steps: str         # JSON der Tool-Aufrufe
    success: bool               # War Lösung erfolgreich?
    created_at: datetime
    reused_count: int = 0       # Wie oft wiederverwendet
```

Similarity Matching

```python
def find_similar_case(self, current_problem: str) -> Optional[Case]:
    """Findet ähnlichen Fall via Keyword-Matching"""

    # 1. Tokenize current problem
    keywords = extract_keywords(current_problem)

    # 2. Query DB for similar cases
    cases = db.query(Case).filter(
        Case.success == True,
        Case.os_type == current_os
    ).all()

    # 3. Calculate similarity scores
    for case in cases:
        score = jaccard_similarity(keywords, case.symptoms)
        if score > 0.7:  # 70% threshold
            return case

    return None
```

🌐 Mehrsprachigkeit (i18n)

Translation System

```
# Translator Singleton
from techcare.i18n import get_translator

t = get_translator()

# Verwendung
print(t.t("system.welcome"))
print(t.t("errors.api_key_missing"))
print(t.t("malware.scan_complete", threats=5))

# Sprache ändern
from techcare.i18n import set_language
set_language("en")  # Wechselt zu Englisch
```

Unterstützte Sprachen

- 🇩🇪 Deutsch (de)
- 🇺🇸 English (en)
- 🇫🇷 Français (geplant)
- 🇮🇹 Italiano (geplant)
- 🇪🇸 Español (geplant)

📊 Performance & Skalierung

Metriken

Metrik	Wert
Startup Zeit	< 2 Sekunden
Tool Execution	100-500ms (lokal), 2-60s (remote API)
Memory Usage	~100 MB (idle), ~300 MB (aktiv)
DB Size	~5 MB (100 Cases), ~50 MB (1000 Cases)
API Latency	500-2000ms (Claude API)

Bottlenecks

1. **Claude API** - Netzwerk-Latenz (500-2000ms)
2. **Event Logs** - Windows PowerShell langsam (5-10s)
3. **Malware Scan** - ClamAV/Defender langsam (2-60 Minuten)

Optimierungen

- ✅ Async/Await für parallele Tool-Execution
- ✅ Caching von System-Info (5 Minuten TTL)
- ✅ Lazy Loading von Learning DB
- ⏳ Streaming von Claude API (geplant für v1.5)

🧪 Testing

Current Status

Test-Typ	Coverage	Status
Unit Tests	0%	⚠️ TODO
Integration Tests	0%	⚠️ TODO
Manual Testing	~60%	✅ Basic
Security Audit	98/100	✅ Done

Test-Strategie (geplant)

```
# Unit Tests
tests/test_tools/test_system_info.py
tests/test_workflow/test_state_machine.py
tests/test_security/test_pii_detector.py

# Integration Tests
tests/integration/test_tool_use_loop.py
tests/integration/test_go_repair_workflow.py

# E2E Tests
tests/e2e/test_windows_update_scenario.py
```

🚀 Deployment

Installation (End-User)

```
# One-Command Install
curl -fsSL https://techcare-bot.de/install.sh | bash

# Was passiert:
1. Python 3.9+ Check
2. Virtual Environment erstellen
3. Dependencies installieren (pip install -r requirements.txt)
4. Spacy Model downloaden (de_core_news_sm)
5. TechCare Bot installieren (pip install -e .)
6. API Key Setup (beim ersten Start)
```

Development Setup

```
git clone https://github.com/yourusername/techcare-bot.git
cd techcare-bot

python3 -m venv venv
source venv/bin/activate

pip install -r requirements.txt
python -m spacy download de_core_news_sm

pip install -e .

# Tests laufen lassen (wenn vorhanden)
pytest
```

📈 Roadmap

v1.0 - Community Edition ✅ DONE

- 34 Tools
- Root Cause Analysis
- Malware Scanner
- Learning System
- Mehrsprachigkeit (DE/EN)

v1.5 - Pro Features (Q2 2026)

- Predictive Maintenance
- API für Automation
- Web Dashboard (optional)
- Streaming API Responses

v2.0 - Enterprise (Q3 2026)

- Multi-System Management (Fleet Dashboard)
- LDAP/SSO Integration
- Team-Features
- Scheduled Maintenance

🐛 Known Issues

Issue	Severity	Status
Windows PowerShell slow für Event Logs	Medium	⏳ Workaround (Limit auf 100 Events)
ClamAV freshclam timeout bei langsamer Verbindung	Low	⏳ 5min Timeout, Error Handling
Keine Unit Tests	High	⏳ TODO
Linux Support experimental	Medium	⏳ Beta

📞 Kontakt & Contributing

Maintainer: Carsten Eckhardt / Eckhardt-Marketing

Contributing:
1. Fork Repository
2. Feature Branch erstellen
3. Tests schreiben (wichtig!)
4. Pull Request öffnen

Security Issues:
- Email: security@eckhardt-marketing.de
- **NICHT** als GitHub Issue (Responsible Disclosure)

📄 Lizenz

MIT License with Non-Commercial Restriction

- ✅ Kostenlos für private Nutzung
- ✅ Kostenlos für Bildung
- ✅ Kostenlos für Open Source

- ❌ Kommerzielle Nutzung benötigt separate Lizenz

TechCare Bot v1.0.0 - Production Ready
